2 Mile Slope Remediation

Review of Environmental Factors

Transport for NSW | March 2022

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Transport for NSW | March 2022

Prepared by GHD Pty Ltd and Transport for NSW

Document controls

Approval and authorization

Title	2 Mile Slope Remediation review of environmental factors
Accepted on behalf of Transport for NSW by:	
Signed:	
Dated:	

Executive summary

The proposal

Transport for NSW is proposing to stabilise and rehabilitate a section of the roadside slope (Slope #17552) along the “2 mile” stretch of Jenolan Caves Road at Jenolan which was subject to slope failure following extensive rainfall in 2021. Key features of the proposal include:

- Installation of soil nails into the slope which was subject to failure to stabilise the slope
- Installation of drainage infrastructure within the impacted section of slope
- Installation of surface stabilisation including shotcrete with a high quality mock rock texture finish sympathetic to the surrounding environment
- Establishment of construction compound and stockpile sites at Kanangra Walls Road intersection and Car Park 1 and 2 at Jenolan Caves.

Need for the proposal

The proposal is required due to a slope failure which occurred following extensive rainfall experienced in March 2021. The failure has resulted in a safety risk to users of Jenolan Caves Road which has resulted in the section of road below the failure to be closed to the public. Access into the Jenolan Caves Precinct is available by foot or shuttle bus. However, this arrangement has the potential to limit access for some members of the community, particularly those who are less mobile.

The proposal is therefore critically required to enable the reopening of Jenolan Caves Road thus restoring access directly into the precinct. This would benefit the businesses operating within the precinct as it would increase the visitation due to improved access, particularly for those who are less mobile to which the temporary arrangements may not be desirable. The proposal would also allow access to a range of other projects planned to occur in the Jenolan Caves Precinct and surrounding area, which under the current restricted access are unable to get all required equipment and materials in to allow the works to commence.

Proposal objectives

The objectives of the proposal include:

- Stabilise the existing failed slope profile which occurred in March 2021
- 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 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 Jenolan Caves Road would be required to remain closed, 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 - Gabion Wall or other retaining wall support structures
- Option 2 - Soil nails and shotcrete
- Option 3 - Soil nails and shotcrete hidden by architectural panels or suitable covering
- Option 4 - Regrading the slope

- Option 5 - Soil nails with mesh and erosion mat.

The preferred method of stabilisation for the slope is the installation of a soil nail wall with shotcrete (Option 2). Option 2 was the most constructible option, with Options 1 and 3 resulting in substantial constructability issues due to the limited space at the base of the slope (existing roadway) from which construction of these options could be undertaken. Options 3 and 5 also resulted in substantial structures which are difficult to maintain and integrate into the surrounding visual landscape, and Option 4 would result in substantial changes to the angle of the hillside landscape.

Statutory and planning framework

The proposal is categorised as development for the purpose of road infrastructure facility and is being carried out by or on behalf of a public authority. Under section 2.108 of *State Environmental Planning Policy (Transport and Infrastructure) 2021* (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 *Environmental Planning and Assessment Act 1979* (EP&A Act). 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, 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 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 the rain event in 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 been undertaken between all three determining authorities to discuss the proposed options for stabilising the failed slope. Consultation has also been undertaken with Heritage NSW with regards to the suitability of the proposal in reducing any impacts on the State Heritage Listed Jenolan Caves Reserve.

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 about 0.29 hectares of vegetation mapped as PCT 870 Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion
- Minor visual impacts during construction and operation to a listed heritage item 'Jenolan Caves House', located within the Jenolan Caves Reserve which is listed on the NSW State Heritage Register, overall impacts on the Jenolan Caves Reserve State Heritage listing is not considered to be impacted upon
- Short term noise and air impacts as a result of the operation of construction equipment

- Potential partial road closures or road adjustments during construction, including complete removal of access to the Jenolan Caves Precinct at times.

Justification and conclusion

The proposal is considered to be justified as it would allow the reopening of the section of Jenolan Caves Road which is currently restricted to a small number of movements and with the public unable to use this section of the road. The reopening of the road would benefit the businesses within the Jenolan Caves Precinct as it would increase the visitation to restore access to all users, particularly for those who are less mobile to which the temporary arrangements may not be desirable.

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 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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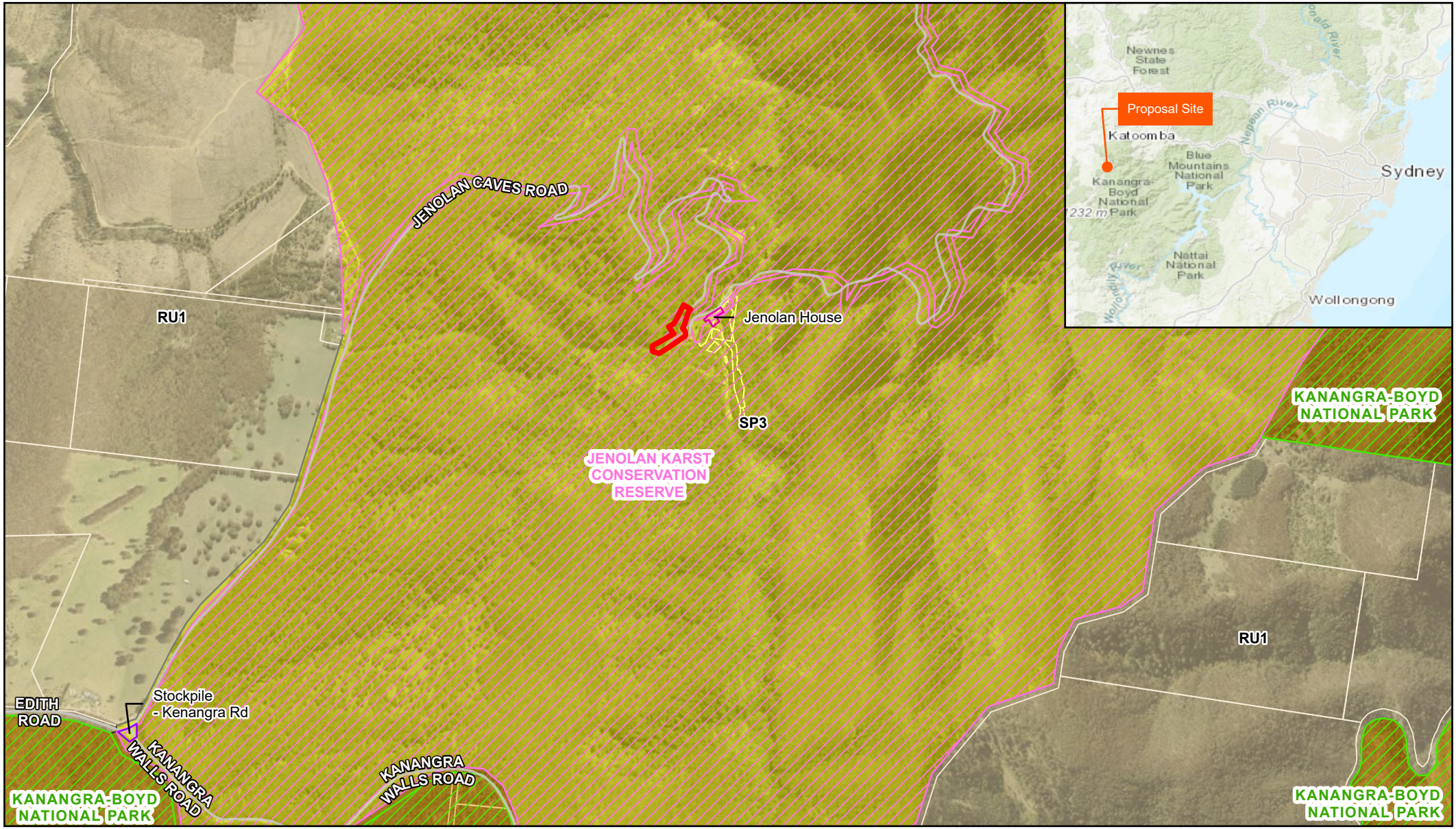
1. Introduction

1.1 Proposal identification

Transport for NSW is proposing to stabilise and rehabilitate a section of the roadside slope (Slope #17552) along the “2 mile” stretch of Jenolan Caves Road at Jenolan which was subject to slope failure following extensive rainfall in 2021. Key features of the proposal include:

- Installation of soil nails into the slope which was subject to failure to stabilise the slope
- Installation of drainage infrastructure within the impacted section of slope
- Installation of surface stabilisation including shotcrete with mock rock texture finish
- Establishment of construction compound and stockpile sites at Kanangra Walls Road intersection and Car Park 1 and 2 at Jenolan Caves.

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.



Legend

- Proposal site
- Stockpile - Kenangra Rd
- Jenolan House
- National Park
- Conservation Reserve

Zoning

- E1 National Parks and Nature Reserves
- RU1 Primary Production
- SP3 Tourist

Paper Size ISO A4

0 180 360 540 720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Transport for NSW
2 Mile Slope Remediation
Review of Environmental Factors

Project No. **12561560**
Revision No. **A**
Date **27/10/2021**

Location of the proposal

FIGURE 1-1

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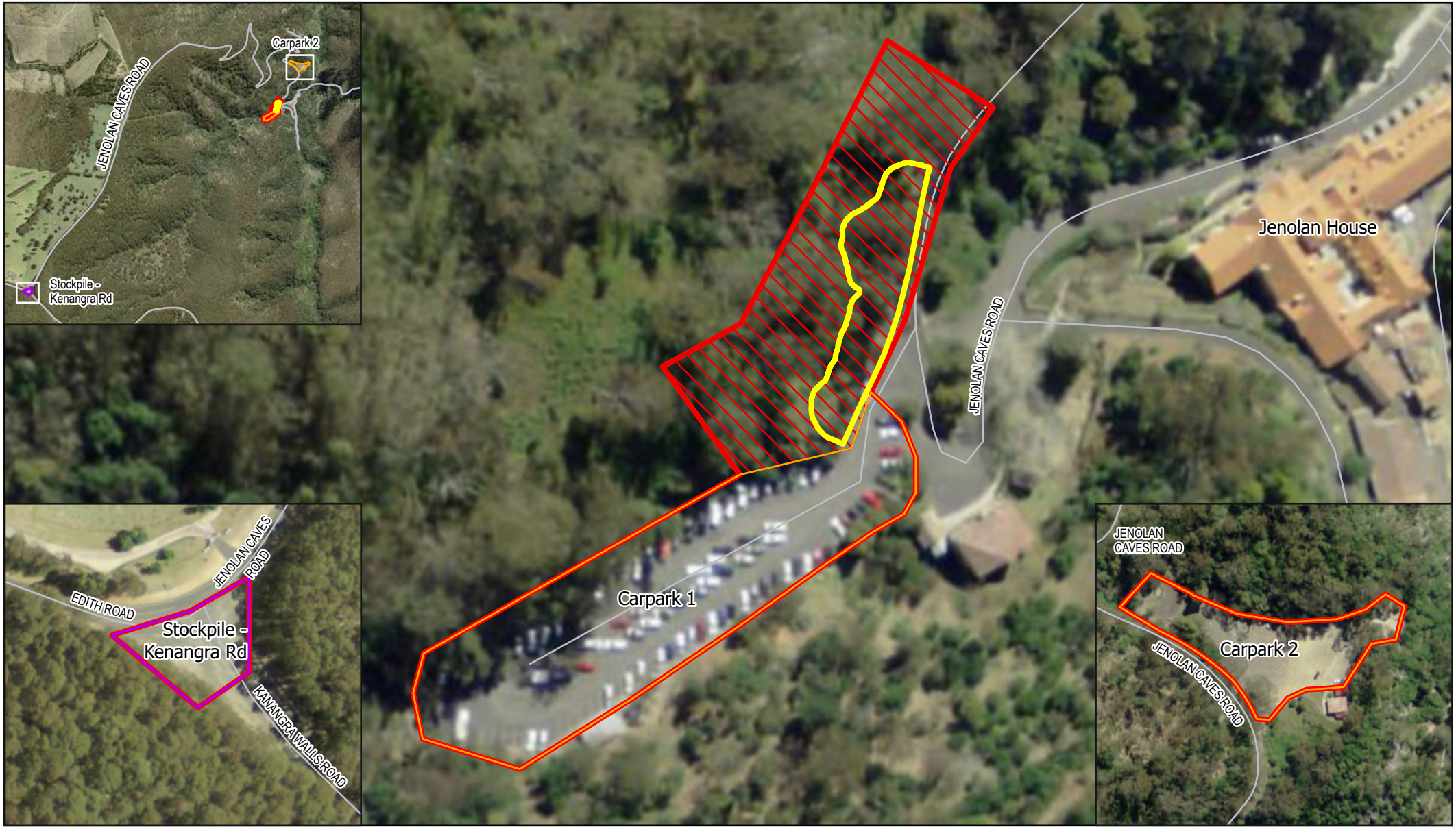
Print date: 27 Oct 2021 - 14:53

Data source: LPI: DCDB/DTDB, 2017; World Topographic Map: Esri, HERE, Garmin, FAO, USGS sixmaps/LPI_Imagery_Best: © Department of Customer Service 2020. Created by: bkaemmerling



Legend

- Indicative extent of proposed soil nail works
- Construction Area
- Carpark
- Stockpile - Kenangra Rd
- Total footprint

Paper Size ISO A4

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Transport for NSW
2 Mile Slope Remediation
Review of Environmental Factors

The proposal

Project No. **12561560**
Revision No. **A**
Date **27/10/2021**

FIGURE 1-2

\\ghdnet\ghd\AU\Orange\Projects\21\12561560\GIS\Maps\12561560_2_Mile_Slope_Remediation_REF\REF_A.aprx
Print date: 27 Oct 2021 - 16:05

Data source: GHD: Site Features, 2021; LP: DCDB/DTDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Customer Service 2020. Created by: bkaemmerling

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 these works, Transport for NSW is the proponent and Transport for NSW, NSW National Parks and Wildlife Service (NPWS) and the Jenolan Caves Reserve Trust are the determining authorities 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 undertaken 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, NPWS and Jenolan Trust 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 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 (EIS) to be prepared and approval to be sought from the Minister for Planning 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 the 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 Agriculture, Water and the Environment for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

2. Need and options considered

2.1 Strategic need for the proposal

The proposal is needed because of safety issues associated with the failure of the slope adjacent to the Jenolan Caves Road during extensive rainfall experienced in March 2021. While some emergency clearing works 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 of the slope, there is a potential risk of further slope failure. The temporary measures currently in place has some restrictions for the public to access to the Jenolan Caves Precinct (including Jenolan Caves, Jenolan Caves House and Jenolan Caves Mountain Lodge) with vehicular access not available into the precinct for the public due to safety risks associated with the impacted section of road.

The proposal would assist in meeting road safety objectives outlined in several NSW Government strategic plans including the Long-Term Transport Master Plan (Transport for NSW, 2014). The proposal would ensure that movements along this section of road can be undertaken in a safe manner with a reduced risk of further slope failures which impact the ability to use the road and the safety of road users.

The Central West and Orana Regional Plan 2036 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 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 works required to stabilise these areas. With the closure of the eastern access indefinitely, access from Oberon (from the west) is currently the only access to the Jenolan Caves Precinct. The slip which occurred at the proposal site has resulted in public access through this area being removed, thus resulting in vehicular access for the public into the precinct not being possible. Public access into the precinct requires visitors to park in car park 2 and either walk 600 metres into the precinct or to catch the provided shuttle bus. This change in access has the potential to impact on the use of the precinct due to the inconvenience caused by this arrangement particularly for less mobile visitors or for access during periods of adverse weather.

Due to the above access issues, the proposal is required to ensure that vehicular access into the Jenolan Caves Precinct can be restored to aid in the continued use of this key tourism facility within the Oberon LGA.

2.2 Limitations of existing infrastructure

Following the failure of the slope at the proposal site in March 2021, Transport for NSW installed a continuous series of concrete barriers along the toe of the slope and soil debris was placed against the toe of failed slopes at some locations to improve temporary stability and to reduce the likelihood of further slumping of the cutting. This temporary measure to support the slope is not considered to be a long-term solution due to the ongoing safety risk and resulting access issues.

2.3 Proposal objectives and development criteria

2.3.1 Proposal objectives

The objectives of the proposal include:

- stabilise the existing failed slope profile which occurred in March 2021

- 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 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 of the proposal 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 works 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 event in March 2021, which necessitated the requirement for the proposal, site inspections and discussions were undertaken 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. Descriptions of the key features of each option are provided in section 2.4.2.

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

2.4.2 Identified options

Proposal options

Option 1 – Do nothing

This option involves not undertaking any further works beyond the initial emergency response as described in section 2.2. This option would involve the ongoing use of the emergency temporary measures (concrete barriers along toe of slope and the resulting access restrictions) put in place following the failure of the slope in March 2021.

Option 2 – Stabilisation of area subject to slope failure

This option would involve the permanent stabilisation of the failed slope to ensure that the risk of any further failures is reduced and to allow the road to be fully opened as per prior to the failure event. The methodology for slope stabilisation was noted to be constrained by the restricted site geometries. A review of options for stabilising the slope are presented below.

Method of stabilisation

Option 1- Gabion Wall or other retaining wall support structures

This option involves excavation into the existing slope and construction of a gabion or retaining wall structure to stabilise the slope and prevent it from further slumping and debris falling onto Jenolan Caves Road.

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 with a mock rock finish as a substitute to standard shotcrete faces used adjacent to many roads.

Option 3- Soil nails and shotcrete hidden by architectural panels or suitable covering

This option is the same as Option 2 with the inclusion of architectural panels or suitable covering to standard shotcrete faces used adjacent to many roads.

Option 4- Regrading the slope

This option involves excavation of soil and regrading the existing slope to a suitable gradient.

Option 5- Soil nails with mesh and erosion mat

This option involves the installation of soil nails into the failed slope and the installation of erosion control mat over the slope.

2.4.3 Analysis of options

Proposal options

Option 1

The ‘do nothing’ option is not considered to be 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. The temporary measures also represent an impact on the significance of the precinct from both a heritage and biodiversity viewpoint.

The ‘do nothing’ would also not improve access into the Jenolan Caves Precinct as the existing temporary access arrangements (shuttle bus or walking from Car Park 2) would likely remain in place due to the safety risks of using this section of Jenolan Caves Road. The continued prevention of access into the precinct for vehicles would potentially limit access for some people in the community, particularly those who are less mobile and for which changing vehicles into the shuttle bus or the walk down a steep path is difficult. The importance of reopening the section of road subject to the proposal is further intensified due to the alternate access from the east unlikely being reopened soon due to the level of works required to rectify the damage caused by slope failures in these locations.

The ‘do nothing’ option would also result in a partially exposed slope to be left insitu which poses an ongoing risk for water quality in watercourses downstream as unstable sediment on the slope (including sediment from any further slope failures) would be at greater risk of mobilization without any more permanent stabilisation works.

Option 2

Option 2 is a viable option as it stabilises the existing embankment thus reducing the risk of further slope failures which have the potential to impact upon Jenolan Caves Road. The stabilisation of the slope would also allow for the impacted section of Jenolan Caves Road to be reopened, allowing vehicular access into the Jenolan Caves Precinct. This would provide some 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.

Method of stabilisation

Option 1

Option 1 was considered to have substantial constructability issues due to the limited space located at the base of the failed slope, with the existing road providing the only available land from which the wall could be constructed. Due to the height of the wall required, the base of this wall type is required to be large which within the limited space would require a significant temporary cut to construct the wall. This temporary cut has the potential to further destabilise the slope during construction. The wall would also result in visual impacts which would not be consistent with the existing visual landscape.

Option 2

Option 2 can be constructed within the limited space available with the installation of the soil nails able to be undertaken within the extent of the existing road below the failed slope. This option also involves the least civil works, thus reducing the costs of the works. The treatment of the slope face with mock rock also allows the look of the new slope face to be consistent with other rock outcrops in the area, thus making the new slope more consistent with the surrounding visual landscape.

Options 3

Option 3 was considered to have substantial constructability issues due to the undulating slope of the hill, which would make it difficult to install panels without additional excavation. The limited space located at the base of the failed slope would also restrict equipment access for panel installation. The panels would also restrict access and long-term slope management would be required including ongoing inspections and maintenance.

Option 4

Option 4 was considered to have substantial constructability issues due to the extensive amount of excavation required which would decrease the slope angle of the entire hillside.

Option 5

Option 5 was not considered a suitable treatment due to the soil composition of the slope and concern for further erosion of soil and additional failures between the individual soil nails.

2.5 Preferred option

2.5.1 Proposal options

The preferred option was to undertake remediation works which would improve safety along the section of Jenolan Caves Road subject to this slope failure, which would allow it to be reopened to the public, thus improving access to the Jenolan Caves Precinct including reinstating public vehicular access into the precinct.

2.5.2 Method of stabilisation

The preferred method of stabilisation for the slope is the installation of a soil nail wall with shotcrete. The preferred option (Option 2) was the most constructible option, with Options 1 and 3 resulting in substantial constructability issues due to the limited space at the base of the slope (existing roadway) from which construction of these options could be undertaken. Options 3 and 5 also resulted in substantial structures which are difficult to maintain and integrate into the surrounding visual landscape, and Option 4 would result in substantial changes to the angle of the hillside landscape. Overall, Option 2 was considered the

preferred option as it best balanced the geotechnical, access, environment (including heritage specifically) need of the locality while also allowing works to be undertaken in a timely manner to allow the reopening of the road and subsequently the Jenolan Caves Precinct.

3. Description of the proposal

3.1 The proposal

Transport for NSW is proposing to stabilise and rehabilitate a section of the roadside slope (Slope #17552) along the “2 mile” stretch of Jenolan Caves Road at Jenolan which was subject to slope failure following extensive rainfall in 2021. Key features of the proposal include:

- Installation of soil nails into the slope which was subject to failure to stabilise the slope
- Installation of drainage infrastructure within the impacted section of slope
- Installation of surface stabilisation including shotcrete with mock rock texture finish
- 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. Detailed design drawings are included in Appendix A.

3.2 Design

3.2.1 Design criteria

The design of the proposal was undertaken 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 are as follows:

- 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 works.
- Area of the slope failure forms part of a much larger slope which extends beyond the already disturbed areas in all directions (both upslope and across the slope) meaning that access around the disturbed area is not practicable due to risk of further slope failure. This limits access for construction to the area below the failed slope.
- Access to the slope failure area from upslope of the failure is limited due to topography issues and the risk of further failures. These risks mean that all works are required to be undertaken from Jenolan Caves Road. However, the area along the road is further limited to just the roadway itself due to another slope located directly east of the roadway. This limited work area means only relatively small plant and equipment can be used thus limiting methods which can be employed for the proposal.

3.2.3 Environmental constraints

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

- Surrounding precinct is heritage listed including on the State Heritage register and, therefore, 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
- Position of the site within the Sydney Water Drinking Catchment making it sensitive to changes in water quality
- Importance to maintain access into the precinct to allow ongoing tourism activities
- Positioning of the slope failure area partially 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 Proposal zones

The proposal site has been split into two distinct areas with each of the areas showing differing levels of failure, thus requiring different levels of rehabilitation.

Table 3-1 provides an overview of the two zones which have been considered as part of the design. The location of these two zones is shown in Figure 3-1.

Table 3-1 Summary of zones within proposal site

Characteristic	Zone 1	Zone 2
Maximum height	9.5 metres	13.5 metres
Depth of soil	5.5 metres	3.5 metres
Overview of failed slope	Failure in this zone is superficial and consists of four areas with one of these areas being a historic failure and the remaining three occurring in 2021. Much of the soil material is yet to have mobilised on this slope.	Large scale failure with 90 per cent of the zone having failed. The large failure results in a more uniform failure.

3.2.5 Major design features

Soil nail wall

The proposal would involve the installation of indicatively about 259 soil nails into the failed slope. The positioning and length of nails would be dependent on their position within each of the zones outlined in section 3.2.3.

Table 3-2 outlines the indicative spacing and length of soil nails within each of the two zones. As outlined in Table 3-2, soil nails within Zone 1 would differ in length for the lower and upper slope due to differing depths of soil material above the bed rock.

Table 3-2 Indicative spacing and length of soil nails

Design element	Zone 1 (lower)	Zone 1 (upper)	Zone 2
Length of nails	5.5 metres	8 metres	6 metres
Number of rows	3	4	Up to 7

Design element	Zone 1 (lower)	Zone 1 (upper)	Zone 2
Horizontal spacing	1.5 metres	1.5 metres	1.5 metres
Vertical spacing	1.5 metres	1.5 metres	2 metres

The wall would include the installation of drainage infrastructure (discussed below) with the face of the wall to consist of shotcrete applied across the entire face of the slope.

A typical elevation of the proposed soil nail wall including the spacing of the soil nails is provided within Appendix A. Appendix A also includes typical cross sections of the proposed soil nail arrangement within each of the two zones.

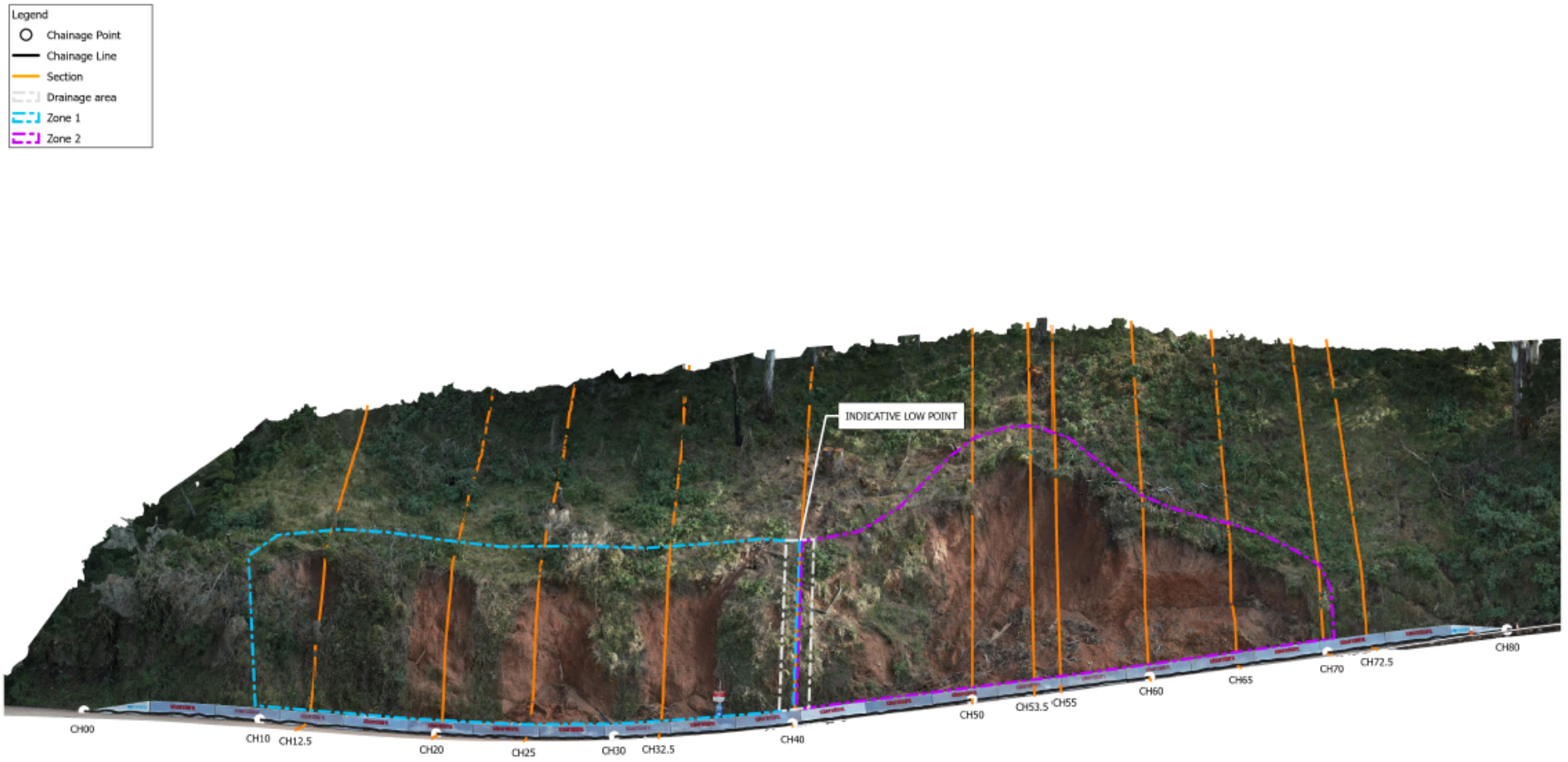


Figure 3-1 Remediation elevation and zoning

Mock rock treatment

Due to the positioning of the wall in a visually sensitive environment (due to heritage and natural features), the use of plain shotcrete as the final treatment for the wall was not considered a viable option. The final surface would be treated with a high-quality mock rock surface finish which will be developed to match other rock outcrops located in the local area, resulting in the new wall integrating better within the visual landscape.

Figure 3-2 and Figure 3-3 provide examples of the final mock rock treatment implementation in areas near the proposal. The final treatment of the wall would be determined in consultation with Heritage NSW as part of the heritage approvals required for the proposal.

Figure 3-2 Example of mock rock along Jenolan Caves Road at Hampton

Figure 3-3 Example of mock rock at Windamere Slope

Drainage infrastructure

Table 3-3 outlines the drainage infrastructure that is proposed to be installed as part of the proposal to manage water in the vicinity of the wall. These works are not considered to impact upon any heritage significance drainage infrastructure which currently exists on the site. All new drainage infrastructure would drain to existing box drains located along Jenolan Caves Road, with water then managed as per the existing situation.

Table 3-3 Indicative drainage infrastructure

Drainage type	Overview of drainage
Horizontal drains	Drains to be drilled perpendicular to the slope face in two rows located between the first, second and third row of nails at four metre intervals. Appendix A includes indicative arrangement of these drains.
Flexible strip filter drains	Drains to be installed on a 45 degree angle across the face of the slope behind the shotcrete at about three metre intervals. Appendix A includes an indicative arrangement of these drains.
Crest drain	Drain would be installed along the crest of the wall to capture any localised surface water flows. Drain would be formed with shotcrete. Water would then be diverted to a low point in the wall where it would run down the face of the wall into the existing box drain located along Jenolan Caves Road.

3.3 Construction activities

3.3.1 Work methodology

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 methodology for the proposal is provided below.

Early works and site establishment

- Relocate 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 works going outside the approved work area
- Install traffic management measures including temporary traffic signs and roadside safety barriers (where required)
- Undertake face scaling, excavation and removal of vegetation (including stump grinding) within area of proposed soil nail wall
- Mark out soil nail locations.

Stabilisation works

- Install specified nails at nominated locations and conduct suitability testing
- Install horizontal and strip drains and install shotcrete layer
- Install steel wire mesh, face plates and tension nails
- Apply shotcrete and finish with mock rock texture and conduct suitability testing.

Demobilisation of construction site

- Rehabilitate disturbed areas (as required) including existing road surface along Jenolan Caves Road where damage has occurred because of the proposal
- Decommissioning 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 15 personnel per day. The final number of construction workers would be identified by the construction contractor.

3.3.3 Construction hours and duration

Where possible, construction would be undertaken during recommended standard hours as outlined in the Interim Construction Noise Guideline (DECC 2009). The proposal would be undertaken Monday to Friday between 7am and 6pm in accordance with the recommended standard hours for construction. The exception to this would be that works would be completed by 4pm Friday to allow the reopening of the Jenolan Caves Precinct for the weekend. Works are not proposed to be undertaken on weekends or public holidays with access along Jenolan Caves Road required past the proposal site to allow shuttle buses into the Jenolan Caves Precinct which would be open to the public from Friday afternoon and over the weekend.

It is anticipated that most of the construction would be carried out during the above hours. However, out-of-hours work may be required. Any out-of-hours work times would be confirmed by the contractor, and any work undertaken outside of standard working hours would be in accordance with the Transport for NSW Construction Noise and Vibration Strategy ST-157/4.1 (Transport for NSW, 2020). No less than seven days prior notification would be given to the community regarding work hours. Seven days notification would also be provided to NPWS and JCRT prior to any weekend or public holiday works, if required.

Construction of the proposal is expected to commence in April 2022. The works are expected to take about 14 weeks to complete.

3.3.4 Plant and equipment

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

- Elevated work platform
- Excavator (long reached version likely)
- Dump trucks
- Soil nail drill rig
- Shotcrete spray rig
- Cement trucks
- Light vehicles (utes/cars).

Final selection of equipment would be required to consider that access to the site is limited by the tight curves located along Jenolan Caves Road.

3.3.5 Earthworks

To ensure safety during construction, the existing slope within Zone 1 which is currently at about 70 to 80 degrees from horizontal is required to be adjusted to about 60 degrees. Works in Zone 2 would be limited to minor regrading and the removal of loose material

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 slope as well as removal of any stumps which were left following removing any trees located on the slope following the failure.

Based on the assumption that about half a metre of material would be excavated from across the face of the slope, a total of approximately 325 cubic metres of material would be excavated during the earthworks and 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 tested if 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 at an appropriately licenced facility.

3.3.6 Source and quantity of materials

Most materials would be sourced from a local licensed supplier. Table 3-4 outlines the indicative quantities of materials required for the construction of the proposal. These would be confirmed by the construction contractor, with further materials potentially required.

Table 3-4 Indicative quantity of materials required

Material	Quantity
Soil nails	Total of 259 soil nails consisting of the following: • 88 eight metre long nails • 105 six metre long nails • 66 5.5 metre long nails.
Shotcrete (including for mock rock facing)	1,300 square metres
Horizontal drains	103 metres
Strip filter drains	231 metres

3.3.7 Traffic management and access

Access to the proposal site

Existing access

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

Following the rainfall events during March 2021, access from the east (a section of Jenolan Caves Road known as '5 mile') was closed due to several slope failures including several sections of road being washed away. This requires extensive works to reinstate the access from this direction and such works are considered to occur outside the program for the proposal.

Access from the west is available until about 400 metres north of the proposal site with access to the public not available past the proposal site due to safety issues. With current restriction for public access into the Jenolan Caves Precinct, when open, visitors are required to park in Car Park 2 located north of the proposal site. From there, visitors may use the shuttle bus provided or walk from the car park to facilities located within the Jenolan Caves Precinct to the south through existing tracks/paths. Access into the Jenolan Caves Precinct past the proposal site is limited to a small number of movements required to service the Jenolan Caves Precinct and associated businesses and facilities. However, the number of movements is expected to increase as other projects within the precinct begin.

Proposed changes to access

The closure of Jenolan Caves Road would occur either at Kanangra Walls Road (with local traffic allowed beyond this point to access properties) or at a point 1.6 kilometres north of Kanangra Walls Road (which would be at the last property requiring access) to allow the works to be undertaken as part of the proposal. These closures may coincide with other works by others along Jenolan Caves Road west of the Jenolan Caves Precinct.

Closures would be limited to Monday to Friday with the road to reopen on Friday afternoon to provide access to the Jenolan Caves Precinct which would be open to the public during the weekend. Access into the Jenolan Caves Precinct would remain as per the existing situation with visitors to use Car Park 2 with access into the Jenolan Caves Precinct using the shuttle bus or walking.

The use of Car Park 2 as a construction compound would be managed in a way that ensures adequate parking is provided for visitors on weekends.

Notification of works and any pending road closures would be undertaken 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. Around six heavy vehicles movements are anticipated per day, however, during peak periods such as during shotcreting activities this could increase to around 10 heavy vehicle movements per day. Further light vehicle movements would be required to allow for staff accessing the proposal site. Light vehicle movements are anticipated to be about 30 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 Traffic Control at Work Sites Technical Manual (Transport for NSW, 2020) and Roads and Maritime Specification G10 - Control of Traffic (RTA, 2006) and included in the CEMP. 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.

Access through the proposal site would be maintained for Jenolan Caves staff and associated movements, and emergency services. Access will also be provided for required vehicles for other projects within the precinct. Due to the limited space, movements would be undertaken under traffic control and contra-flow arrangements. Consultation with the Jenolan Caves Trust would be undertaken to confirm access requirements to ensure that movements through the proposal site can occur when required. Emergency response and evacuation plans would also be developed in consultation with all relevant stakeholders to ensure safe passage through the proposal site in the event of an emergency.

3.4 Ancillary facilities

3.4.1 Construction compound and stockpile sites

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

- Car Park 1 – located south of the failed slope directly adjacent to the proposal site
- Car Park 2 – located north of the failed slope 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 1-2.

These areas would be utilised primarily as stockpile locations; however, a site office would potentially be established in Car Park 1. The use of each area would be dependent on the materials required 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 required.

Where possible, the use of Car Park 2 would be limited to weekdays only with the site cleared of any construction equipment and materials by 4pm Friday to allow this car park to be used for visitor parking as per the existing access arrangements to the Jenolan Caves Precinct. The use of the Kanangra Walls Road site would be subject to similar restrictions with stockpiling in this sensitive area to be limited and not left on

site over weekend periods. Stockpiling at the Kanangra Walls Road site would not impact on vehicular traffic along Kanangra Walls Road.

Site specific management plans would be developed for each of the proposed stockpile areas outlining 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 is not considered to impact upon any public utilities based on the information reviewed to date and, therefore, adjustments are not required. Prior to the commencement of works, further investigations would be undertaken to confirm the presence of any currently unidentified utilities.

In the event utility relocations are identified and they are located outside the proposal site, consultation with the Transport for NSW Senior Environmental Officer would be undertaken to seek advice regarding 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 NPWS and Jenolan Caves Reserve Trust. Therefore, no property acquisition would be required 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 2.108 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* and requires authorisation by or under the 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 prior to the commencement of certain types of development. 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

Chapter 8 of *State Environmental Planning Policy (Biodiversity and Conservation) 2021* (Biodiversity and Conservation SEPP) relates to the use of land within the Sydney Drinking Water Catchment. The proposal is located within the Mid Coxs River sub-catchment of the Sydney Drinking Water Catchment.

Section 8.11 of the Biodiversity and Conservation SEPP requires consideration of 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. A neutral or beneficial effect assessment is included in Appendix D. The assessment concludes that the proposal would have a beneficial effect on water quality.

4.1.2 Oberon Local Environmental Plan 2013

The proposal site is located within the Oberon LGA 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 minimise the risk of further landslips which may result in access to Jenolan Caves being 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 works under the Oberon LEP as the works are erosion protection works and would protect land from environmental degradation (that is, further landslips). Such works are 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 (Infrastructure) 2007.'* We note that on 1 March 2021, *State Environmental Planning Policy (Infrastructure) 2007* was repealed. The provisions of *State Environmental Planning Policy (Infrastructure) 2007* were consolidated into Chapter 2 of the Transport and Infrastructure SEPP. To this this the above mention of *State Environmental Planning Policy (Infrastructure) 2007 is taken to be* Chapter 2 of the Transport and Infrastructure SEPP.

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 even though the proposal is development without consent under the Oberon LEP.

Heritage

Section 5.10 of the Oberon LEP relates to heritage items to which this section applies. The proposal site is located within the following areas considered to have heritage significance under the Oberon LEP:

- Jenolan Caves Heritage Conservation Area
- Jenolan Caves Archaeological site.

Jenolan Caves House, The Six Foot Track and Limestone Bridge (near Grand Arch) 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.

The proposal is permissible under the NPW Act in accordance with Section 39 of the NPW Act which states that the reservation of land does not impact the uses permitted under existing interest. Given the road and the associated modified slope (that is, the cutting) are considered existing interests, the proposal is therefore considered permissible under the NPW Act.

Table 4-1 outlines the consistency of the proposal with the objects of the NPW Act, while Table 4-2 outlines the consistency of the proposal against the management principles for a karst conservation area. The proposal is considered to be consistent with both the objects of the act and the management principles for a karst conservation area.

In accordance with Section 81(4) of the NPW Act, all works within National Parks estate must be in accordance with the plan of management for the relevant park or reserve. The proposal is considered to be consistent with the Jenolan Karst Conservation Reserve Plan of Management which establishes the permissibility of the proposal as Jenolan Caves Road is identified as the main public access into the park and therefore works to maintain this road are considered permissible.

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 4-1 Consistency with the Objects of the *National Parks and Wildlife Act 1974*

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. Where possible, impacts are proposed to be limited to the area subject to slope failure in March 2021 which is largely cleared of any vegetation. Impacts on biodiversity are discussed further in section 6.3.
(ii) biological diversity at the community, species and genetic levels, and	The proposal is not considered to reduce the biodiversity in the locality with impacts likely to be limited to areas already disturbed as a result of the slope failure. Impacts on biodiversity are discussed further in section 6.3.
(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 slope which has been subject to slope failure and poses further risk for additional failure 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	As outlined in section 6.6, the likelihood of Aboriginal heritage items is considered limited due largely to the past disturbance of the site firstly in construction of the road cutting and also the recent slope failure.
(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.

Object	Consistency with object
(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 in Appendix G.
(c) 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 clause 30I of the NPW Act) are detailed in Table 4-2

Table 4-2 Consistency with the management principles for karst conservation area

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 which currently poses a potential risk to further slips which would result in impacts on water quality in downslope areas. Overall, the project (during both construction and operation) would not result in any reduction in the conservation of the karst environment.
(b) the conservation of cultural values,	The proposal would not result in any Aboriginal heritage impacts as the site is considered to be heavily disturbed due to construction of the road and the recent slope failure. The proposal is located within the curtilage of the Jenolan Caves Reserve State Heritage Listing. The proposal has been designed to minimise the impacts on this listing.

Management principles	Consistency with principles
	This is discussed further in section 6.6 and in Appendix G.
(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.
(d) the conservation of biodiversity, the maintenance of ecosystem function, the protection of the geological and geomorphological features and natural phenomena and the maintenance of natural landscapes, cave formations and fossil deposits,	Impacts on native vegetation in the proposal site would be minimised where possible. Where possible, impacts are proposed to be limited to the area subject to slope failure in March 2021 which is largely cleared of any vegetation. Impacts on biodiversity are discussed further in section 6.3. The proposal would also reduce the risk of further slips in the area which has the potential to impact upon vegetation.
(e) provision for research and monitoring,	The proposal involves the stabilisation of an existing slope which provides access into the Jenolan Caves and thus reopening this road would improve 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 provide access into the Jenolan Caves Precinct which would allow the ongoing public appreciation of the caves through existing tourist facilities located in the precinct.
(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 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 Jenolan Caves.
(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.

Authorisation of works encroaching onto National Parks estate

Where works are located on National Parks estate, authorisation from NPWS in accordance with the NPW Act is required to be obtained prior to works commencing. NPWS are required to assess the 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 outlined in Table 4-3.

Table 4-3 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 a slope failure. The stabilisation of the slope has been undertaken in a manner that seeks to maintain natural and cultural values, as outlined in sections 6.3 and 6.7, respectively.
2. Sustainable resource use	The proposal is considered to sustainably use resources. The proposal is not expected to utilise any substantial volumes of water or electricity.
3. Appropriate built form and scale	The development of the proposal, as detailed in section 2.4, has taken into account selecting a preferred option which has an appropriate built form for the highly sensitive environment and to ensure the new wall 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 adjacent to Jenolan Caves Road, where a slope failure (also referred to as a landslide) has occurred. The stabilisation of the slope 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 failure both within the impacted areas and in adjacent areas, thus 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 the existing vehicular access into the Jenolan Caves Precinct which would ensure that access can once again meet the precinct requirements and would reinstate full access which 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 retaining structure has 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. The stabilisation of the slope 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 works 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 his 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 works being located within the State Heritage curtilage. A section 60 application is, therefore, to be submitted for the proposed works.

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 B and Chapter 6 of this REF.

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.

The proposal would not impact upon any nationally listed threatened species, endangered ecological communities or migratory species. Potential impacts to these biodiversity matters are considered in section 6.1.

The assessment of the proposal's impact on matters of national environmental significance and the environment of Commonwealth land found that there is unlikely to be a significant impact on relevant matters of national environmental significance or on Commonwealth land. Accordingly, the proposal has not been referred to the Australian Government Department of Agriculture, Water and the Environment under the EPBC Act.

The proposal is located adjacent to the Greater Blue Mountains World Heritage Area (GBMWHA). The proposal will not have an impact on this listing, as outlined in section 6.7 and Appendix G.

4.3.2 Native Title Act 1993

The *Native Title Act 1993* (Native Title Act) recognises and protects native title. The Native Title 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 Native Title 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 undertaken, with no Native Title holders/claimants identified. No Future Acts also apply to the proposal site.

The proposal site is, however, located on land which is subject to an Indigenous Land Use Agreement (ILUA) held with the Gundungurra people. As Transport for NSW is not a signatory of the ILUA, no consultation has been undertaken to date. Given that the proposal is unlikely to result in any environmental or social impacts, Transport for NSW do not propose to undertake any consultation. NPWS and JCRT would undertake consultation in accordance with the ILUA, if considered required.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of road infrastructure facility and is being carried out by or on behalf of a public authority. Under section 2.108 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.

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 Community involvement

Community consultation specific to the proposal has not been undertaken to date, however, communication has been ongoing with regards to the status of impacts on Jenolan Caves Road because of the damage cause by the rain event in March 2021.

5.2 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 25 November by Transport for NSW Aboriginal Cultural Heritage Advisor.

Based on the Stage 1 PACHCI preliminary assessment results for the Jenolan Caves Road 2-mile Remediation, the proposal is unlikely to have an impact on Aboriginal cultural heritage. No consultation with the Aboriginal community is required.

5.3 Consultation in accordance with the Transport and Infrastructure SEPP

A review of the proposal against the consultation requirements outlined in the Transport and Infrastructure SEPP has been undertaken, as shown in Appendix C. This review concluded that no consultation was required. Consultation with NPWS is a requirement of Transport and Infrastructure SEPP due to the works proximity to a national park or reserve, however NPWS been involved in consultation to date, consultation is not considered to be required.

5.4 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.

Consultation has been undertaken with Heritage NSW with regards to the impacts on the Jenolan Caves Reserve State Heritage listing. This consultation has included discussion with regards to the approvals required and the mitigation of impacts including the final treatment of the proposed wall. The NSW Heritage Council have requested examples of how shotcrete would be applied to blend into the existing environment. Test panels are to be created prior to the application of shotcrete for consideration and approval by Heritage NSW and Transport for NSW.

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

5.5 Ongoing or future consultation

Ongoing consultation would be undertaken 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 proposal as well as other works in the locality, including with any property owners who would be in the closed sections of road once confirmed
- Notification of periods during which the Jenolan Caves Precinct would be closed to the public
- Notification of measures put in place to maintain access to the Jenolan Caves Precinct when the precinct is open.

All consultation and notification to the community would be undertaken in advance of works occurring.

Ongoing consultation with Heritage NSW would be undertaken in relation to the approvals required for the proposal as well as to determine the final treatment of the mock rock wall.

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) as required under section 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 Soils

A geotechnical investigation was undertaken to identify the geotechnical conditions and inform the design. The findings of the geotechnical investigation and field work have been summarised in this chapter.

6.1.1 Existing environment

Topography and geology

The topography of the proposal site is characterised as narrow crests and steep to precipitous side slopes and elevations ranging from 820 and 850 metres above sea level.

The site is underlain by the Ordovician to Early Silurian aged Campbells Group and comprises a number of rock types including interbedded cherty siltstone, sandstone and andesite. Observations made during a site visit by GHD in June 2021 confirmed that the rocks exposed in parts of the cutting comprised of andesite (GHD 2021).

Soil

The proposal site falls under the classification of two soil landscape profiles. The eastern area of the site belongs to the Kanangra Gorge soil profile and the western area falls under the Jenolan Caves soil landscape profile (eSpade 2020).

For most of the proposal site, the slope and roadway have been excavated into the colluvial soil profile located near the toe of a ridgeline that slopes down towards the south-east. The geotechnical profile of the proposal site comprised of gravelly clay/clayey gravel colluvium material with cobbles up to about 100 millimetres in diameter. The geotechnical conditions and observations made during the site investigation identified two distinct zones based on overall depth of colluvial material which is remaining within the area of the slope failure. The development of the design is based on these geotechnical conditions and is discussed in section 3.2.3.

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

Contamination

A search of the EPA contaminated sites land record and notifications on 16 September 2021 for the suburb of Jenolan indicated no contaminated land notifications have been received by the EPA in the vicinity of the proposal site.

6.1.2 Potential impacts

Construction

Construction of the proposal would require 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 receiving waterways including tributaries of 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 safeguards and management measures provided in section 6.1.3 would be implemented to manage the potential for erosion and sedimentation impacts and potential soils contamination during construction. The potential for water quality impacts due to sedimentation is considered in section 6.2.3.

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.

6.1.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Accidental spill	An Incident Emergency Spill Plan will be developed and incorporated in the CEMP. The plan will include measures to avoid and manage spillages of fuels, chemicals, and fluids onto any surfaces and an emergency response procedure.	Contractor	Pre-construction
Erosion and sediment control	An Erosion Sediment Control Plan will be developed as part of the CEMP in accordance with the *Blue Book 'Managing Urban Stormwater. Soils and Construction- Volume 1, 4th Edition* (Landcom, 2004).	Contractor	Pre-construction
Contaminated land	If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed.	Contractor	Construction
Sediment transported off site	All stockpiles will be designed, established, operated and decommissioned in accordance with the RTA's Stockpile Management Procedures.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Excavated material/spoil	A contamination assessment and waste classification report will be required to assess the environmental and human health risks as well as potential for material reuse or disposal in accordance with the POEO Act	Contractor	Construction
Heavy rainfall management	Weather conditions will be monitored daily, and no works will be conducted if there is an imminent threat of a heavy rainfall event. In the event of a rainfall event, works will cease if there is a risk of sediment loss off site or ground disturbance due to waterlogged conditions.	Contractor	Construction

6.2 Water

6.2.1 Existing environment

Surface water

The study area is characterised by several waterways and tributaries. The proposal site is also located about 340 metres west of Blue Lake, which is a manmade body of water that is connected to the River Styx and Jenolan River.

The Jenolan River is located about 300 metres east of the proposal site, and about 30 metres east of the proposed construction compound located at Car Park 2. Surveyors Creek flows south-west away from the proposal site and a tributary of Camp Creek is located about 115 metres west of the proposal site.

Flooding

A desktop search of the Jenolan Caves study area on DPE spatial viewer was undertaken on 16 September 2021. The search has not identified the site to be in a flood planning area and is not on land 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 risk for poor water quality is increased due to unstabilised areas in the catchment.

Groundwater

A search of WaterNSW groundwater map on 16 September 2021 has identified no groundwater bores present at the proposal site or within about 1.2 kilometres of the proposed site. A search of the Groundwater Dependant Ecosystems (GDE) Atlas on 16 September 2021 identified the waterways adjacent to the proposal site as having a high potential GDE.

Aquifers in this landscape are unconfined to semi-confined with vertical groundwater flow occurring through fractured bedrock and saprolite. Minor lateral flow occur through colluvial sediments on lower slopes and hydraulic conductivity and transmissivity are moderate. The groundwater flow systems are local with short flow lengths.

6.2.2 Potential impacts

Construction

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.

A Neutral or Beneficial Effect assessment has been undertaken (refer Appendix D) to determine the impacts of the works on water quality due to the proposal site being located within the Sydney Drinking Water Catchment. This assessment concluded that the project would have a neutral or beneficial effect on water quality within the Sydney Drinking Water Catchment.

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.

Surface water

The proposal would result in some short-term changes to existing surface water movements, due to the excavation, scaling and construction of drainage infrastructure 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.

Operation

Operation of the proposal is expected to improve surface water flows from the face of the hillside and prevent staining and undermining of the crest. Flows would not be impacted as the management of water would continue to direct flows to the stormwater system along Jenolan Caves Road.

6.2.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Erosion and sedimentation	Soil and water management will be 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. Soil and water management would be undertaken to address the following, but not limited to: • Roads and Maritime Services Code of Practice for Water Management, the Roads and Maritime Services' Erosion and Sedimentation Procedure • Roads and Maritime Services Technical Guideline: Temporary Stormwater Drainage for Road Construction, 2011	Contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	• Roads and Maritime Services Technical Guideline: Environmental Management of Construction Site Dewatering, 2011		
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
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 spillages of fuels, chemicals, and fluids into any stormwater inlets and an emergency response procedure.	Contractor	Construction
Contamination of soils and waterways	Vehicle wash downs and/or concrete truck washouts will be undertaken within a designated bunded area on an impervious surface or undertaken off-site	Contractor	Construction
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
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

6.3 Biodiversity

6.3.1 Methodology

A desktop review was undertaken on 28 September 2021 to identify potential threatened flora and fauna species, populations, and ecological communities listed under the BC Act and EPBC Act that are expected to occur in the proposal site. The review was based on previous records, known distribution ranges and habitats present. No site surveys have been undertaken.

A search of the NSW SEED Portal on 28 September 2021 identified an inconsistency in the Plant Community Type (PCT) mapped within the proposal site. The mapped PCT 1853- *Blue Mountains Gorges Grey Gum Sheltered Forest* is not registered on the NSW Bionet Vegetation Classification database. A review of available resources was undertaken by a GHD ecologist, and PCT 870-*Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion* was identified as the most accurate PCT to represent the vegetation mapped within the proposal site. The PCT vegetation mapping is shown on Figure 6-1, and the community profile report for PCT 870 is provided in Appendix E.

6.3.2 Existing environment

The study area is mapped within the Jenolan Karst Conservation Reserve. The proposal site is however located within the World Heritage Listed Greater Blue Mountains Area, which comprises of the conservation reserve and other National Parks and reserves in the Blue Mountains.

The proposal site and surrounding area is mapped as PCT 870-*Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion*. The Blue Mountains Gorges Grey Gum Sheltered forest is a tall eucalypt forest found on steep protected slopes in major gorges, valleys

and escarpments of the dry western Blue Mountains. It forms localised stands underneath major cliff lines and along escarpment water courses. The PCT is not listed as endangered or critically endangered under the BC Act or EPBC Act and no threatened species have been identified within the site.

A two kilometre search of the Department of Environment Protected Matters Online Search Tool for matters of national environmental significance (MNES) listed under the EPBC Act was undertaken on 16 September 2021. The search identified three listed threatened ecological communities, 37 listed threatened species and 13 listed migratory species.

The proposal site consists of the existing road corridor and hill side that was subject to slope failure which caused damage and removed most of the native vegetation located within the proposal site. The previously mapped vegetation on the hill slope is shown in Figure 6-1.

Due to the degraded nature of the site and proximity to the road corridor, it is unlikely that any threatened fauna species occur within the proposal site. The site has the potential to be frequented by common fauna species on occasion.

A search of the Department of Primary Industries Fisheries spatial portal identified the Jenolan River, Surveyors Creek and Camp Creek as Key Fish Habitat, however the proposal does not result in any direct impacts to these watercourses.

Legend

- Indicative extent of proposed soil nail works
- Construction area
- Carpark 1
- Total footprint

Plant Community Type

- PCT 870-*Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion* (formally PCT 1853)

Paper Size ISO A4

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Transport for NSW
2 Mile Slope Remediation
Review of Environmental Factors

Vegetation Communities

Project No. **12561560**
Revision No. **A**
Date **27/10/2021**

FIGURE 6-1

\\ghdnet\ghd\AU\Orange\Projects\21\12561560\GIS\Maps\12561560_2_Mile_Slope_Remediation_REF\REF_A.aprx
Print date: 27 Oct 2021 - 14:29

6.3.3 Potential impacts

Construction

Vegetation clearance

The proposal would require the clearance of some vegetation from within the proposal site. Clearance of the proposal site would result in the removal of about 0.29 hectares of vegetation mapped as PCT 870 *Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion*. This community is not threatened under either the BC Act or EPBC Act.

The above clearance of vegetation is worst case. Based on the design and the likely construction methodology (that is, undertaking the works from Jenolan Caves Road) the clearance of vegetation is considered likely to be limited to the area where the soil nails are proposed (as shown in Figure 6-1). This area would result in about 0.07 hectares of PCT 870 to be cleared, however, most of this area is already clear of vegetation as a result of the slope failure and the subsequent temporary stabilisation and clean-up works. Impacts on the remaining 0.22 hectares of vegetation within the proposal site would be minimised, where possible, through the implementation of safeguards during construction. The nature of the works required to be undertaken within vegetated area of the proposal site are not considered likely to impact on the whole area.

Regardless of the area to be impacted, the removal of about 0.29 hectares of vegetation of which a proportion is already disturbed is not considered to result in a substantial reduction in this community due to the extensive availability of similar vegetation in the surrounding areas. The area to be impacted is also considered to be more degraded than other patches due to its proximity to the roadway which results in some edge effects including where vegetation has been managed.

Fauna

The proposal would potentially involve the removal of some intact stands of native vegetation located adjacent to the slope failure area. This clearance has the potential to impact on local populations of fauna species. Such impacts are minimal as fauna is likely to vacate the proposed clearance area.

Mobile threatened fauna species which have been recorded in surrounding areas may occur within the site on occasion. The vegetation to be removed is unlikely to constitute habitat of importance for the persistence of any local populations of these threatened fauna species. The use of machinery and general disturbance associated with work activities may deter some fauna species from utilising potential habitat within the site. However, this would only be temporary for the duration of construction.

There is no habitat for threatened aquatic fauna listed under the FM Act in the proposal site or immediately downstream of the proposal. Safeguards and management measures are proposed to avoid any indirect impacts on aquatic habitats or species (refer to sections 6.1.3 and 6.2.3). There are unlikely to be any operational impacts on aquatic habitats.

Flora

The clearance of vegetation has the potential to impact upon flora species including potentially threatened species. No threatened flora species have been recorded in the proposal site. As impacts are likely to be limited to the area of the proposed soil nails, impacts on threatened flora species is unlikely as this area has been heavily disturbed because of the slope failure and any subsequent works.

Indirect impacts

Construction activities within the site have the potential to introduce or spread weeds and pathogens such as Phytophthora (*Phytophthora cinnamomi*) and Myrtle Rust (*Uredo rangelii*) in nearby retained vegetation. There is also some potential for indirect impacts arising from erosion and release of sediment, water pollution, dust generation and temporary increase in noise and vibration which could reduce quality flora and fauna species.

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 1999 and, therefore, a strategic assessment would not be required.

Operation

The proposal is not expected to result in any impacts on biodiversity once operational.

6.3.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
General Biodiversity management	Flora and fauna management will be undertaken 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 • 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
General Biodiversity Management	If any damages occur to vegetation outside of the nominated work area (as shown in the CEMP). The project manager and environmental representative will be notified to determine a suitable course of action.	Contractor	Construction
Vegetation clearance	Vegetation clearance is to be minimise where possible with works to be contained where possible to areas where vegetation has been disturbed by the slope failure.	Contractor	Construction
Vegetation clearance	Prior to the clearance of any large trees, an appropriately qualified individual is to undertake a pre clearance survey to identify any fauna utilising the tree.	Contractor	Construction
Vegetation clearance	Clearance of vegetation to be undertaken in a manner which reduces the risk of additional damage to vegetation in surrounding areas (in particular on National Parks and Wildlife Service land).	Contractor	Construction
Vegetation clearance	Removed trees, are to be relocated to outside the works area in a suitable location to allow for use as habitat for fauna species.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Protection of vegetation	Where works are proposed adjacent to vegetation on National Parks and Wildlife Service land, this vegetation is to be protected in accordance with Australian Standard 4970-2009 Protection of Trees on Development Sites. This is to be implemented, in particular, near any significant, old-growth and hollow bearing trees.	Contractor	Construction
Weed management if encountered	Should priority weeds be encountered, weeds will be controlled in accordance with contemporary bush regeneration principles and practices, the *Biosecurity Act 2015,* the NSW Department of Primary Industries noxious and environmental weed control handbook, and the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011), to ensure construction does not promote the spread of weeds. Any weeds encountered in the study area will be stockpiled separately and disposed of at an appropriate waste facility.	Contractor	Construction
Fauna management	Animals that emerge from felled trees will be captured and inspected for injury (if necessary), then relocated to pre-determined proximate suitable habitat identified for release. If animals are unable to be captured, they would be moved into areas of adjoining habitat that is outside the proposal site	Contractor	Construction
Fauna management	An unexpected finds procedure will be developed specifying measures for the management of any threatened biota or habitat resources identified during construction. The unexpected finds procedure will include the requirement for work to stop immediately if any threatened fauna is encountered and the project manager and environmental representative to be notified. Work will recommence only once relevant approvals have been obtained as required. The species will be included in subsequent toolbox talks.	Contractor	Construction
Weed management	Monitoring of weed invasion within the proposal site to be undertaken as part of Transport for NSW monitoring of weeds within the wider Jenolan Caves Road. Where weeds are identified they would be managed in accordance with Transport for NSW's existing procedures in relation to roadside weeds.	Transport for NSW	Operation

6.4 Traffic and transport

6.4.1 Existing environment

The proposal is located on the "2-mile" stretch of Jenolan Caves Road located west of the Jenolan Caves Precinct. This portion of the road serves as the only, currently operational, vehicular access to the Jenolan Karst Conservation Reserve including the Jenolan Caves Precinct. 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.

The key road features surrounding the proposal site include:

- Edith Road is a local road that consists of 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 is an unsealed narrow dirt road allowing traffic in both directions. The 'No Through Road' transects high country grazing land and pine plantations and terminates at a carpark providing access to Kanangra Boyd Lookout.

Access to the proposal site would be limited to Jenolan Caves Road from the west due to current road closures as discussed in section 3.3.7.

6.4.2 Potential impacts

Construction

The proposal would result in the closure of Jenolan Caves Road between the proposal site and either Kanangra Walls Road or at a point 1.6 kilometres north of Kanangra Walls Road. The closure would prevent any public access along this section of road, however access for Jenolan Caves staff and private residences would be allowed following consultation to confirm any access requirements. The closure of the road would result in impacts on access to the Jenolan Caves Precinct however these impacts are discussed further in section 6.10.2. Jenolan Caves Road would be reopened on Friday afternoons to ensure that access to the Jenolan Caves Precinct is available to allow its operations over the weekend.

During weekends, vehicles would be required to be parked at Car Park 2 to provide access into the Jenolan Caves Precinct. This car park has the potential to contain some stockpiling and equipment storage and therefore would reduce the capacity of the car park. Where possible the use of this car park on weekends would be kept to an absolute minimum with Car Park 1 to be used where possible to maximise the available parking spaces in Car Park 2.

The proposal would result in the generation of construction vehicles, namely workers and heavy vehicles, accessing and egressing 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 Kanangra Walls Road intersection and 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 environment of the study area, as this additional construction traffic would be within the range of daily variation in traffic and capacity along Jenolan Caves Road would be at its maximum with the road not in use by the public during weekdays when the works are occurring.

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 to the Jenolan Caves Precinct.

6.4.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
General Traffic management	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 Manual* (TfNSW, 2021) 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 • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to maintain pedestrian and cyclist access • 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 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
Vehicle generation	Vehicle movements (in particularly heavy vehicles) to the proposal site will be limited to weekdays and peak periods will be avoided, where possible.	Contractor	Construction
Heavy vehicle management	Heavy vehicle routes to the proposal site and construction compound/stockpile site will be identified and included within the TMP.	Contractor	Construction
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 negotiate the limitations along Jenolan Caves Road to the proposal site.	Contractor	Construction
Road and lane closures	The closure of Jenolan Caves Road will be limited to Monday to Friday with the road to reopen on Friday afternoon to provide access to the Jenolan Caves Precinct	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Road and lane closures	Access to Car Park 2 and the proposal site will be maintained over weekend periods when the Jenolan Caves Precinct is open to the public. The number of spaces within Car Park 2 on weekends is to be maximised where possible, with other stockpiles to be used as a preference for the weekend storage of materials and equipment.	Contractor	Construction
Pedestrian access	Pedestrian access to the Jenolan Caves Precinct will be maintained on weekends from Car Park 2.	Contractor	Construction
Property access impacts	Access to properties along Jenolan Caves Road will be available throughout construction. Where impacts are anticipated, consultation will be undertaken with the affected property owner to confirm any access arrangements.	Contractor	Construction
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

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. Such sources include traffic noise from visitors accessing the site and general noise generated by visitors within the Jenolan Caves Precinct.

Sensitive receivers located near the proposal site include:

- Jenolan Cave House Hotel, located about 30 metres east of the proposal site
- Jenolan Mountain Lodge, located about 120 metres south of the proposal site
- Six Foot Track walking trail and others located in the surrounding area.

As a result of COVID-19 restrictions the Jenolan Caves Precinct has been frequently closed to the public. As outlined in section 3.3.7, as part of the proposal (and other works in the locality) access to the precinct would be restricted to weekends (and Friday afternoons). With the proposal intended to be undertaken Monday to Friday, for the purpose of the assessment the above receivers are not considered sensitive receivers as they would not be in use during the proposed construction of the proposal.

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 (about three months) and would not permanently affect the community and surrounding environment. Nearby receivers would be mostly unoccupied except for a few staff at the Precinct since it would be closed to the public during construction periods (i.e. during the week). Noise and vibration impacts would be limited to the construction period and would occur over short durations when the construction equipment is operational. Elevated levels of noise due to construction-related activities would occur and noise management controls would be implemented to reduce impacts as far as reasonably practicable. Noise impacts would primarily occur during the day, however there is potential for night works to occur. Night works are minimal and due to the lack of any receivers being present during any such works due to the closure of the precinct impacts are considered minimal.

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. Vibration, however, has the potential to cause further land slips in adjacent 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 rehabilitation works.

6.5.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Construction noise and vibration	Noise and Vibration Management will be undertaken and implemented as part of the CEMP. The noise and vibration management 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 • Management measures to minimise the potential noise impacts from the quantitative noise assessment and for potential works outside of standard working hours • 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 • Restrictions on construction delivery times to minimise noise impacts to receivers near the compound site	Contractor	Pre-construction and Construction

Impact	Environmental safeguards	Responsibility	Timing
Construction noise	Noise impacts will be minimised in accordance with Practice Note 7 in Roads and Maritime Services' *Environmental Noise Management Manual* and *Environmental fact sheet No. 2- Noise management and Night Works*.	Contractor	Construction
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
Construction noise	As a guide, high noise and vibration generating activities near receivers should be carried out in continuous blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers. Unless negotiated with the community with consultation documented and approved by Transport for NSW project manager or permitted under the licence, there should be no more than: • Two consecutive evenings or nights per week; and • Three evenings or nights per week; and • Six evenings or nights per month. For night work these periods of work should be separated by not less than one week.	Contractor	Construction
Construction noise from machinery and equipment	All plant and equipment will be appropriately maintained to ensure optimum running conditions, with periodic monitoring.	Contractor	Construction
Construction noise from machinery and equipment	Noise-emitting plant will be directed away from sensitive receivers, where possible.	Contractor	Construction
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
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

Impact	Environmental safeguards	Responsibility	Timing
Construction noise from construction compound	Delivery vehicles will be fitted with straps rather than chains for unloading, wherever possible. Out of hours movements will be avoided or minimised, where possible.	Contractor	Construction
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 the use of outdoor radios during the night-time period • 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
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 as per RMS ENMM Practice Note 7 requirements.	Contractor and Transport for NSW	Construction
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

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. 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 site. Several sites have been previously impacted by activities in the Jenolan Conservation Reserve, and 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.

A search of the Aboriginal Heritage Information Management System (AHIMS) database maintained by OEH was undertaken on 8 September 2021. The search indicated that no Aboriginal heritage items have previously been recorded within 200 metres of the study area. Two sites were recorded more than 400 metres from the proposal site along the Jenolan Cave River.

Stage 1 of PACHCI has been completed for the proposal with the conclusion of this assessment being that the presence of any Aboriginal objects or places is considered to be unlikely. This is a result of past development in the study area associated with the Jenolan Caves house and carpark. A copy of the Stage 1 PACHCI letter is provided in Appendix F.

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 slope failure and the existing carpark and roadway. As per above, no Aboriginal sites were previously recorded within 200 metres of the study area.

The potential for unidentified archaeological deposits to exist within areas with low archaeological potential is very low and the proposal is unlikely to result in harm to Aboriginal objects during construction. Appropriate safeguards and management measures are proposed in the case of unexpected finds during construction works (refer to section 6.6.3).

Operation

No impacts on Aboriginal heritage are anticipated during operation.

6.6.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Aboriginal heritage	Transport for NSW will need to be contacted if the scope of works changes to reassess the potential to impact on Aboriginal cultural heritage.	Contractor	Construction
Aboriginal heritage	Aboriginal heritage management will be undertaken in accordance with the *Procedure for Aboriginal cultural heritage consultation and investigation* (Transport for NSW, 2012) and *Standard Management Procedure - Unexpected Heritage Items* (Transport for NSW, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The management of Aboriginal heritage will be prepared in consultation with all relevant Aboriginal groups.	Contractor	Pre-construction
Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (Transport for NSW, 2015) 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.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Aboriginal 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.	Contractor	Construction

6.7 Non-Aboriginal heritage

6.7.1 Methodology

A Statement of Heritage Impacts Assessment (SOHI) was prepared by specialist heritage consultants Mountains Heritage. The SOHI is provided in Appendix G.

The assessment included:

- 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 damaged section of the 2-Mile section of Jenolan Caves Road and views to and from the Caves House
- review of remediation options considered by Transport for NSW and consultation with Heritage NSW regarding the various options and engineering constraints
- conclusions and recommendations to mitigate the potential impact of the proposal on the heritage significance of the Jenolan Caves Reserve.

6.7.2 Existing environment

Jenolan Caves Reserve is one of the most important areas of natural history in Australia. The area includes one of the largest interconnected cave systems in Australia and is an outstanding site of geological and speleological interest. 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. Jenolan Caves House, in particular, is a dominant building in this landscape providing a distinctive 'European Resort' atmosphere. Due to the steep terrain and topography, Jenolan Caves House is highly visible from multiple vantage points.

The proposal is partially located within the curtilage of the Jenolan Caves Reserve, a landscape heritage item listed on the NSW State Heritage Register (SHR No. 01698). The Jenolan Caves Road is excluded from this curtilage. The failed slope is also contained within Jenolan Karst Conservation Reserve, one of eight reserves that comprise the Greater Blue Mountains World Heritage Area (GBMWHA), listed on the National Heritage List and World Heritage List (#917).

A summary of the heritage listings associated with, and within close proximity to, the study area is provided in Table 6-1 with further detail provided in Appendix G.

Table 6-1 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		
Greater Blue Mountains World Heritage Area	UNESCO World Heritage List Item No. 917	'Jenolan Caves Reserve' forms part of the listing, which is primarily focused on natural heritage values

Item name	Item number/listing	Details of heritage items listed within / directly adjacent to the proposal site
Greater Blue Mountains	National Heritage List	'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 #I11	
Stone Bridge	LEP Item #I11	
Jenolan Caves Reserve Conservation Area (Part 2 – Heritage Conservation Areas)	LEP C1	
Jenolan Caves (Part 3 – Archaeological Sites)	LEP A1	
Rowe's Homestead	LEP Item #I56	
Non-Statutory		
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.
Register of the National Estate	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 locally listed heritage item, Jenolan Caves House. The presence of plant and equipment as well as stockpiles would be visible from the downstairs dining room and upstairs guest rooms. The proposed works would be short term and only undertaken during weekdays when the Caves House is closed for business. The slope repair and surrounding work site would be kept clean so that it does not detract from the surrounding environment and views. No other items of heritage significance identified in Table 6-1 would be impacted during construction of the proposal.

Operation

Operation of the proposal is expected to have a minor visual impact on views from Jenolan Caves House. The use of a mock rock finish to make the shotcrete wall more realistic and natural would reduce the visual impact while providing the structural support required to remediate the slope. Application of the mock rock would match with the natural rock colours and textures of the surrounding rock outcrops. Safeguards provided in section 6.7.4 would reduce the long-term visual impact of the proposal from Caves House.

The proposal is unlikely to impact on the GBMWHA's National Heritage values as it 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 other items of heritage significance identified in Table 6-1 would be impacted during operation of the proposal

6.7.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
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. The NAHMP will be prepared in consultation with the Office of Environment and Heritage	Contactor	Pre-construction
Non-Aboriginal heritage	The Standard Management Procedure - Unexpected Heritage Items (Transport for NSW, 2015) 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
Non-Aboriginal heritage	A copy of the SOHI will be provided to the Jenolan Caves Reserve Trust and NPWS for their review and endorsement.	Transport for NSW	Construction
Non-Aboriginal heritage	A section 60 application will be prepared and submitted to Heritage NSW for approval prior to works commencing.	Transport for NSW	Pre-construction
Non-Aboriginal heritage	Appointed contractor will provide the following: • details of contractor who will be applying the mock rock finish, to ensure they are suitably qualified and experienced • evidence and examples of previously completed work that utilised realistic mock rock finish The appointed contractor will stipulate that the mock rock finish is to be coloured, sculpted and textured in a manner which provides a finish that replicates the natural rock textures adjacent to the area and in accordance with the Transport for NSW Shotcrete design guidelines (Transport for NSW, 2016)	Contractor	Pre-construction
Non-Aboriginal heritage	Mock rock finishing contractor will provide at least three test panels prior to the first application of shotcrete to show the colour and texture to be used, to demonstrate suitability and realistic outcomes to be achieved. The test panels must measure at least 750 mm x 750 mm with an applied shotcrete thickness of the sculpted layer, showing both the colours and textures proposed to be used. The test panels must be viewed on site and approved by Transport for NSW, in consultation with Heritage NSW, NPWS and Jenolan Caves Reserve Trust, prior to the application of shotcrete.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	Approval of the mock rock finishing, once complete is required by Transport for NSW, Heritage NSW and NPWS and Jenolan Caves Reserve Trust.	Contractor	Post-construction
Non-Aboriginal heritage	The following hold points will be included in the Construction Program: **HOLD POINT 1** – Contractor to commence panel trial at agreed location with Transport for NSW. The Contractor is to provide at least seven days notification for in situ inspections of the three test panels by the Transport for NSW Project Manager and the Transport for NSW Senior Manager, Environment and Sustainability. **WITNESS POINT 1** - Suitable finish – texture and colour. Release via the Transport for NSW Project Manager and the Transport for NSW Senior Manager, Environment and Sustainability **HOLD POINT 2** - Sufficient completion of remaining surfaces for each section via Transport for NSW. **WITNESS POINT 2** – Endorsement of finish. On completion of suitable realistic finish on all sections via Transport for NSW with consultation from NPWS, Jenolan Caves Reserve Trust and Heritage NSW.	Contractor	Construction

6.8 Landscape character and visual impacts

6.8.1 Existing environment

The proposal site is located within a visually sensitive environment because of the natural and heritage significance of the area. The proposal site is, however, in a location which consists of an existing roadside cutting. The proposal site currently consists of a slope which has been subject to failure and has therefore resulted in a reduction in the landscape character due to the failed area not yet being rehabilitated.

Views of the proposal site are limited to visitors to the Jenolan Caves Precinct with most views being short term in nature as visitors travel past the site. Partially screened views of the proposal site are however available from the Jenolan Caves Precinct including Jenolan Caves House.

6.8.2 Potential impacts

Construction

Construction of the proposal would result in construction areas being highly visible from adjacent land uses including accommodation located within the Jenolan Caves Precinct. These impacts would include primarily the presence of plant and equipment at the proposal site and use of car parks as compounds and stockpile areas. The use of the Jenolan Caves Precinct would be restricted during the construction of the proposal and therefore views of the construction areas would be limited to view of locations (Car Park 1 and Car Park 2) where equipment and materials would be stockpiled over the weekend when works are not occurring. These impacts are minimal as they would be contained to as small an area as possible and be positioned to minimise their intrusiveness into any views. Overall, the duration of construction would mean impacts are limited to a relatively short period of time (about three months).

Operation

The proposal seeks to rehabilitate the existing disturbed slope which currently results in impacts on the visual environment. The proposal would result in the introduction of a man-made structure (soil nail wall) into the visual landscape which is dominated by vegetation. The proposed wall would have a high quality mock rock finish which would be developed to match the surrounding rock outcrops thus reducing the dominance of the new wall on the surrounding visual landscape. The wall would also be located adjacent to an existing road and is not considered to be out of context for a roadway to have a wall structure along its edge.

The visual impacts of the proposal in relation the heritage precinct is outlined in section 6.7.3.

6.8.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Visually intrusive works	The footprint of the proposal will be minimised where possible to minimise the dominance of the works.	Contractor	Construction
Compound management	The construction compound will be left in a clean and tidy state at the end of each working day.	Contractor	Construction
Compound management	The extent of construction compounds and stockpile areas are to be minimised, where possible, during weekends and positioned in less visible areas, where possible.	Contractor	Construction
Impact of new wall	Final finish of wall is to be developed in consultation with Heritage NSW, NPWS and Jenolan Caves Reserve Trust and would seek to match surrounding rock outcrops in colour.	Transport for NSW	Pre-construction

6.9 Property and land use

6.9.1 Existing environment

The proposal site at the proposed remediation area consists of no specific land use, with the area forming part of the roadside for Jenolan Caves Road.

The proposal site includes the Car Park 1 and Car Park 2 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 areas located at the intersection within the road reserve with no specific use of this land.

6.9.2 Potential impacts

Construction

The proposal is not expected to result in any impact on the use of the land at the slope failure location.

The use of Car Park 1 is not expected to impact the use of the car park, as current access to this location is not possible due to road closures. If access to the car park is possible prior to the works commencing,

impacts on the use of this area as a car park are considered to be minimal as the Jenolan Caves Precinct would be closed during periods when works are occurring and therefore demand for parking would be low or non-existent. Such impacts would be minimised where possible with alternate compound and stockpiles to be used to maximise the amount of parking available. Any impacts would be short term in nature.

The use of Car Park 2 during construction when works are occurring would be limited as the precinct would be closed and therefore access to the car park for the public would not be required. Any stockpiling or other construction activities occurring in Car Park 2 would be required to be removed prior to 4 pm on Friday to allow the use of this area for visitors to the precinct. The use of other compound and stockpiles would be considered where possible to minimise the area within Car Park 2 which is required to be used. Impact on this car park are considered minimal due to the abovementioned arrangements.

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 minimal. This area is also likely to be used as a staging area for short periods prior to 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. However, the proposal would indirectly result in benefits for land use within the Jenolan Caves Precinct as it would reinstate road access to land uses located in the precinct.

6.9.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
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 outline the requirements for the areas to be cleared for use by visitors.	Contractor	Construction
Impacts on existing car parks	Areas to be used within existing car parks when Jenolan Caves Precinct is open are to be minimised with alternative locations to be used based on where the demand for parking is at the time.	Contractor	Construction

6.10 Socio-economic

6.10.1 Existing environment

Oberon LGA has a population of 5,301 in 2020 and is expected to increase up to 6,650 by 2038. This increase factors in potential known jobs that will be generated from development projects that will boost the economy as well as the tourism sector. The current largest employment sectors are agricultural with 16.5 per cent of the population, manufacturing sector at 15.4 per cent and the health sector at 7.9 per cent. The tourism sector is anticipated to grow, given its natural attraction. The Jenolan Caves immediately adjacent to the proposal site is considered a major tourist attraction with an estimate of 200,000 visitors annually (Oberon Council 2020). The Jenolan Caves Precinct located south and east of the proposal site contains the Jenolan Caves House and the Jenolan Mountain Lodge. The area 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 and associated businesses would be closed during the week to allow the proposed works to be undertaken within the proposal site. The closure of the precinct would reduce the potential for impacts on the users of the precinct. The closure would result in a loss of business during these periods however the nature of the visitation to the precinct is that visitor numbers are higher on weekends and therefore closure during the week is considered to result in less impacts on businesses within the precinct. The closure of the precinct during construction would be offset by the benefits the proposal would provide as outlined in the below section.

The closure of the precinct would also reduce any amenity and access issues which would be experienced should they remain operational throughout construction.

There is potential for some impacts to access for businesses within the precinct throughout construction (that is, during the week) due to the potential for further restrictions and the positioning of construction equipment on Jenolan Caves Road at the slope failure area. Such impacts are manageable as the number of vehicle movements required is expected to be minimal and access would be maintained where possible. Consultation would also be undertaken with affected businesses to determine any property access requirements to ensure suitable access can be provided when required.

Operation

Following construction, the proposal is considered to provide a community benefit as it would allow vehicular access into the precinct for the public and therefore remove the need for transfers to a shuttle bus or trips by foot into the precinct. 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 the business within the Jenolan Caves Precinct as improved access would potentially increase business to include those who may not visit currently due to access arrangements currently in place.

6.10.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
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 affected residents, including changed traffic 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).	Contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Business impacts	Access to the Jenolan Caves Precinct will always be maintained. Where access is impacted, consultation will be undertaken with all businesses operating within the Jenolan Caves Precinct to confirm access requirements including timing and nature of access required (for example for what sized vehicle). Where a closure of the road to the Jenolan Caves Precinct is proposed, 48 hours notice is required to be given to both Jenolan Caves Reserve Trust and National Parks and Wildlife Service.	Contractor	Construction
Business impacts	Management of closures of the precinct would be managed with all relevant stakeholders with closure to avoid any busy periods such as school holidays and public holidays.	Contractor and Transport for NSW	Construction

6.11 Other impacts

6.11.1 Existing environment and potential 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 6-2. Safeguards and management measures to avoid or minimise impacts to these environmental factors is provided in section 6.11.2.

Table 6-2 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 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 works would not require the use of equipment or activities which would potentially 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 manage 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.

6.11.2 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Air quality	Air quality will be managed and implemented as part of the CEMP. The management of air quality 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
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 project • 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 *Environmental Procedure - Management of Wastes on Transport for NSW Land* (Transport for NSW, 2014) and relevant Transport for NSW Waste Fact Sheets.	Contractor	Pre-construction
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, including but not limited to bushfire, slope failure and rockfalls risk • 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 • contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations.	Contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	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. The plan will also outline the reporting requirements following an incident, including reporting incidents to the Environmental Line on 131 555 and in writing to the manager of the NPWS Kanangra Area.		
Bushfire	Consultation with NPWS, Rural Fire Service and other emergency services to be undertaken throughout construction to advise of any access changes. Where possible, access through the proposal site is to be maintained at all times.	Contractor	Construction

6.12 Cumulative impacts

6.12.1 Study area

Cumulative impacts associated with the proposal were considered likely for those projects which are located within the Oberon and Lithgow LGAs located along Jenolan Caves Road.

Rainfall in March 2021 which resulted in the slope failure discussed in this document, caused similar slope failures along Jenolan Caves Road and in the surrounding area. Transport for NSW, National Parks and Wildlife Service and the Jenolan Caves Reserve Trust are undertaking several works in the area to stabilise areas impacted by the rainfall in March 2021. These works are proposed to be undertaken in late 2021 and into 2022 with many of these works still in the planning and design phases.

6.12.2 Potential impacts

The proposed stabilisation works along Jenolan Caves Road and in surrounding areas are likely to result in the closure of Jenolan Caves Road at times thus limiting access to the Jenolan Caves Precinct which would also be closed during these periods. Works are expected to implement a similar approach to the proposal in that the precinct would close during the week to allow works to occur without the need to manage the movement of the public through work areas, prior to reopening the precinct on the weekend. The number of works requiring such an arrangement has the potential to cumulatively result in extended periods of time in which the Jenolan Caves Precinct is required to be closed. Such impacts are minimised as peak visitation during weekends would continue and any closures required are being discussed with the Jenolan Caves Reserve Trust. These closures would also factor in periods in which the Jenolan Caves Precinct would be closed for other works such as renovations for facilities within the precinct.

The various 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 stabilisation works would reinstate road access to the Jenolan Caves Precinct from both the east and west. The proposal would provide the initial improvement to access, with other later works looking to reopen the road from Hartley in the east. The proposed works would also ensure that the pristine natural environment which is a major selling point for the area is not further impacted because of further slope failures and impacts such as the sedimentation of waterways.

6.12.3 Safeguards and management measures

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

7. Environmental management

This chapter describes how the proposal will be managed to reduce potential environmental impacts throughout construction and operation. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements required prior to construction are also listed.

7.1 Environmental management plans (or system)

Several 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 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 works. 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 of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works 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
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 project 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
GEN2	General - notification	All businesses, residential properties and other key stakeholders (e.g. schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity.	Contractor / Transport for NSW project manager	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
GEN3	General – environmental awareness	All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the project. This will include up-front site induction and regular "toolbox" style briefings. •	Contractor / Transport for NSW project manager	Pre-construction / detailed design
GEN4	Delineation of proposal site	The proposal site is to be clearly delineated prior to works commencing with the use of fencing or high visibility tape (or similar). The extent of the proposal site is to be clearly identified as part of up-front induction and regular 'toolbox' style briefings.	Contractor	Construction
GEN5	Works within reserve	Works within the Jenolan Karst Conservation Reserve are not to commence until authorisation has been received from the National Parks and Wildlife Service. The boundary of the reserve is to be made clear to all workers through site induction with this area to be considered a restricted area until authorisation is obtained.	Contractor	Construction
SOI1	Accidental spill	An Incident Emergency Spill Plan will be developed and incorporated in the CEMP. The plan will include measures to avoid and manage spillages of fuels, chemicals, and fluids onto any surfaces and an emergency response procedure.	Contractor	Pre-construction
SOI2	Erosion and sediment control	An Erosion Sediment Control Plan will be developed as part of the CEMP in accordance with the *Blue Book 'Managing Urban Stormwater. Soils and Construction- Volume 1, 4th Edition* (Landcom, 2004).	Contractor	Pre- construction
SOI3	Contaminated land	If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed.	Contractor	Construction
SOI4	Sediment transported off site	All stockpiles will be designed, established, operated and decommissioned in accordance with the RTA's Stockpile Management Procedures.	Contractor	Construction
SOI5	Excavated material/spoil	A contamination assessment and waste classification report will be required to assess the environmental and human health risks as well as potential for material reuse or disposal in accordance with the POEO Act	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
SOI6	Heavy rainfall management	Weather conditions will be monitored daily, and no works will be conducted if there is an imminent threat of a heavy rainfall event. In the event of a rainfall event, works will cease if there is a risk of sediment loss off site or ground disturbance due to waterlogged conditions.	Contractor	Construction
WAT1	Erosion and sedimentation	Soil and water management will be 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. Soil and water management would be undertaken to address the following, but not limited to: • Roads and Maritime Services Code of Practice for Water Management, the Roads and Maritime Services' Erosion and Sedimentation Procedure • Roads and Maritime Services Technical Guideline: Temporary Stormwater Drainage for Road Construction, 2011 Roads and Maritime Services Technical Guideline: Environmental Management of Construction Site Dewatering, 2011	Contractor	Pre-construction
WAT2	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
WAT3	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 spillages of fuels, chemicals, and fluids into any stormwater inlets and an emergency response procedure.	Contractor	Construction
WAT4	Contamination of soils and waterways	Vehicle wash downs and/or concrete truck washouts will be undertaken within a designated bunded area on an impervious surface or undertaken off-site	Contractor	Construction
WAT5	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

No.	Impact	Environmental safeguards	Responsibility	Timing
WAT6	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
BIO1	General Biodiversity management	Flora and fauna management will be undertaken 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 • 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
BIO2	General Biodiversity Management	If any damages occur to vegetation outside of the nominated work area (as shown in the CEMP). The project manager and environmental representative will be notified to determine a suitable course of action.	Contractor	Construction
BIO3	Vegetation clearance	Vegetation clearance is to be minimise where possible with works to be contained where possible to areas where vegetation has been disturbed by the slope failure.	Contractor	Construction
BIO4	Vegetation clearance	Prior to the clearance of any large trees, an appropriately qualified individual is to undertake a pre clearance survey to identify any fauna utilising the tree.	Contractor	Construction
BIO5	Vegetation clearance	Clearance of vegetation to be undertaken in a manner which reduces the risk of additional damage to vegetation in surrounding areas (in particular on National Parks and Wildlife Service land).	Contractor	Construction
BIO6	Vegetation clearance	Removed trees, are to be relocated to outside the works area in a suitable location to allow for use as habitat for fauna species.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
BIO7	Protection of vegetation	Where works are proposed adjacent to vegetation on National Parks and Wildlife Service land, this vegetation is to be protected in accordance with Australian Standard 4970-2009 Protection of Trees on Development Sites. This is to be implemented, in particular, near any significant, old-growth and hollow bearing trees.	Contractor	Construction
BIO8	Weed management if encountered	Should priority weeds be encountered, weeds will be controlled in accordance with contemporary bush regeneration principles and practices, the *Biosecurity Act 2015,* the NSW Department of Primary Industries noxious and environmental weed control handbook, and the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011), to ensure construction does not promote the spread of weeds. Any weeds encountered in the study area will be stockpiled separately and disposed of at an appropriate waste facility.	Contractor	Construction
BIO9	Fauna management	Animals that emerge from felled trees will be captured and inspected for injury (if necessary), then relocated to pre-determined proximate suitable habitat identified for release. If animals are unable to be captured, they would be moved into areas of adjoining habitat that is outside the proposal site	Contractor	Construction
BIO10	Fauna management	An unexpected finds procedure will be developed specifying measures for the management of any threatened biota or habitat resources identified during construction. The unexpected finds procedure will include the requirement for work to stop immediately if any threatened fauna is encountered and the project manager and environmental representative to be notified. Work will recommence only once relevant approvals have been obtained as required. The species will be included in subsequent toolbox talks.	Contractor	Construction
BIO11	Weed management	Monitoring of weed invasion within the proposal site to be undertaken as part of Transport for NSW monitoring of weeds within the wider Jenolan Caves Road. Where weeds are identified they would be managed in accordance with Transport for NSW's existing procedures in relation to roadside weeds.	Transport for NSW	Operation
TT1	General Traffic management	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 Manual* (TfNSW, 2021) and *QA*	Contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		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 • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to maintain pedestrian and cyclist access • 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 to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic Monitoring, review and amendment mechanisms.		
TT2	Vehicle generation	Vehicle movements (in particularly heavy vehicles) to the proposal site will be limited to weekdays and peak periods will be avoided, where possible.	Contractor	Construction
TT3	Heavy vehicle management	Heavy vehicle routes to the proposal site and construction compound/stockpile site will be identified and included within the TMP.	Contractor	Construction
TT4	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 negotiate the limitations along Jenolan Caves Road to the proposal site.	Contractor	Construction
TT5	Road and lane closures	The closure of Jenolan Caves Road will be limited to Monday to Friday with the road to reopen on Friday afternoon to provide access to the Jenolan Caves Precinct	Contractor	Construction
TT6	Road and lane closures	Access to Car Park 2 and the proposal site will be maintained over weekend periods when the Jenolan Caves Precinct is open to the public. The number of spaces within Car Park 2 on weekends is to be maximised where possible, with other stockpiles to be used as a preference for the weekend storage of materials and equipment.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
TT7	Pedestrian access	Pedestrian access to the Jenolan Caves Precinct will be maintained on weekends from Car Park 2.	Contractor	Construction
TT8	Property access impacts	Access to properties along Jenolan Caves Road will be available throughout construction. Where impacts are anticipated, consultation will be undertaken with the affected property owner to confirm any access arrangements.	Contractor	Construction
TT9	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
NV1	Construction noise and vibration	Noise and Vibration Management will be undertaken and implemented as part of the CEMP. The noise and vibration management 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 • Management measures to minimise the potential noise impacts from the quantitative noise assessment and for potential works outside of standard working hours • 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 Restrictions on construction delivery times to minimise noise impacts to receivers near the compound site	Contractor	Pre-construction and Construction
NV2	Construction noise	Noise impacts will be minimised in accordance with Practice Note 7 in Roads and Maritime Services' *Environmental Noise Management Manual* and *Environmental fact sheet No. 2- Noise management and Night Works*.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
NV3	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
NV4	Construction noise	As a guide, high noise and vibration generating activities near receivers should be carried out in continuous blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers. Unless negotiated with the community with consultation documented and approved by Transport for NSW project manager or permitted under the licence, there should be no more than: • Two consecutive evenings or nights per week; and • Three evenings or nights per week; and • Six evenings or nights per month. For night work these periods of work should be separated by not less than one week.	Contractor	Construction
NV5	Construction noise from machinery and equipment	All plant and equipment will be appropriately maintained to ensure optimum running conditions, with periodic monitoring.	Contractor	Construction
NV6	Construction noise from machinery and equipment	Noise-emitting plant will be directed away from sensitive receivers, where possible.	Contractor	Construction
NV7	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

No.	Impact	Environmental safeguards	Responsibility	Timing
NV8	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
NV9	Construction noise from construction compound	Delivery vehicles will be fitted with straps rather than chains for unloading, wherever possible. Out of hours movements will be avoided or minimised, where possible.	Contractor	Construction
NV10	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 the use of outdoor radios during the night-time period • 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
NV11	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 as per RMS ENMM Practice Note 7 requirements.	Contractor and Transport for NSW	Construction
NV12	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
ACH1	Aboriginal heritage	Transport for NSW will need to be contacted if the scope of works changes to reassess the potential to impact on Aboriginal cultural heritage.	Contractor	Construction
ACH2	Aboriginal heritage	Aboriginal heritage management will be undertaken in accordance with the *Procedure for Aboriginal cultural heritage consultation and investigation*	Contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		(Transport for NSW, 2012) and *Standard Management Procedure - Unexpected Heritage Items* (Transport for NSW, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The management of Aboriginal heritage will be prepared in consultation with all relevant Aboriginal groups.		
ACH3	Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (Transport for NSW, 2015) 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.	Contractor	Construction
ACH4	Aboriginal 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.	Contractor	Construction
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. The NAHMP will be prepared in consultation with the Office of Environment and Heritage	Contactor	Pre-construction
NAH2	Non-Aboriginal heritage	The Standard Management Procedure - Unexpected Heritage Items (Transport for NSW, 2015) 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
NAH3	Non-Aboriginal heritage	A copy of the SOHI will be provided to the Jenolan Caves Reserve Trust and NPWS for their review and endorsement.	Transport for NSW	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
NAH4	Non-Aboriginal heritage	A section 60 application will be prepared and submitted to Heritage NSW for approval prior to works commencing.	Transport for NSW	Pre-construction
NAH5	Non-Aboriginal heritage	Appointed contractor will provide the following: • details of contractor who will be applying the mock rock finish, to ensure they are suitably qualified and experienced • evidence and examples of previously completed work that utilised realistic mock rock finish The appointed contractor will stipulate that the mock rock finish is to be coloured, sculpted and textured in a manner which provides a finish that replicates the natural rock textures adjacent to the area and in accordance with the Transport for NSW Shotcrete design guidelines (Transport for NSW, 2016)	Contractor	Pre-construction
NAH6	Non-Aboriginal heritage	Mock rock finishing contractor will provide at least three test panels prior to the first application of shotcrete to show the colour and texture to be used, to demonstrate suitability and realistic outcomes to be achieved. The test panels must measure at least 750 mm x 750 mm with an applied shotcrete thickness of the sculpted layer, showing both the colours and textures proposed to be used. The test panels must be viewed on site and approved by Transport for NSW, in consultation with Heritage NSW, NPWS and Jenolan Caves Reserve Trust, prior to the application of shotcrete.	Contractor	Construction
NAH7	Non-Aboriginal heritage	Approval of the mock rock finishing, once complete is required by Transport for NSW, Heritage NSW and NPWS and Jenolan Caves Reserve Trust.	Contractor	Post- construction
NAH8	Non-Aboriginal heritage	The following hold points will be included in the Construction Program: **HOLD POINT 1** – Contractor to commence panel trial at agreed location with Transport for NSW. The Contractor is to provide at least seven days notification for in situ inspections of the three test panels by the Transport for NSW Project Manager and the Transport for NSW Senior Manager, Environment and Sustainability. **WITNESS POINT 1** - Suitable finish – texture and colour. Release via the Transport for NSW Project Manager and the Transport for NSW Senior Manager, Environment and Sustainability	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		HOLD POINT 2 - Sufficient completion of remaining surfaces for each section via Transport for NSW. **WITNESS POINT 2** – Endorsement of finish. On completion of suitable realistic finish on all sections via Transport for NSW with consultation from NPWS, Jenolan Caves Reserve Trust and Heritage NSW.		
LCV1	Visually intrusive works	The footprint of the proposal will be minimised where possible to minimise the dominance of the works.	Contractor	Construction
LCV2	Compound management	The construction compound will be left in a clean and tidy state at the end of each working day.	Contractor	Construction
LCV3	Compound management	The extent of construction compounds and stockpile areas are to be minimised, where possible, during weekends and positioned in less visible areas, where possible.	Contractor	Construction
LCV4	Impact of new wall	Final finish of wall is to be developed in consultation with Heritage NSW, NPWS and Jenolan Caves Reserve Trust and would seek to match surrounding rock outcrops in colour.	Transport for NSW	Pre-construction
PLU1	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 outline the requirements for the areas to be cleared for use by visitors.	Contractor	Construction
PLU2	Impacts on existing car parks	Areas to be used within existing car parks when Jenolan Caves Precinct is open are to be minimised with alternative locations to be used based on where the demand for parking is at the time.	Contractor	Construction
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 affected residents, including changed traffic and access conditions • contact name and number for complaints.	Contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		The CP will be prepared in accordance with the *Community Involvement and Communications Resource Manual* (RTA, 2008).		
SE2	Business impacts	Access to the Jenolan Caves Precinct will always be maintained. Where access is impacted, consultation will be undertaken with all businesses operating within the Jenolan Caves Precinct to confirm access requirements including timing and nature of access required (for example for what sized vehicle). Where a closure of the road to the Jenolan Caves Precinct is proposed, 48 hours notice is required to be given to both Jenolan Caves Reserve Trust and National Parks and Wildlife Service.	Contractor	Construction
SE3	Business impacts	Management of closures of the precinct would be managed with all relevant stakeholders with closure to avoid any busy periods such as school holidays and public holidays.	Contractor and Transport for NSW	Construction
OTH1	Air quality	Air quality will be managed and implemented as part of the CEMP. The management of air quality 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
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 project • 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.	Contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		The WMP will be prepared taking into account the *Environmental Procedure - Management of Wastes on Transport for NSW Land* (Transport for NSW, 2014) and relevant Transport for NSW Waste Fact Sheets.		
OTH3	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, including but not limited to bushfire, slope failure and rockfalls risk • 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 • 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. The plan will also outline the reporting requirements following an incident, including reporting incidents to the Environmental Line on 131 555 and in writing to the manager of the NPWS Kanangra Area.	Contractor	Pre-construction
OTH4	Bushfire	Consultation with NPWS, Rural Fire Service and other emergency services to be undertaken throughout construction to advise of any access changes. Where possible, access through the proposal site is to be maintained at all times.	Contractor	Construction
CI1	Cumulative impacts	The Communication Plan will include consultation with Transport for NSW, NPWS and Jenolan Caves Reserve Trust to determine the timing of all works proposed and details of how to manage any impacts.	Transport for NSW/NPWS/Jenolan Caves Reserve Trust	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
			and any relevant contractors	

7.3 Licensing and approvals

Table 7-2 outlines the licences and approvals which are required for the project.

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 NSW.	Prior to start of the activity.
National Parks and Wildlife Act 1974	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 considering 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 because of numerous slope failures along Jenolan Caves Road. This has resulted in limited access into the precinct, with public access restricted due to the ongoing safety risks associated with the proposed slope failure located between Car Park 1 and Car Park 2 north of the Jenolan Caves Precinct. While access past the slope failure is available this has been limited to movements required for the operation of the Jenolan Caves Precinct with access for the public required to be undertaken via shuttle bus or foot from Car Park 2. This current arrangement has the potential to limit access for those less mobile and therefore potentially limits the visitors to the precinct due to the inconvenience caused.

The proposal would result in the ability to reopen public vehicular access directly into the Jenolan Caves Precinct which currently is not feasible due to the slope failure at the proposal site as well as other failures impacting on the access from the east. The reopening of this section of Jenolan Caves Road is considered to provide benefits to businesses operating out of the Jenolan Caves Precinct due to the improved access making the area more accessible for all visitors. This reinstatement of the 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 limited use of this section of Jenolan Caves Road for required access into the Jenolan Caves Precinct by the shuttle buses currently operating and vehicles associated with the operation of the Jenolan Caves Precinct.

The proposal would also stabilise the existing slope which is currently at risk of further slope failure which has the potential to result in the movement of sediment into the downslope receiving waters resulting in a reduction in water quality in what forms part of Sydney's Drinking Water Catchment.

The proposal is located wholly within the Jenolan Karst Conservation Reserve (land designated as National Park). 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	Steep slope Watercourses Native vegetation Sydney Drinking Water Catchment

Category of impact		Significance of impacts	
		Generation of dust and noise	Jenolan Caves Precinct including accommodation
	Long term - positive	Stabilisation of existing slope subject to past failure	
Biological	Short term - low adverse	Potential clearance of native vegetation (not threatened), however, area to be impacted is largely cleared due to the slope failure and the emergency stabilisation works Impacts on habitat for threatened species	Potential habitat for threatened species
	Long term - positive	Stabilisation of slope would prevent any future failures, thus minimising impacts on other surrounding vegetation and vegetation down slope	
Natural resources	Short term - low adverse	Impacts on access to the Jenolan Karst Conservation Reserve due to road closures and closures of the Jenolan Caves Precinct	Watercourses Native vegetation Sydney Drinking Water Catchment
	Long term - positive	Improved access into the Jenolan Karst Conservation Reserve	Jenolan Karst Conservation Reserve
Community	Short term – low adverse	Road closures and closures to Jenolan Caves Precinct Impacted access to Jenolan Caves Precinct and flow on impact on tourism (access currently impacted due to slope failure)	Jenolan Caves Precinct including accommodation
	Long term – low adverse	Introduction of new man-made structure into the natural visual environment, though design reduces the	

Category of impact		Significance of impacts	
	Long term - positive	dominance of this structure Stabilisation would allow existing road to open to the public improving access to the Jenolan Caves Precinct Improvement to public safety through stabilisation of slope	
Cultural heritage	Nil (Aboriginal heritage) Long term - Low adverse (non-Aboriginal heritage)	Nil Introduction of new man-made structure into natural environment forming part of heritage listing Introduction of modern structure into heritage precinct	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 the reopening of full public vehicular access into the Jenolan Caves Precinct which is currently limited in a way that may result in lower visitation into the precinct, therefore, impacting on the businesses operating in this location. The proposal would also seek to stabilise the slope to ensure that the risk of further failures is reduced.
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 seeks to restore the existing use of land downslope of the slope failure for the purpose of a road which would, in turn, improve access to the existing businesses located within the Jenolan Caves Precinct.
1.3(d) To promote the delivery and maintenance of affordable housing.	Not relevant to the proposal.

Object	Comment
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 is not expected to result in any substantial impacts on threatened biota. Impacts would be limited to a small area of native vegetation which is not listed as threatened. The proposal would also be limited to areas which have been disturbed because of the slope failure in March 2021 leaving the site largely void of vegetation.
1.3(f) To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	The proposal would not impact non-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.
1.3(g) To promote good design and amenity of the built environment.	The proposal would incorporate design features including a mock rock finish 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.
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 nature of the proposal and that it can be viewed as a maintenance activity to ensure ongoing use of the existing access road to the Jenolan Caves Precinct. Limited consultation has been undertaken to date, however, the community would be well informed of the works 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 project.

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 route options development (refer to Chapter 2). The precautionary principle has guided the assessment of environmental impacts for this REF and the development of safeguards and management measures.

The preferred option was selected as it can provide long term safety for road users and improve access to the Jenolan Caves Precinct, including public vehicular access into the precinct. The proposal does not pose a risk of serious or irreversible environmental damage. Adverse impacts associated with the project 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. 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.

The proposal would assist in meeting road safety objectives outlined in several NSW Government strategic plans and would improve access to the Jenolan Caves Precinct which is an important tourism asset identified in the Central West and Orana Regional Plan.

Conservation of biological diversity and ecological integrity

The environment in which the proposal would be undertaken is a roadside hillslope which has been subject to slope failure. A thorough assessment of the existing local environment was undertaken 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 6.3. An assessment of section 171 of the EP&A Regulation factors that broadly consider biological diversity and ecological integrity of the project area has been included in Appendix B.

Improved valuation, pricing and incentive mechanisms

The principle of internalising environmental costs into decision making requires consideration of all environmental resources which may be affected by the carrying out of a project, 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 those environmental resources have been given appropriate valuation.

The detailed 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 stabilisation and remediation at the “2 Mile slope” 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 project objectives but would still result in some impacts to biodiversity, traffic, Aboriginal heritage 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 road access for the public into the Jenolan Caves Precinct. 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 and Public Spaces 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 Agriculture, Water and the Environment 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.

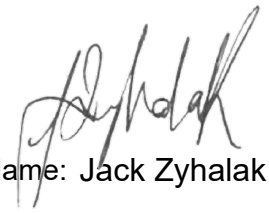
Ben James

Senior Environmental Planner

GHD Pty Ltd

Date: 25/03/2022

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



Name: Jack Zyhalak

Position: Project Engineer

Transport for NSW - Western Region

Date: 28/03/2022

10. References

Mountain Heritage, 2021 2-Mile Slope Rehabilitation, Jenolan Caves Road Statement of Heritage Impact

NPWS. 2020. *Development adjacent to National Parks and Wildlife Service lands: Guidelines for consent and planning authorities*

NSW Government, 2021, NSW Planning Portal spatial viewer. Accessed September 2021

NSW Government SEED Portal Viewer Accessed on 28 September 2021

NSW Government Bionet Vegetation Maps Accessed on 28 September 2021

Transport for NSW, 2014 *NSW Government strategic plans including the Long-Term Transport Master Plan*

Transport for NSW, 2016, *Shotcrete design guideline*.

Terms and acronyms used in this REF

Term / Acronym	Description
AHMP	Aboriginal Heritage Management Plan
AQMP	Air Quality Management Plan
BC Act	*Biodiversity Conservation Act 2016*
CEMP	Construction Environmental Management Plan
DPE	Department of Planning and Environment
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
GBMWHA	Greater Blue Mountains World Heritage Area
GDE	Groundwater Dependent Ecosystems
HRMP	Hazard and Risk Management Plan
Heritage Act	*Heritage Act 1977*
ICNG	Interim *Construction Noise Guideline*
LEP	Local Environmental Plan
LGA	Local government area
MNES	Matters of national environmental significance
NAHMP	Non-Aboriginal Heritage Management Plan
NPW Act	*National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Service
NVMP	Noise and Vibration Management Plan
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PCT	Plant community type
POEO Act	*Protection of the Environmental Operations Act 1997*
REF	Review of Environmental Factors
SOHI	Statement of Heritage Impacts
SWMP	Soil and Water Management Plan
TMP	Traffic Management Plan
WMP	Waste Management Plan

Appendix A
Design drawings

JENOLAN CAVES RD-2-MILE
SLOPE REMEDIATION DETAILED DESIGN
SLOPE 17552
12548561

SITE OF WORKS

LOCALITY PLAN
SCALE NTS

DRAWING LIST		
DRAWING No.	EDMS No.	DRAWING TITLE
12548561-17552-01		COVER SHEET, DRAWING LIST & LOCALITY PLAN
12548561-17552-02		GENERAL NOTES
12548561-17552-03		INDICATIVE SOIL NAIL ARRANGEMENT - ELEVATION
12548561-17552-04		INDICATIVE SECTION DETAILS - SHEET 1 OF 2
12548561-17552-05		INDICATIVE SECTION DETAILS - SHEET 2 OF 2
12548561-17552-06		SUB-HORIZONTAL DRAIN PIPE DETAILS
12548561-17552-07		SOIL NAIL SHOTCRETE AND DRAINAGE DETAILS

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AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

GHD GEOTECHNICAL

DRAWN	J. MCMILLAN	14.10.2021
DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD
JENOLAN CAVES RD-2-MILE SLOPE 17552
GEOTECHNICAL
SLOPE REMEDIATION DETAILED DESIGN
COVER SHEET, DRAWING LIST & LOCALITY PLAN

FILE No. 12548651 | SHEET: 1 OF 1 | A1
STATUS: 100% DETAILED DESIGN | ©
DRG No. 12548561-17552-01 | 0 | EDMS No. - | 0

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Plotted by JMCMILLAN
Plot Date & Time 10/14/2021 9:57 AM

GENERAL NOTES

1. THESE DESIGN DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE JENOLAN CAVES 2-MILE SLOPE REMEDIATION 100% DETAILED DESIGN REPORT -Rev 0, REF: 12548561-RPT-GE-002-0.
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 TO ENSURE SUITABILITY FOR 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. METHODOLOGY OF SELF DRILLING SOIL NAIL INSTALLATION SHALL BE PROVIDED.
5. SITE COMPOUND, ACCESS OR OTHER AREAS OUTSIDE OF THE TREATMENT WORKS EXTENTS ARE TO BE REINSTATED TO THE ORIGINAL CONDITION OR BETTER POST CONSTRUCTION.
6. REFER DISCREPANCIES TO THE PRINCIPAL BEFORE PROCEEDING WITH WORK.
7. NOMINATION OF PROPRIETARY ITEMS DOES NOT INDICATE EXCLUSIVE PREFERENCE, BUT INDICATES REQUIRED PROPERTIES OF ITEM. SIMILAR ALTERNATIVES HAVING REQUIRED PROPERTIES MAY BE OFFERED FOR APPROVAL. APPROVAL DOES NOT AUTHORISE A VARIATION TO THE CONTRACT. INSTALL PROPRIETARY ITEMS IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
8. GIVE TWO WORKING DAYS (48 HOURS) NOTICE SO THAT INSPECTION MAY BE MADE OF CRITICAL STAGES OF WORK INCLUDING BUT NOT LIMITED TO WITNESS POINTS.
9. INSPECTIONS AND REVIEWS UNDERTAKEN BY THE PRINCIPAL OR OTHERS DO NOT RELIEVE THE CONTRACTOR OF RESPONSIBILITY FOR COMPLIANCE WITH DRAWINGS.
10. DO NOT OBTAIN DIMENSIONS BY SCALING FROM DRAWINGS.
11. EXISTING STRUCTURES SHOWN ON DRAWINGS ARE IN APPROXIMATE LOCATIONS ONLY.
12. CONTRACT SOIL NAIL LENGTHS 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 LENGTH CHANGES TO ACHIEVE THE MINIMUM SOCKET REQUIREMENTS NOMINATED.
13. NO KNOWN SERVICES ARE LOCATED WITHIN THE WORK SITE. CONTRACTOR TO CONFIRM BY ADOPTING INDEPENDENT SERVICES SEARCHES AND CONSTRUCTION PROTOCOLS.

SCHEDULE OF QUANTITIES.

1	SLOPE PREPARATION WORKS (INCL. SCALING, GROOMING, EXCAVATION AND DE-VEGETATION).	m^3	325
2	SUPPLY AND INSTALLATION OF 8m LONG R51N-33 SOIL NAILS.	No.	88
3	SUPPLY AND INSTALLATION OF 6m LONG R51N-33 SOIL NAILS.	No.	105
4	SUPPLY AND INSTALLATION OF 5.5m LONG R51N-33 SOIL NAILS	No.	66
5	SUPPLY AND INSTALLATION OF REINFORCED SHOTCRETE FACING (225mm MIN STRUCTURAL THICKNESS).	m^2	650
6	SUPPLY AND INSTALLATION OF MOCK-ROCK FACING (THICKNESS TO BE DETERMINED BY THE CONSTRUCTION CONTRACTOR).	m^2	650
7	SUPPLY AND INSTALLATION OF R40 HORIZONTAL DRAINS	Linear m	103
8	SUPPLY AND INSTALLATION OF 150mm HDPE STRIP FILTER DRAINS	Linear m	231
9	SUPPLY AND INSTALLATION OF CREST DRAIN AT CREST OF SLOPE.	Linear m	70

THE ABOVE QUANTITIES ARE INDICATIVE AND DO NOT MAKE ALLOWANCE FOR WASTAGE, DAMAGE DURING CONSTRUCTION OR CONTINGENCY. SUCH APPROPRIATE ALLOWANCES FOR WASTAGE, DAMAGE DURING CONSTRUCTION OR CONTINGENCY SHOULD BE CONSIDERED BY THE CONTRACTOR AS NECESSARY AND SHALL NOT CONSTITUTE A VARIATION.

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. REFER TO DESIGN REPORT FOR DETAILS.
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 ANDESITE BEDROCK, BOULDERS, COBBLES, LOOSE TO HARD GRAVELLY CLAY, CLAYEY GRAVEL OR SANDY CLAY COLLUVIUM. SELECTION OF DRILLING EQUIPMENT TO BE SUITABLE FOR EXPECTED GROUND CONDITIONS.
4. FOR ALL SOIL NAILS, CONSTRUCTION CONFORMITY RECORDS ARE TO BE COMPLETED AS PER R64.
5. 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.

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.

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 - MOCK-ROCK FACING.

DRAINAGE

1. 150mm HDPE STRIP FILTER DRAIN TO BE IN ACCORDANCE WITH TfNSW R3557.
2. HORIZONTAL DRAINS TO BE 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.

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 SL72 IS 225mm AND SL81 IS 125mm. LAP LENGTHS ARE TO BE BASED ON THE LARGEST MESH SPACING.

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. HOLD POINT - EXTENT OF WORKS AND SET OUT OF NAIL LOCATIONS. (INCLUDING SURVEY OF THE LOCAL SITE CHAINAGE SYSTEM)
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. HOLD POINT - SUBMISSION OF MOCK-ROCK PROPOSALS FOR FINAL PROFILE
16. WITNESS POINT - SHOTCRETE MESH PLACEMENT AND WALL DRAINAGE (TfNSW R68 CL. 5.5 AND CL. 5.6).
17. WITNESS POINT - SHOTCRETE PLACEMENT (TfNSW R68 CL. 7).
18. HOLD POINT - SUBMISSION OF SHOTCRETE TEST RESULTS (TfNSW R68 CL. 8.5).

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

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 THE CONCRETE JERSEY KERB TYPE BARRIERS ENSURE LOCAL PROJECT CHAINAGE IS SETOUT. CONFIRM THE EXTENT OF WORKS WITH THE PRINCIPAL.
6. CONDUCT FACE SCALING, EXCAVATION AND GENERAL DE-VEGETATION (INCLUDING STUMP GRINDING) OF THE SLOPE OF VEGETATION WHICH MAY IMPACT THE INSTALLATION OF SOIL NAILS, REINFORCING MESH AND SHOTCRETE UNDER SUPERVISION OF THE PRINCIPAL OR THE PRINCIPAL'S GEOTECHNICAL REPRESENTATIVE.
7. SET OUT SYSTEMATIC SOIL NAIL LOCATIONS AT HORIZONTAL AND VERTICAL SPACING NOMINATED. SOIL NAILS MAY BE RELOCATED BY THE PRINCIPALS REPRESENTATIVE TO INTERSECT GEOTECHNICAL HAZARDS IDENTIFIED.
8. INSTALL SUITABILITY NAILS. NAILS SUBJECT TO SUITABILITY TESTING ARE ADDITIONAL TO THE PERMANENT NAILS AS DIRECTED BY THE PRINCIPALS REPRESENTATIVE.
9. CONDUCT SUITABILITY TESTING IN ACCORDING WITH TfNSW R64.
10. CONFIRM SUITABILITY TEST RESULTS WITH THE PRINCIPAL.
11. INSTALL PRODUCTION NAILS. IT IS RECOMMENDED THAT SOIL NAILS ARE INSTALLED IN A "TOP TO BOTTOM" APPROACH. HOWEVER THIS IS AT THE DISCRETION OF THE CONSTRUCTION CONTRACTOR.
12. CONDUCT ACCEPTANCE TESTING .
13. SET-OUT HORIZONTAL DRAINS.
14. INSTALL HORIZONTAL DRAINS AND STRIP DRAINS.
15. INSTALL INITIAL SHOTCRETE LAYER
16. INSTALL STEEL WIRE MESH IN ACCORDANCE WITH TfNSW R64 & R68 AND THE DRAWINGS. INSTALL FACE PLATES AND TENSION NAILS.
17. APPLY INTERMEDIATE LAYER OF SHOTCRETE.
18. APPLY FINAL LAYER OF SHOTCRETE AND FINISH AS DIRECTED BY THE PRINCIPAL.
19. CONDUCT SUITABILITY TESTING Of SHOTCRETE.
20. RESTORE SITE TO ITS ORIGINAL CONDITION, OR BETTER, REPAIRING ANY DAMAGE TO ROAD PAVEMENT OR FURNITURE (E.G. GUARD RAILS/POSTS, SIGNPOSTS, ETC.).

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AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

GHD GEOTECHNICAL

DRAWN	J. MCMILLAN	14.10.2021
DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD
JENOLAN CAVES RD-2-MILE SLOPE 17552
GEOTECHNICAL
SLOPE REMEDIATION DETAILED DESIGN
GENERAL NOTES

FILE No. 12548651 | SHEET: 1 OF 1 | A1
STATUS: 100% DETAILED DESIGN ©
DRG No. 12548561-17552-02 | 0 | EDMS No. - | 0

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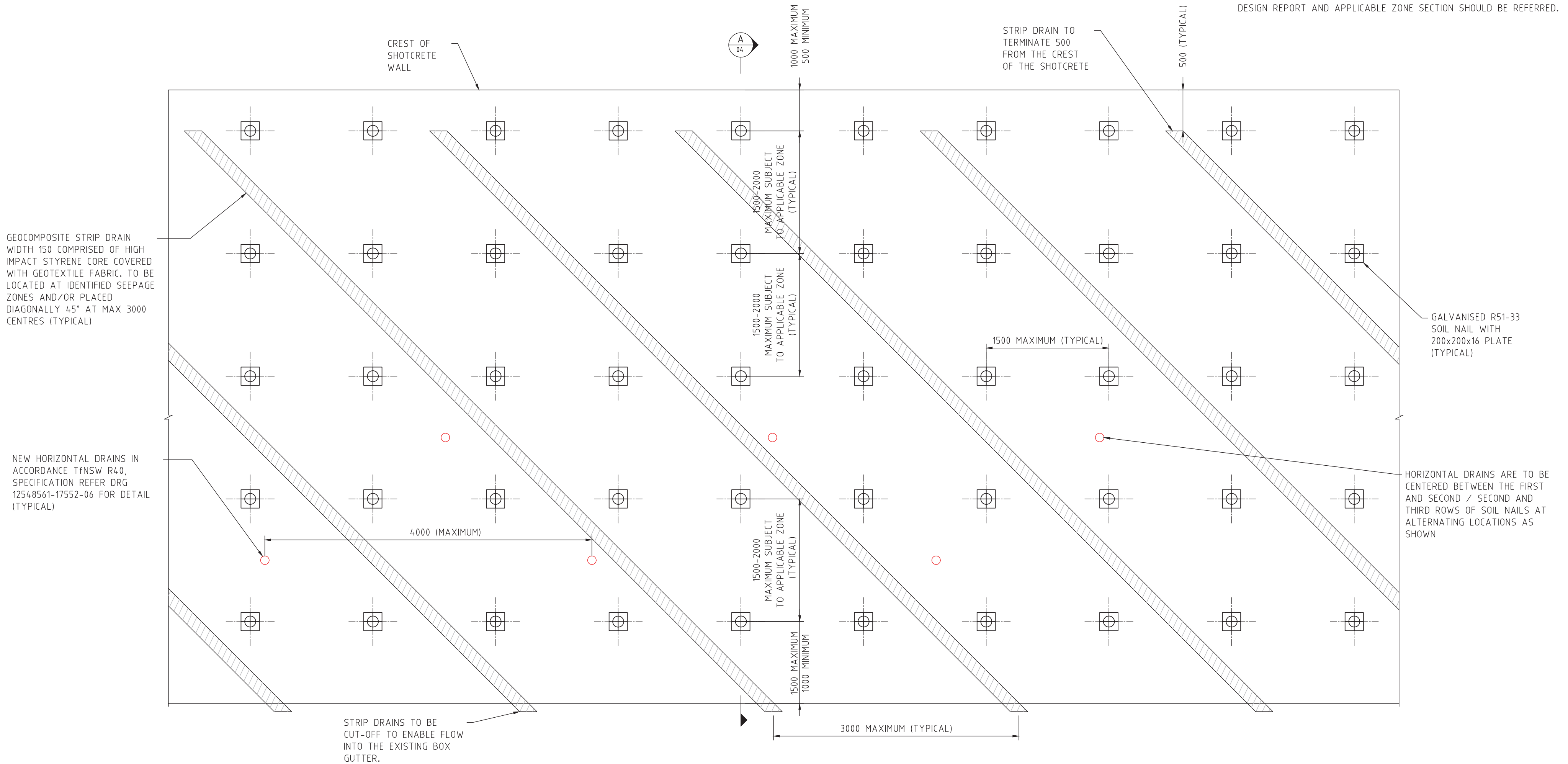
Plot Date & Time 10/14/2021 10:18 AM
Plotted by JMCMILLAN

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.
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.



LEGEND

- SOIL NAIL
- HORIZONTAL DRAIN

SOIL NAIL WALL - TYPICAL ELEVATION

SCALE: NTS

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

NSW GOVERNMENT Transport for NSW

GHD

GHD GEOTECHNICAL

DRAWN	J. MCMILLAN	14.10.2021
DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD

JENOLAN CAVES RD-2-MILE SLOPE 17552

GEOTECHNICAL

SLOPE REMEDIATION DETAILED DESIGN

INDICATIVE SOIL NAIL ARRANGMENT - ELEVATION

FILE No. 12548651 | SHEET: 1 OF 1 | A1

STATUS: 100% DETAILED DESIGN ©

DRG No. 12548561-17552-03 | 0 | EDMS No. - | 0

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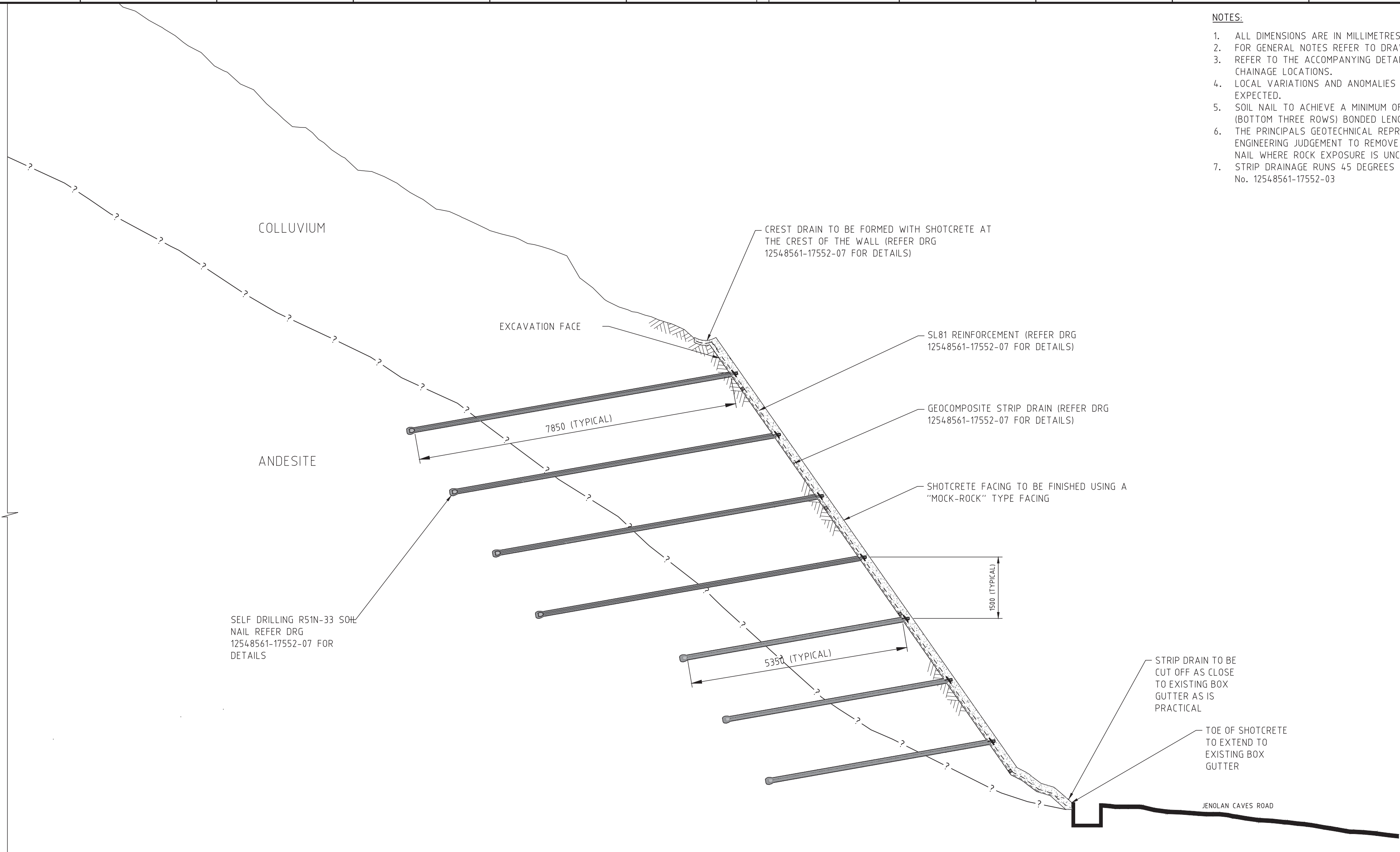

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.
3. REFER TO THE ACCOMPANYING DETAILED DESIGN REPORT FOR CHAINAGE LOCATIONS.
4. LOCAL VARIATIONS AND ANOMALIES IN GROUND CONDITIONS MUST BE EXPECTED.
5. SOIL NAIL TO ACHIEVE A MINIMUM OF 7850 (TOP 4 ROWS) OR 5350 (BOTTOM THREE ROWS) BONDED LENGTH.
6. THE PRINCIPALS GEOTECHNICAL REPRESENTATIVE MAY USE ENGINEERING JUDGEMENT TO REMOVE OR SHORTEN THE BOTTOM SOIL NAIL WHERE ROCK EXPOSURE IS UNCOVERED DURING SCALING WORKS.
7. STRIP DRAINAGE RUNS 45 DEGREES TO THE FACE AS PER DRAWING No. 12548561-17552-03

TYPICAL SECTION AT CHAINAGE 10-40m

SCALE: 1:50

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0 0.5 1.0 1.5 2.0 2.5m

SCALE 1:50 AT ORIGINAL SIZE

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

NSW GOVERNMENT | Transport for NSW

GHD

GHD GEOTECHNICAL

DRAWN	J. MCMILLAN	14.10.2021
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JENOLAN CAVES ROAD

JENOLAN CAVES RD-2-MILE SLOPE 17552

GEOTECHNICAL

SLOPE REMEDIATION DETAILED DESIGN

INDICATIVE SECTION DETAILS - SHEET 1 OF 2

FILE No. 12548651 | SHEET: 1 OF 2 | A1

STATUS: 100% DETAILED DESIGN | ©

DRG No. 12548561-17552-04 | 0 | EDMS No. - | 0

DF 801*554

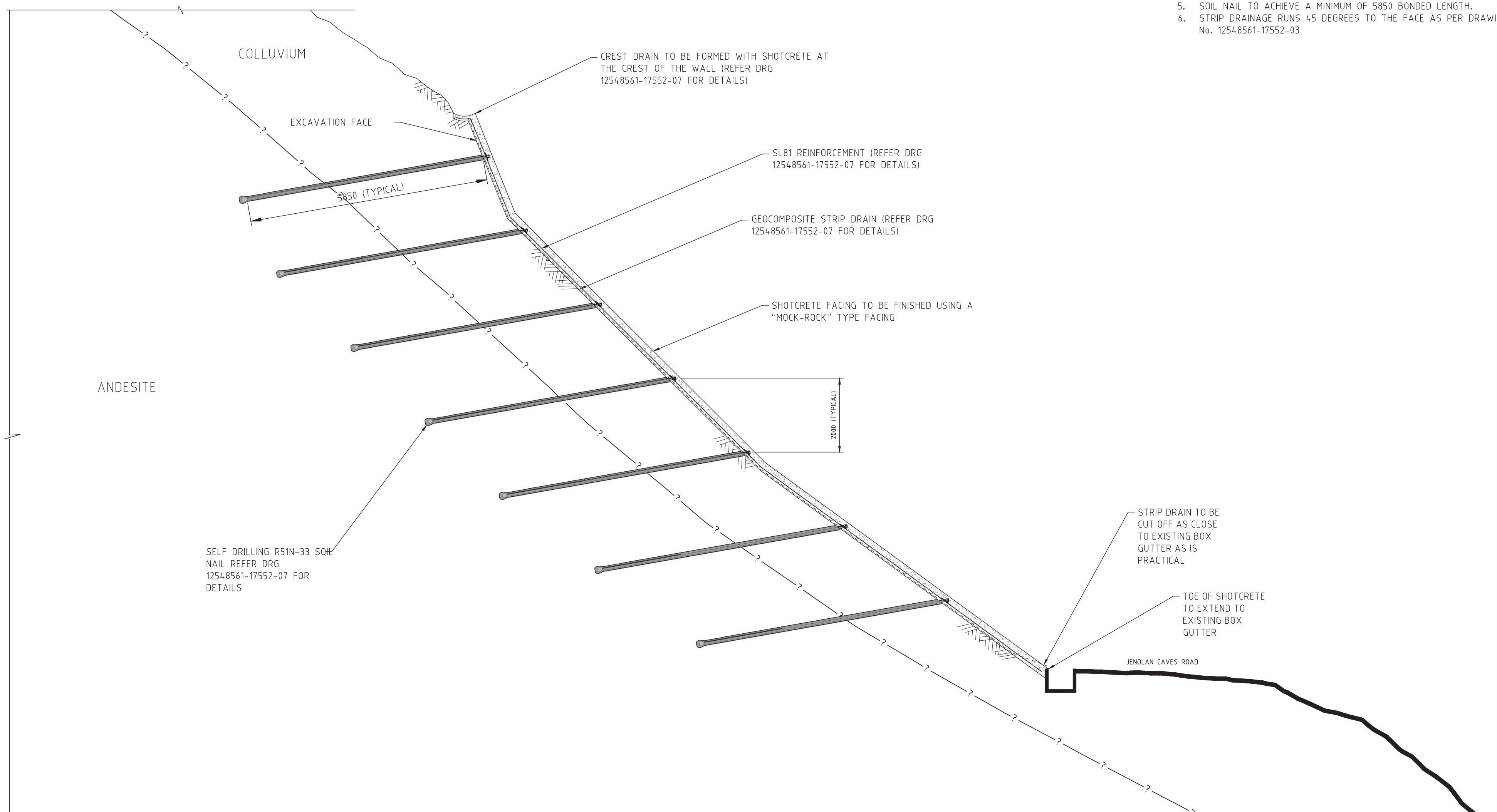
Plot Date & Time: 10/14/2021 10:16 AM

Plotted by: JMCMILLAN

tbDocFullName

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.
3. REFER TO THE ACCOMPANYING DETAILED DESIGN REPORT FOR CHAINAGE LOCATIONS.
4. LOCAL VARIATIONS AND ANOMALIES IN GROUND CONDITIONS MUST BE EXPECTED.
5. SOIL NAIL TO ACHIEVE A MINIMUM OF 5850 BONDED LENGTH.
6. STRIP DRAINAGE RUNS 45 DEGREES TO THE FACE AS PER DRAWING No. 12548561-17552-03



TYPICAL SECTION AT CHAINAGE 40-75m
SCALE: 1:50

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0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

NSW GOVERNMENT Transport for NSW

GHD

GHD
GHD GEOTECHNICAL

DRAWN	J. MCMILLAN	14.10.2021
DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD

JENOLAN CAVES RD-2-MILE SLOPE 17552
GEOTECHNICAL
SLOPE REMEDIATION DETAILED DESIGN
INDICATIVE SECTION DETAILS - SHEET 2 OF 2

FILE No. 12548651 | SHEET: 2 OF 2 | A1
STATUS: 100% DETAILED DESIGN | ©
DRG No. 12548561-17552-05 | 0 | EDMS No. - | 0

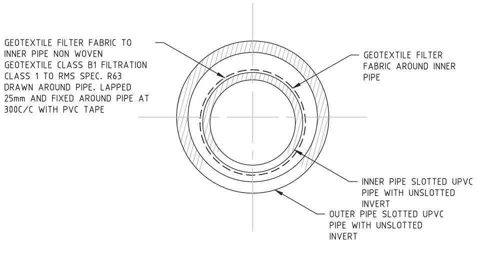
Plot Date & Time 10/14/2021 10:23 AM
File Plotted: \\AU\Sydney\Projects\21\01012\04\Geo_gint projects\CURRENT PROJECTS\5_12548561_Jenolan Caves\Drawings\Geotech\12548561-17552-05.dwg
Plotted by: JMCMILLAN
DF 801*554

NOTES:

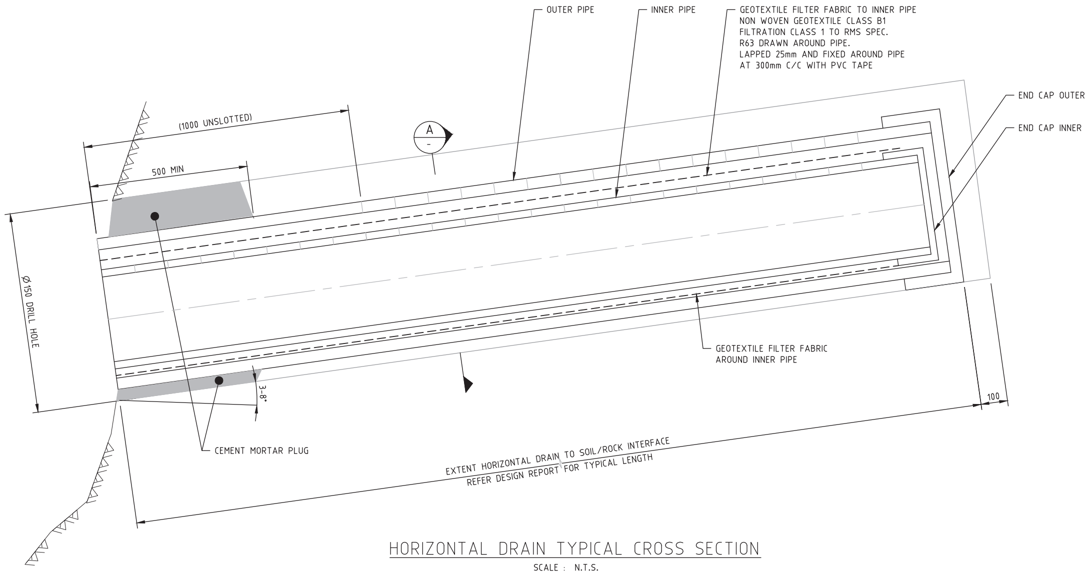
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.

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



A SECTION
SCALE : N.T.S.



HORIZONTAL DRAIN TYPICAL CROSS SECTION
SCALE : N.T.S.

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AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

GHD GEOTECHNICAL

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DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD
JENOLAN CAVES RD-2-MILE SLOPE 17552
GEOTECHNICAL
SLOPE REMEDIATION DETAILED DESIGN
SUB-HORIZONTAL DRAIN PIPE DETAILS

FILE No. 12548651 | SHEET: 1 OF 1 | A1
STATUS: 100% DETAILED DESIGN ©
DRG No. 12548561-17552-06 | 0 | EDMS No. - | 0

DF 801*554

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Plotted by: JMCMILLAN

NOTES:

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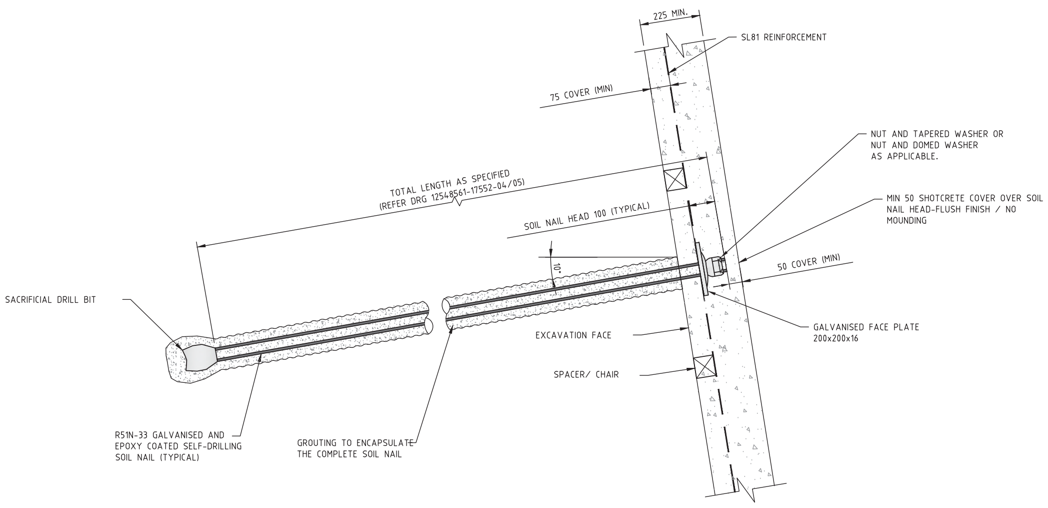
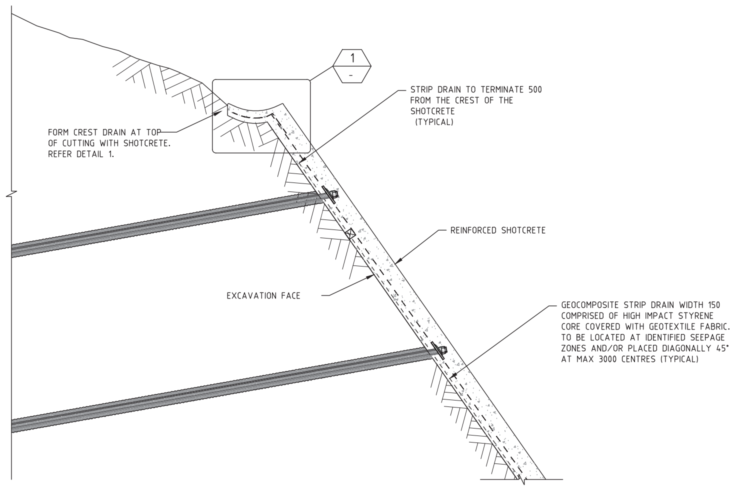
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.



DECLINED GROUTED SOIL NAIL DETAIL

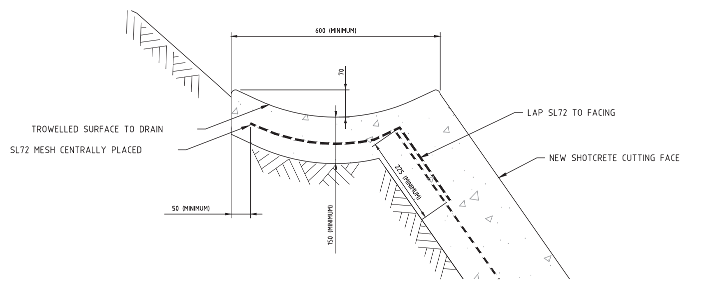
SCALE : N.T.S.



TYPICAL DRAINAGE DETAILS

SCALE : NTS

SOIL AND ROCK MATERIAL PROPERTIES ASSUMED IN DESIGN				
MATERIAL	BULK UNIT WEIGHT (kN/m^2)	EFFECTIVE FRICTION ANGLE (°)	EFFECTIVE COHESION (kPa)	NAIL DESIGN WORKING LOAD (kN/m)
COLLUVIUM	19	32	7	38.75
ANDESITE	26	50	180	38.75



1 - DETAIL

SCALE : NTS

CREST DRAIN DETAILS (TYPICAL)

SCALE : NTS

SOIL NAIL DETAIL		
PARAMETER	REQUIREMENTS	REQUIREMENTS
ZONE	ZONE 1 (CH 10-40)	ZONE 2 (CH 40-75)
SOIL NAIL BAR SIZE	R51N-33	R51N-33
SOIL NAIL BAR LENGTH	8m (7.85m BONDED) 5.5m (5.35m BONDED)	6m (5.8m BONDED)
HORIZONTAL NAIL SPACING	1.5m (MAX)	1.5m (MAX)
VERTICAL NAIL SPACING	1.5m (MAX)	2.0m (MAX)
SOIL NAIL INCLINATION	10° BELOW HORIZONTAL	10° BELOW HORIZONTAL

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AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

NSW GOVERNMENT Transport for NSW

GHD

GHD GEOTECHNICAL

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DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD

JENOLAN CAVES RD-2-MILE SLOPE 17552

GEOTECHNICAL

SLOPE REMEDIATION DETAILED DESIGN

SOIL NAIL SHOTCRETE AND DRAINAGE DETAILS

FILE No. 12548651 | SHEET: 1 OF 1 | A1

STATUS: 100% DETAILED DESIGN ©

DRG No. 12548561-17552-07 | 0 | EDMS No. - | 0

DF 801*554

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Plotted by: JMCMILLAN

Appendix B

Consideration of section 171(2) factors and matters of national environmental significance and Commonwealth land

Section 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 section 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 and minor traffic impacts to the local community for the duration of construction. Construction would be undertaken during the week when the Jenolan Caves Precinct is to be closed to avoid further disruptions to the community. 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 and improving the safety for road users of Jenolan Caves Road.	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. The proposal would not result in any substantial change to the locality as the works are to remediate the existing road cutting which has been exposed to slope failure. The locality would continue to be dominated by the existing environment including the surrounding National Park and Jenolan Caves Precent.	Short term: Minor adverse Long term: Nil
c) Any environmental impact on the ecosystems of the locality? The proposal would result in minimal vegetation removal and not anticipated to impact on the existing ecosystem of the locality.	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, visual and traffic movements. These impacts would be mitigated with the implementation of safeguards and management measures located in section 7.2. At completion the remediated localised cutting is expected to have minimal impact to the value of the locality.	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 proposal site is visible from a number of areas within the heritage precinct, in particular Jenolan Caves House, and therefore has the potential to impact upon the significance of the item. The development of the proposal has included consideration of the type of stabilisation works to occur with the preferred option being a shotcrete wall with soil nails with a mock rock finished. With	Short-term: Minor adverse Long term: Neutral

Factor	Impact
this finish, the wall would not have a significant impact upon the heritage significance of the item. The proposal is not considered to impact upon Aboriginal heritage due to the past disturbance at the site due to construction of the road and the recent slope failure.	
f) Any impact on the habitat of protected fauna (within the meaning of the Biodiversity Conservation Act 2016)? The proposal site was subject to slope failure which caused damage and removed a majority of native vegetation. The proposal is not anticipated to have significant impacts on habitat of any protected fauna due to the degraded nature of the proposal site.	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 some intact vegetation has the potential to impact on local populations of fauna species. Such impacts are considered to be minimal as fauna is likely to vacate the proposed clearance area. These impacts would be minimised through the implementation of safeguards and management measures summarised in section 7.2.	Minor
h) Any long-term effects on the environment? The implementation of the stabilisation of the cutting would prevent further creep and erosion by increasing the factor of safety of the slope.	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, soil nutrients, waste, and fuels and chemicals entering the stormwater system. Potential impacts to water quality would be managed with the implementation of controls provided in section 7.2. The proposal is not considered to result in any long-term degradation of the quality of the environment.	Short term: Minor adverse Long term: Nil
j) Any risk to the safety of the environment? The remediation is designed to improve safety and prevent risks of further slope failures.	Nil
k) Any reduction in the range of beneficial uses of the environment? During construction the proposal would restrict the use of the Jenolan Caves Precinct on weekdays to reduce the disruption to the community and allow construction of the proposal to be completed. These impacts would be short-term in nature and minimised with the implementation of safeguards and management measures in section 7.2, During operation the use of Jenolan Caves Road would return to its previous condition and improve access to Jenolan Caves Precinct from both the east and west	Short term: Minor Adverse Long term: Positive
l) Any pollution of the environment? The proposal could potentially result in water pollution from sediments, soil nutrients, waste, and spilt fuels and chemicals. Management of water quality impacts would be undertaken 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 undertaken 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 and would be treated where relevant and disposed of appropriately.	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.	Nil
o) Any cumulative environmental effect with other existing or likely future activities? The various 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 stabilisation works would reinstate road access to the Jenolan Caves Precinct from both the east and west.	Nil
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

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 location. As the works are the remediation of a clumped cutting, the impacts are anticipated to be minimal.	Minor
b) Any impact on a National Heritage place? Similar to the above, the Greater Blue Mountain Area is a national heritage place, but the nature of the works is for remediation and therefore the works have minor impact.	Minor
c) Any impact on a wetland of international importance? A search of the EPBC PMST identified 4 wetlands of international importance in 2 kilometres range. None are identified in proximity to the proposal site.	Nil
d) Any impact on a listed threatened species or communities? A two kilometre search of the EPBC PMST identified 3 listed threatened ecological communities and 37 listed threatened species. Vegetation removal may be required but is unlikely that the project would have a significant impact on these threatened communities and species as the nature of the works is to stabilise the slumped cutting.	Minor
e) Any impacts on listed migratory species? A two kilometre search of the EPBC PMST identified 13 listed migratory species. It is unlikely the proposal would have impact on these species.	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

Certain development types

Development type	Description	Yes / No	If 'yes' consult with	Transport and Infrastructure SEPP section
Car Park	Does the project include a car park intended for the use by commuters using regular bus services?	No		Section 2.110
Bus Depots	Does the project propose a bus depot?	No		Section 2.110
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 2.110

Development within the Coastal Zone

Issue	Description	Yes / No / NA	If 'yes' consult with	Transport and Infrastructure 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

Council related infrastructure or services

Issue	Potential impact	Yes / No	If 'yes' consult with	Transport and Infrastructure 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	No		Section 2.10 (1)(b)

Issue	Potential impact	Yes / No	If 'yes' consult with	Transport and Infrastructure SEPP section
	the existing road system in a local government area?			
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	Transport and Infrastructure 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	Transport and Infrastructure 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.

Public authorities other than councils

Issue	Potential impact	Yes / No	If 'yes' consult with	Transport and Infrastructure 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)
Aquatic reserves	Are the works adjacent to an aquatic reserve or a marine park declared under the *Marine Estate Management Act 2014*?	No	Department of Planning and Environment	Section 2.15 (2)(c)
Sydney Harbour foreshore	Are the works in the Sydney Harbour Foreshore Area as defined by the *Sydney Harbour Foreshore Authority Act 1998?*	No	Property NSW	Section 2.15 (2)(d)
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 2.15 (2)(f)

Issue	Potential impact	Yes / No	If 'yes' consult with	Transport and Infrastructure SEPP section
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)(g)
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)(h)
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)(i)

Appendix D

Neutral or beneficial effect on water quality assessment

Neutral or Beneficial Effect Assessment

Chapter 8 of *State Environmental Planning Policy (Biodiversity and Conservation) 2021* relates to the use of land within the Sydney drinking water catchment. In accordance with section 8.11 of the SEPP, 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? What pollutants are likely? During construction and/or post construction?	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. Likely pollutants range from oils/fuels to nitrogen, phosphorous or other chemicals that may be used to operate plant and equipment for the proposal. 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 identify specific mitigation to be implemented during rainfall events which may increase the potential for pollutants to enter the surrounding 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?	During construction, the proposal is considered to have a neutral effect on water quality as with the implementation of mitigation measures, impacts on water quality are manageable. Following completion of the proposal, a beneficial impact is considered likely as the proposal would stabilise the existing slope which is still at risk of further slips which could impact upon water quality downslope of the proposal site. Overall, the proposal is considered to have a beneficial effect on water quality.

Appendix E

Vegetation community report

BioNet Vegetation Classification - Community Profile Report

Plant Community Type ID (PCT ID): 870

PCT Name: Grey Gum - Thin-leaved Stringybark grassy woodland of the southern Blue Mountains gorges, Sydney Basin Bioregion

Classification Confidence Level: 5-Very Low

Vegetation Description: Other Diagnostics Features: Dry woodland with an open shrub layer and prominent groundcover of forbs and grasses.; LandscapePosition: Occurs on loams on dry slopes within rocky gorges of the Kowmung and Wollondilly Rivers between 100 and 750m.

Variation and Natural Disturbance:

Vegetation Formation: Dry Sclerophyll Forests (Shrub/grass sub-formation);

Vegetation Class: Central Gorge Dry Sclerophyll Forests;

IBRA Bioregion(s): South Eastern Highlands; Sydney Basin;

IBRA Sub-region(s): Bungonia; Kanangra; Bathurst; Burragorang;

LGA: Not Assessed

Lithology: Not Assessed

Landform Pattern: Not Assessed

Landform Element: Not Assessed

Emergent species: None

Upper Stratum Species: Eucalyptus punctata; Eucalyptus eugenioides; Eucalyptus tereticornis; Eucalyptus cypellocarpa; Eucalyptus elata;

Mid Stratum Species: Acacia falciformis; Clematis aristata; Olearia viscidula;

Ground Stratum Species: Cheilanthes sieberi subsp. sieberi; Desmodium gunnii; Dichondra repens; Echinopogon ovatus; Geitonoplesium cymosum; Hypericum gramineum; Lomandra longifolia; Poranthera microphylla; Pratia purpurascens; Veronica plebeia; Wahlenbergia stricta subsp. stricta; Lomandra multiflora;

Diagnostic Species: Not Assessed

Fire Regime:

TEC Assessed: No associated TEC

TEC List: Not Assessed

Associated TEC Comments: 20170314: There are currently no TECs associated with this PCT.

PCT Percent Cleared: 10.00

PCT Definition Status: Approved

Appendix F

PACHCI Stage 1 Clearance Letter

Jack Zyhalak
Project Manager

25/11/2021

Dear Jack

Preliminary assessment results for the Jenolan Caves Road 2-mile Remediation Based on Stage 1 of the *Procedure for Aboriginal cultural heritage consultation and investigation* (PACHCI), on this day

The project, as described in the Project design assessed as being unlikely to have an impact on Aboriginal cultural heritage based on the Information provided in the Project Design

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 area did contain a 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 reduced due to past disturbance.(Previous Road Construction)

Safe Guards:
Please be vigilant for further potential Aboriginal objects when construction 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 G

Statement of Heritage Impact Assessment

2-Mile Slope Rehabilitation, Jenolan Caves Road

Statement of Heritage Impact

Report prepared for Transport for NSW

December 2021

Fiona Leslie, 92 Douglas Street, Springwood NSW 2777 ABN: 98406415286

Contents

Tables

Figures

Executive Summary

This report has been prepared by MTS Heritage (Mountains Heritage) to inform proposed remediation works to the 2-Mile section of Jenolan Caves Road, which failed during heavy rainfall in March 2021. The failed section of slope is partially 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 failed slope is also contained within 'Jenolan Karst Conservation Reserve', one of eight reserves that comprise the Greater Blue Mountains World Heritage Area (GBMWHA), listed on the National Heritage List and World Heritage List. The Reserve attracts more than 230, 000 visitors annually, is considered one of Australia's oldest visitor destinations and is recognised for its outstanding natural, cultural historic, scientific and recreational values.

The significance of the Reserve's cultural landscape is recognised by the 2017 Conservation Management Plan and conservation policies provided to conserve and protect its landscape heritage values. 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. 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.

A site inspection confirmed that the failed slope is in close proximity to Caves House and, due to the steep terrain and topography, is highly visible from Caves House as well as other vantage points from the north east 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 could pose a significant visual impact.

TfNSW considered five (5) options to remediate the slope. These included: gabion wall or other type of retaining wall to support the slope; 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 is 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 is that soil nails and shotcrete is the only viable solution.

Given this advice, a number of mitigation measures have been recommended to ensure that the final mock rock finish matches the natural rock colour, geological pattern and texture of rock outcrops at Jenolan Caves and does not result in a significant impact on the landscape heritage values of the Reserve or the views from Caves House. These measures include:

- The selection of a skilled contractor with previous experience in the application of a realistic mock rock finish.
- The creation of test panels prior to the application of shotcrete for approval by TfNSW in consultation with Heritage NSW, JCRT and NPWS; and
- A final inspection and approval of the mock rock finish by TfNSW in consultation with Heritage NSW, JCRT and NPWS

These measures are considered sufficient to avoid impacting the State significant values of 'Jenolan Caves Reserve'. Remediation of the failed slope is not likely to have a significant impact on the National or World Heritage values of the GBMWHA, which are largely natural. As such, approval from the Minister for Department of Agriculture, Water and the Environment is not required.

1. Introduction

1.1 Project background

MTS Heritage (Mountains Heritage) has been engaged by Transport for NSW (TfNSW) to prepare a Statement of Heritage Impact (SoHI) report for proposed remediation works to the 2-Mile section of Jenolan Caves Road, which failed during heavy rainfall in March 2021. The failed section of road is 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 attracts more than 230, 000 visitors annually, 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, TfNSW has considered a number of remediation options to repair the damaged section of road in consultation with the Jenolan Caves Trust and the National Parks and Wildlife Service (NPWS). Due to the extensive nature of the slope failure, safety risks associated with construction and limited road and construction width, soil nails and shotcrete were chosen as the preferred option. Following consultation with Heritage NSW regarding the proposal, examples of how shotcrete has been applied to blend into the existing environment have been provided by TfNSW and are considered by this report. The repair of the 2-Mile section of Jenolan Caves Road is considered a priority by TfNSW to ensure access to Caves House and allow ongoing maintenance.

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 Urban Affairs and Planning, 2002) 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 west of Sydney. The Reserve is situated on a highland plateau to the east of Oberon and is accessed via both the 2-Mile section of Jenolan Caves Road from the west and the 5-Mile section from the east. The caves are situated roughly 80km west of Katoomba, and form part of McKeowns Valley - a very significant fluvial karst valley (Figure 1.1).

The damaged 2-Mile Road section of Jenolan Caves Road (the subject site) is situated less than 60 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, with Jenolan Caves Road corridor 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, aesthetic, research and rarity values. (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-electic 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 remediation options considered by TfNSW 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 and the Greater Blue Mountains World Heritage Area Strategic Plan prepared by the Department of Environment and Climate Change;
- Inspection of the damaged section of the 2-Mile section of Jenolan Caves Road and views to and from the Caves House;
- Review of remediation options considered by TfNSW and consultation with Heritage 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'.

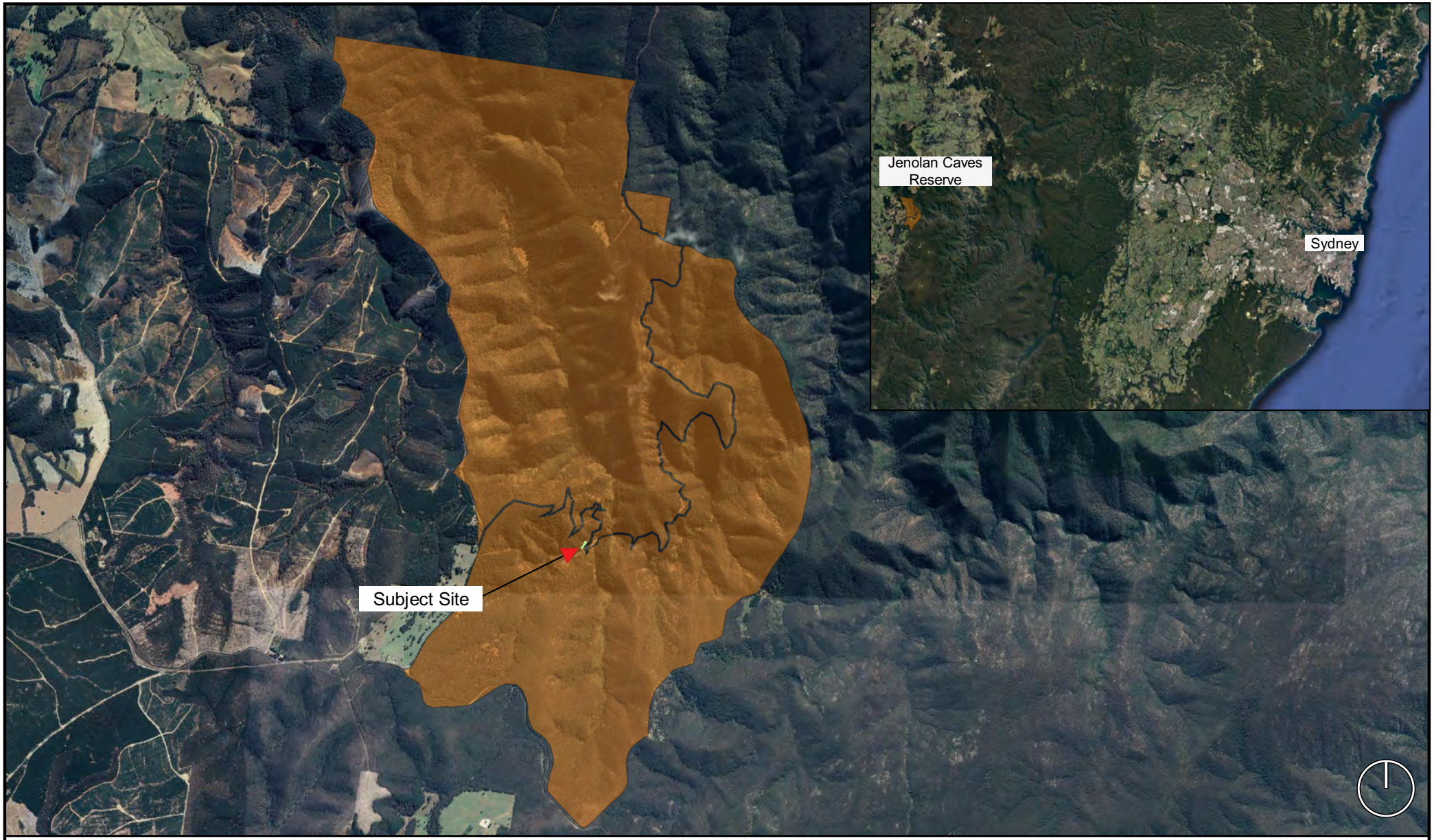
1.5 Report outline

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 by TfNSW and recent examples of shotcrete and an assessment of the potential impacts of the proposed remediation on the heritage significance of Jenolan Caves Reserve (Section 7); and
- conclusions and recommendations (Section 8).

1.6 Authorship and acknowledgements

This report has been prepared by Fiona Leslie (Principal Heritage Consultant, Mountains Heritage) with the history summarised by Charles Barnett (Heritage Consultant, Mountains Heritage). I would like to acknowledge the assistance provided by Jack Zyhalak (Project Engineer, TfNSW), Neil Glastonbury (Senior Manager Environment and Sustainability, TfNSW), Sarah Jane Brazil (Heritage NSW), Denis Gojak (TfNSW) and Alex Timms (TfNSW).



MOUNTAINS HERITAGE

Legend

Subject Site

Jenolan Caves Reserve

Figure 1.1: General Location

0 1 2 3 4 5 km

Map Source: NSW Six Maps (NSW Spatial Data)

MOUNTAINS HERITAGE

Legend

Subject Site

Figure 1.2: Location and extent of the subject site

0 50 100 150 200 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 TfNSW to determine the potential impact of the proposed remediation works on the 2-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.

'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.

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.

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 so 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 TfNSW 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:

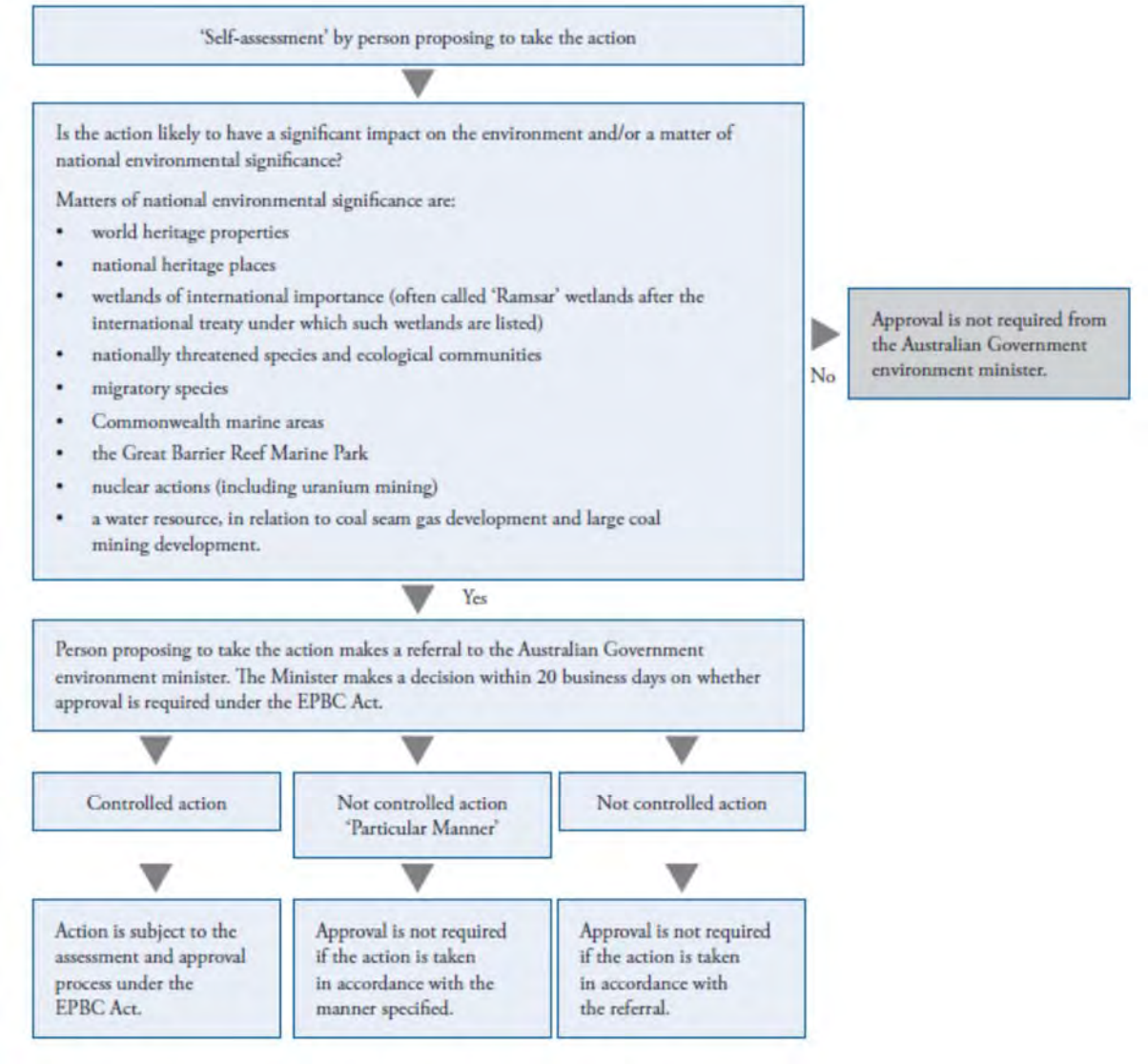


Figure 2:1 EPBC Act Referral Process (Source: Department of the Environment, 2013: 27)

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

Heritage items and places are recorded on statutory and non-statutory registers held at the National, State and local level, depending on their level of significance. Commonwealth managed heritage includes the World Heritage List (WHL) National Heritage List (NHL) and the Commonwealth Heritage List (CHL), all administered under the EPBC Act. Items on the NHL and CHL, as well as World Heritage items in Australia, are recorded on the Australian Heritage Database, currently administered by the Federal Department of Agriculture, Water and the Environment.

State heritage places and items are registered on the NSW State Heritage Inventory (SHI), an online database that records local heritage items, State heritage items and items owned by State statutory authorities. Section 170 of the *Heritage Act 1977* requires all statutory authorities to advise OEH of their heritage assets for recording on the SHI. Items of local heritage significance are recorded in Local Environmental Plans (LEP) for the relevant LGA.

Table 2.1 overleaf summarises the relevant heritage listing for 'Jenolan Caves Reserve' which includes the subject site. Heritage registers searches were conducted on 10 November 2021.

Table 2:1: Summary of Heritage Listings for 'Jenolan Caves Reserve' (Search date: 10 November 2021)

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 2:2 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).

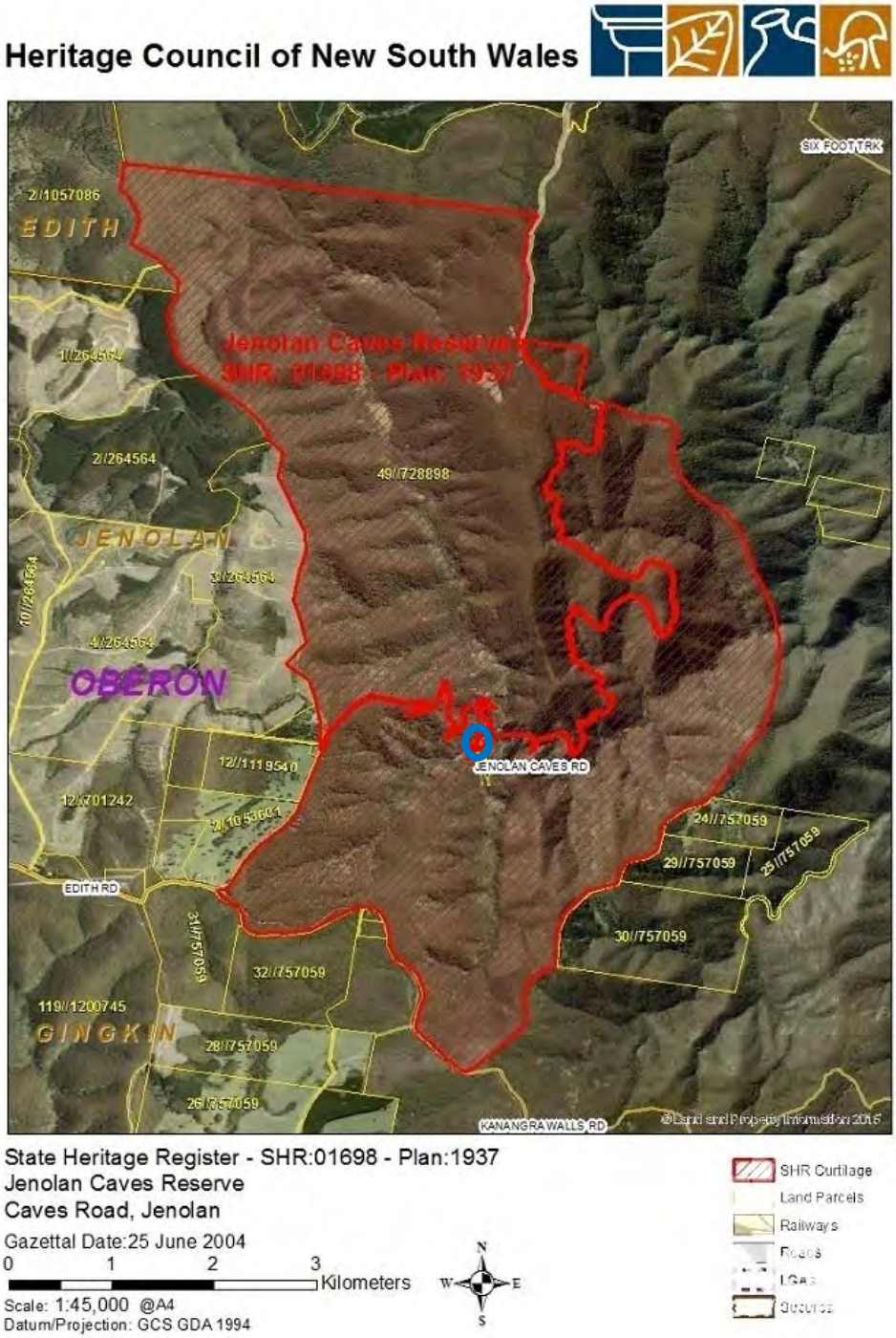


Figure 2:3 The heritage curtilage of 'Jenolan Caves Reserve' as listed on the NSW SHR. The general location of the subject site is circled in blue (Source: https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051578).

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 aspects of European phase structural development, with a focus on the Jenolan Caves House and the 2-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. Finds include mostly stone 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.

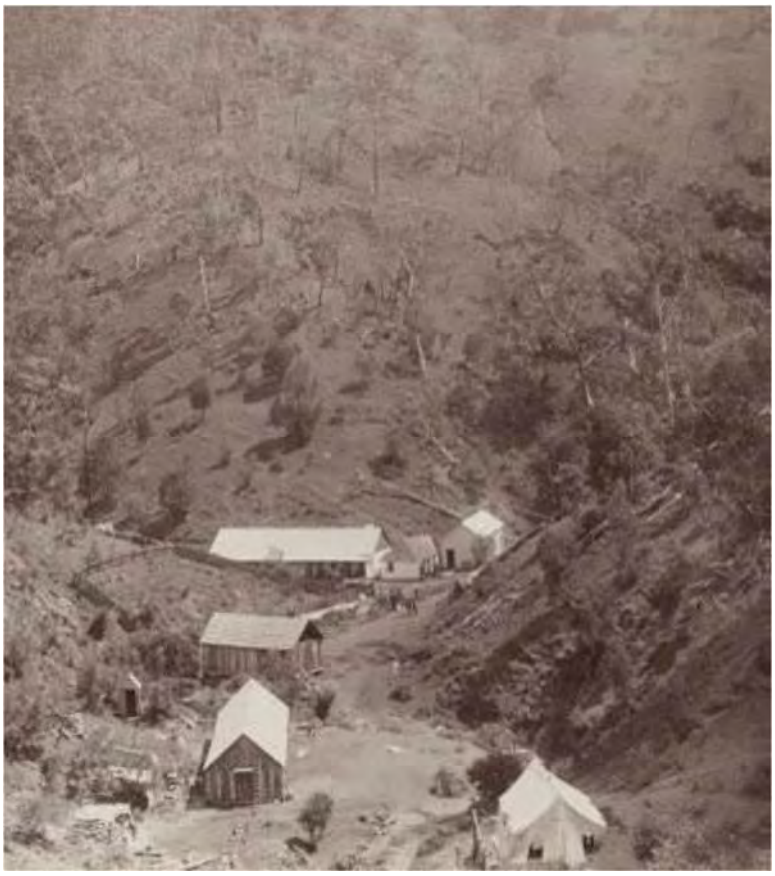


Figure 3:1 Wilson's accommodation at the Reserve, c. 1880. (Source: Urbis 2017: 72).

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).

Figure 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 2-Mile Road was upgraded in the mid-1980s (Urbis 2017: 64 - 68).

Figure 3:3 Accommodation at the Reserve, c. 1895 prior to the fire. (Source: Urbis 2017: 72).

Figure 3:4 The remaining double story timber accommodation building, with new stone Caves House behind, as well as post office and kiosk. (Source: Urbis: 73).

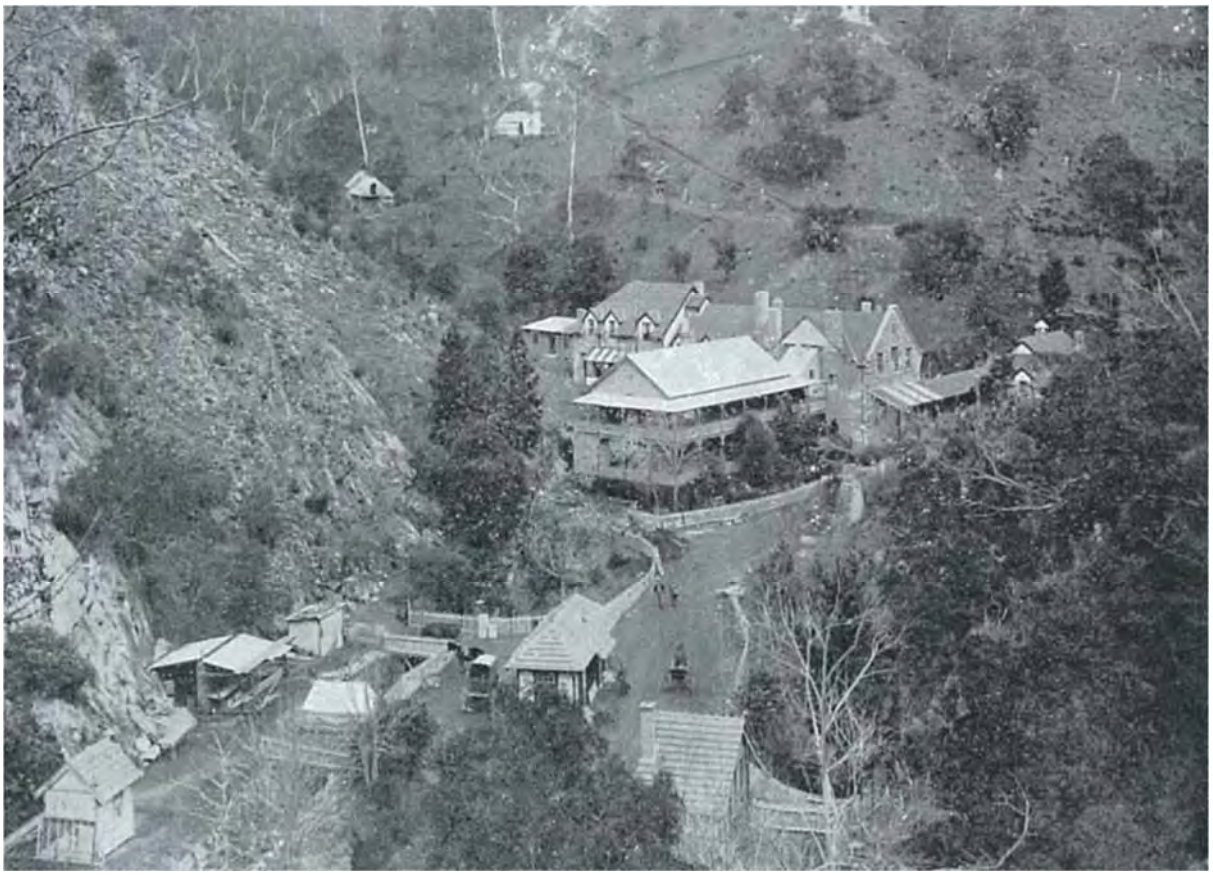


Figure 3:5 Multiple buildings, sheds and kiosks between Caves House and the Grand Arch, c. 1900. (Source: Urbis 2017: 75).

Figure 3:6 Caves House 1910-19. (Source: Urbis 2017: 76).

Figure 3:7 View of Caves House from Carlotta's 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 2-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 5-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 5-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 approved 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 2-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).

Figure 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 Heritage completed a Conservation Management Plan 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 incorporation 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 Figures 4.2 and 4.3), 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 2-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 significance of Caves House is at State level, particularly due to its location within the valley (Urbis 2017: 151). Several specific views around the Reserve were noted for their particular significant heritage vistas, including two (2) views of Caves House (see Figure 4.4). 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).

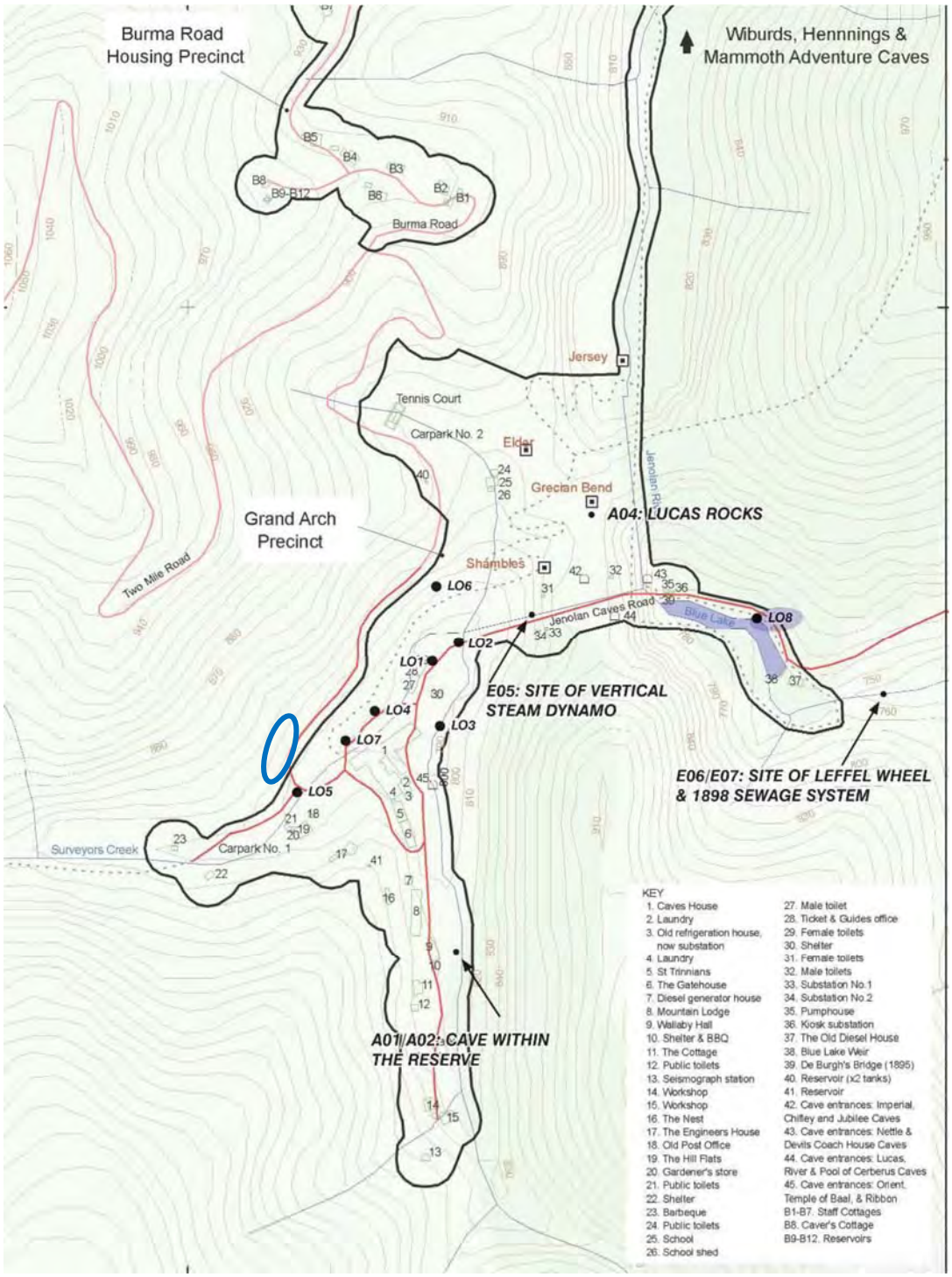


Figure 4:1 Site Plan – Grand Arch Precinct. (Source: Urbis 2017: 46).

Figure 4:2 View of Caves House and the area to the south in December 1927, showing the extensive stone walling and terracing (Source: Urbis, 2017: 97)

Figure 4:3 View of the area directly south of Caves House in c.1927, showing the extensive dry stone walling and terracing (Source: Urbis, 2017: 97)

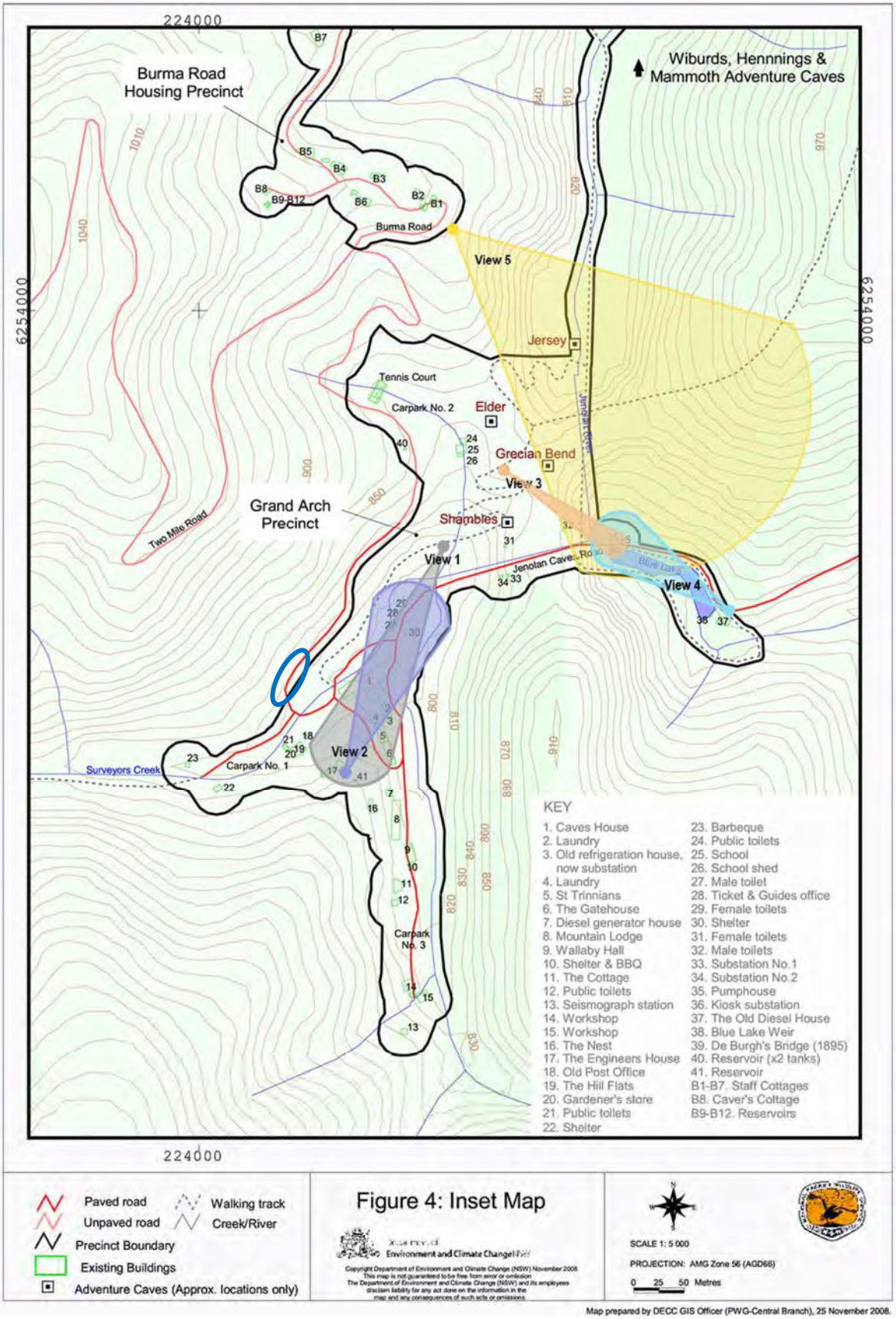


Figure 4:4 Primary significant views and vistas identified in the 2017 CMP. The location of the subject site is circled blue (Source: Urbis 2017: 175).

A number of 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.

Given the proximity of the failed slope to Caves House, potential views and its associated setting, the above policies are relevant to the current study.

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 significance 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 a number of objectives relating to the protection of the GBMWHA's geodiversity, including developing infrastructure and maintenance regimes at Jenolan Caves in order 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 a number of 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).

Figure 4:5 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 (Figure 4.6).

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 proposed for shotcrete 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, TfNSW 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.*

It is noted that the current proposal is consistent with the above conditions.

Figure 4:6 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).

5. Site Inspection

An inspection of the study area was undertaken by Fiona Leslie (Principal Heritage Consultant, Mountains Heritage) and Jack Zyhalak (Project Engineer, TfNSW) on 9 September 2021. The aim of the inspection was to view the failed 2-Mile section of Jenolan Caves Road and discuss the proposed remediation works. The survey also aimed to understand the views, vistas and setting of Caves House and determine the potential for historical archaeological relics.

5.1 Location and topography

The failed section of Jenolan Caves Road is located at the junction of the road with the lower visitor car park (Car Park No. 1 or 'Cambridge Carpark'). In this section, the road descends steeply from the north towards a sharp bend at the junction of the car park, turning towards Cave House (see Figure 5.1). The failed section measures approximately 70 m in length and about 45 m of the slope is located within the road corridor managed by TfNSW and the remaining 25 m by land managed by the NPWS and Jenolan Caves Reserve Trust.

The slope is largely exposed colluvial soil, washed from the top of the embankment onto the road (Figure 5.2 and 5.3). At the time of the inspection the debris on the road had been removed and concrete barriers installed along the base of the toe of the slope to provide some protection and safety to occasional light vehicles that continue to use the road. It should be noted that the 2-Mile section of Jenolan Caves Road is the only, currently operational, vehicle access to Jenolan Caves due to the widespread damage and slope failures along the 5-Mile section of road, which is closed.

Figure 5:1 Site setting within the Grand Arch Precinct of Jenolan Caves Reserve (Source: GHD, 2021: 2).

Figure 5:2 View of the failed section of Jenolan Caves Road, facing north east (Source: MTS Heritage, 2021)

Figure 5:3 View of the failed section of Jenolan Caves Road, facing south west (Source: MTS Heritage, 2021)

5.2 Views and setting

Given the proximity of the failed slope to Caves House, the broader area was surveyed to understand its visibility from Caves House and the potential impact of any remediation works on its setting and views. After descending towards Caves House, it became clear that the wall directly below the failed slope had also failed and gabions installed to create a terrace (Figure 5.4).

Access to rooms in Caves House allowed further consideration of the views from Caves House to the failed slope. The slope was clearly visible from both the rooms on the north west side of the building (Figure 5.6) and from the windows on the north west side of the Dining Room, on the ground floor (Figure 5.7). The proximity of the slope to Caves House was also observed further the access road, looking from the rear of Caves House south, towards the subject site (Figure 5.8)

The site inspection confirmed that, due to the steep terrain and topography, the failed slope is clearly visible from the north and north east, including by visitors staying at Caves House.

Figure 5:4 View of the failed slope from Caves House entrance: Note: modern gabions on the slope below (Source: MTS Heritage, 2021).

Figure 5:5 View of Caves House from the entry, facing north east (Source: MTS Heritage, 2021)

Figure 5:6 View of subject slope from the upstairs visitor's bedroom window, facing south west (Source: MTS Heritage, 2021).

Figure 5:7 View of the failed slope from the downstairs dining room window, facing south west (Source: MTS Heritage, 2021).

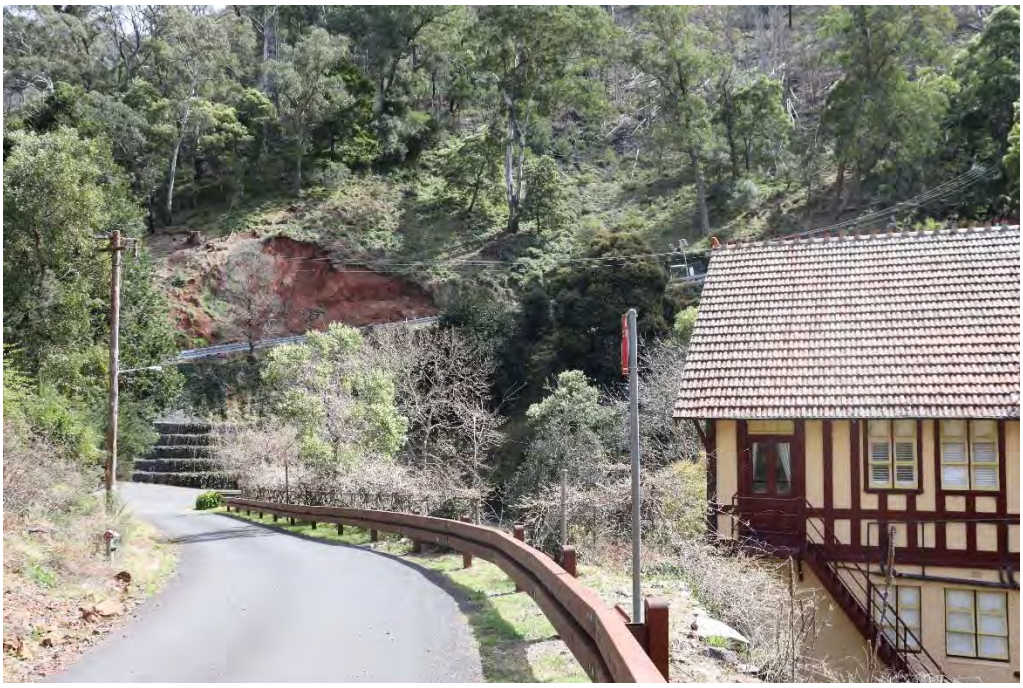


Figure 5:8 View of the failed slope and Caves House, showing its proximity, facing north west (Source: MTS Heritage, 2021).

5.3 The landscape

During the survey existing landscape elements were noted. As highlighted in the 2017 CMP, much of the landscaping around Caves House is dry stone walling and terracing (Figure 5.9). In addition to the more modern gabion stone terrace below Jenolan Caves Road, stone facing was noted below the access road (Figure 5.10) and at the rear of Caves House (5.11).

Figure 5:9 View of dry stone walls at the entrance to Caves House, facing south east (Source: MTS Heritage, 2021).

Figure 5:10 Dry stone retaining wall below Jenolan Caves Road, facing west (Source: MTS Heritage, 2021)

Figure 5:11 View of stone walls and terracing at the rear of Caves House, facing south (Source: MTS Heritage, 2021)

5.4 Potential for historical archaeological relics

Following a review of the 2017 CMP and observations on the ground, the potential for historical archaeological relics within the subject site is considered to be low. Whilst the 2-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. No evidence of any former retaining walls were noted in the failed section of slope and the potential for former road surfaces is low. In addition, no former buildings or structures are indicated in this location in historical maps or plans.

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-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).

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, TfNSW investigated a number of options to remediate the failed slope. These are outlined in the subsections below. Further details on the preferred option are then provided with recent examples of shotcrete. This option is then assessed for its potential impact on the heritage significance of 'Jenolan Caves Reserve' and the broader GBMWHA.

Initial Options Assessment

Unlike other slopes that have failed on the 5-Mile section of Jenolan Caves Road, the subject site is unique with very limited options available for remediation. This is largely due to poor access down to the 2 Mile via a series of hairpin turns and corners that would limit certain construction activities. The narrow road width limits the size of equipment and the availability of options without excavating further into the hill side to create more room. Further excavation poses a considerable risk of de-stabilising the slope further and create additional failures (J. Zyhalak, personal communication, 21 September 2021).

With the above constraints in mind, TfNSW considered the following options:

1. Gabion wall or other type of retaining wall to support the slope;
2. Soil nails and shotcrete;
3. Soils nails and shotcrete hidden by architectural panels or other suitable covering;
4. Regrading of the slope;
5. Soil nails with mesh and erosion mat.

Option 1: Gabion Wall / other retaining structure

- There is limited road and construction width at the site for required access and for installation of the structure.
- This option requires significant excavation into existing slope and large amount of excavation could create further instabilities and trigger further landslides.
- Increased risk and safety concern during construction while excavation was carried out
- The retaining structure would have to be very high; it would be very visible from caves house and the precinct.
- Gabions introduce hazards to road user and decrease road width further.
- The footing for such a large structure may also require piling. Existing road may not support large piling rig and cause further damage to slope below the road.
- Access down the slope unlikely to support access for such equipment.

Option 2: Soil nails and shotcrete

- Deemed as the only feasible option that will satisfy slope stability requirements without significant excavation of the slope.
- Plant required for this are much less impacted by the access constraints of the 2 Mile section of the road.
- It is acknowledged that there will be some visual impacts associated with this method, however the same can be said for all other options as they all essentially involve construction of a man-made structure within a natural environment.

- To lessen this impact and provide a more “natural look” a mock rock finish is proposed that will blend in with the rock outcrop that is exposed adjacent to the failure. Colouring and texturing the shotcrete will provide a more natural look and will be less obtrusive.

Option 3: Soil nails and shotcrete hidden by architectural panels or other suitable covering

- There is limited road and construction width at the site for equipment access and panel installation.
- Undulating shape of the slope would make it difficult to install panels without additional excavation.
- Panels poses difficulty for long term slope risk management as slopes require ongoing inspection and panels would make this very difficult. Removal of panels to inspect the slope would require large cranes and many months of planning to organise.

Option 4: Regarding the slope

- This option was deemed unfeasible due to the extensive amount of excavation required – essentially decreasing the slope angle of the entire hillside.

Option 5: Soil nails with mesh and erosion mat

- not suitable for treatment of the hazard due to the soil composition of the slope and the concern for further erosion of soil and additional failures between individual soil nails.

Option 2: Soil Nails and Shotcrete

To progress the design for Option 2, TfNSW engaged GHD to investigate and design for remediation of the slope, employing the use of soil nails and shotcrete option.

A geotechnical investigation of the slope was carried out to inform the design and confirm suitability of the remediation method. The following methodology was followed to collect the required data:

- 33 probes were drilled into the slope from an Elevated Work Platform (EWP) to assess the soil and rock profile. This helped to determine the length and extent of the soil nails required.
- Surface samples were collected for soil classification.
- Post site works including the classification, chemical and shear box testing of collected soil samples in a geotechnical laboratory.

  (GHD, 2021: 1-2)

The final design drawings for Option 2 are included in Annexure B.

As shown in the typical section (Figure 7.1), deep soil nails would be installed into the face of the slope, with reinforcement and a geo-composite strip drain installed behind the shotcrete facing. A crest drain would be installed at the top of the slope failure and a strip drain installed behind the shotcrete at the interface between the soil and the shotcrete. The strip drain would terminate at the toe of the slope to feed into the existing box gutter. The shotcrete face would extend to the existing box gutter, where the slope meets the road (TfNSW, Drawing No 12548561–17551-04).

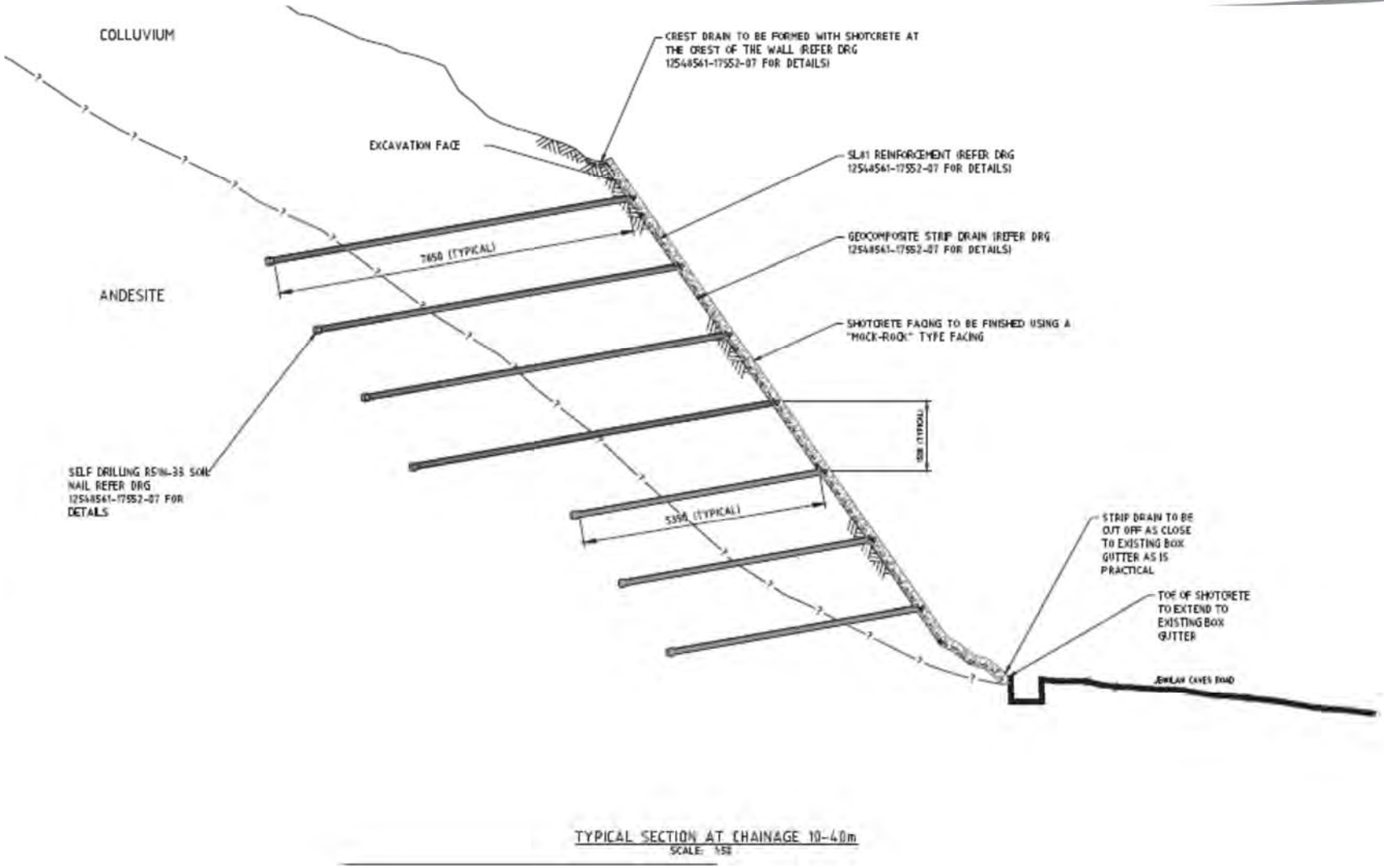


Figure 7:1. Typical section of the failed slope showing proposed soil nails and shotcrete finish (Source: TfNSW, Drawing No 12548561–17551-04 Drawn on 14/10/2021).

Figure 7:2. Examples of mock-rock textured finish on recent shotcrete applied to slope failures in the Sydney region (Source: J. Zyhalak, personal communication, 21 October 2021)

Shotcrete Finish

The design drawings nominate a high-quality mock rock finishing, with the intention for the shotcrete to blend into the existing environment. The realistic treatment for the mock rock is planned to match texture and colour of the adjacent rock outcrops at the corner of the carpark.

TfNSW has provided previous and existing examples of mock rock textured finish. These are included as Figure 7.2.

7.2 Liaison with Heritage NSW and TfNSW Heritage

Following an initial assessment of the potential visual impact of the shotcrete finish on the heritage values of 'Jenolan Caves Reserve' two meetings were held with Heritage NSW and personnel from TfNSW Heritage.

Initial Meeting

An initial meeting was held on 5 October 2021. In this meeting, TfNSW presented the Project and the options were discussed in further detail. Heritage NSW requested further examples of shotcrete applied with a high-quality mock rock finish, be provided as well as investigation of the potential for pockets of vegetation to be incorporated into the design to minimise visual impacts. A follow up meeting was suggested to further discuss the proposal.

Final Meeting

A final meeting was held on 25 October 2021. Advice was sought from TfNSW Centre for Urban Design and specialist Landscape Advisors to provide recommendations and suitability for a range of various vegetation to be grown on the slope with the intention to lessen visual impact of the proposed slope remediation. The advice provided indicated that for this type of work, it is generally better to design a more appropriate finish to the stabilisation treatment than to try and mask it with vegetation i.e. good quality artistic mock rock treatment. Introduced vegetation would likely crack and damage the underlying structure and would require regular maintenance, which would be difficult due to the height of the slope and surroundings (J. Zyhalak, personal communication, 21 October 2021).

It was agreed that a natural rock finish would be preferrable. Examples of shotcrete applied with a high-quality mock rock finish were provided by TfNSW (Figure 7.2) and discussed. TfNSW indicated that they intended to include the following specifics in the construction documentation for the Project:

- A requirement in the contract for the construction contractor to supply details for the contractor who will be applying the mock rock finish, to ensure they are suitably qualified and experienced
- For the mock rock finishing contractor to provide evidence and examples of previously completed work that utilised realistic mock rock finish
- Stipulate that the mock rock finish is to be coloured, sculpted and textured in a manner which provides a finish that is sympathetic to the heritage fabric of the surrounding area and replicates the natural rock textures adjacent to the area and in accordance with TfNSW guidelines.
- The contractor is to provide test panels prior to start of work that shows the colour and texture to be used, to demonstrate suitability and realistic outcomes to be achieved.

Heritage NSW suggested that hold points be considered in the construction program, to provide further control over the final appearance and finish of the shotcrete.

7.3 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. Significant views of this building from the Engineer's cottage and the walking track near Car Park 2 have been identified. Whilst the landscape surrounding Caves House has been progressively modified since the early 1900s when formal gardens were established, remnant of the original gardens, dry stone walls and terraces have survived.

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.

As indicated by the site inspection (Section 5), the failed slope on the 2-Mile section of Jenolan Caves Road is in close proximity and highly visible from Caves House. Day visitor and overnight visitors would be able to view the slope and its repair from both the downstairs windows in the dining room and from the upstairs windows in the guest rooms. The proposed works, as a result, could pose a significant visual impact. For this reason, it is vital that the slope is repaired in a sensitive manner that does not detract from the surrounding environment. Ideally, a stone terrace or modern Gabion wall solution would be used. This would comply with Policy 20. However, as outlined in Section 7.2, the failed slope is unique. The multiple hair-pin turns on the descent and its narrow road width limits access and, due to its height and soil composition, excavation for terracing poses a considerable risk of de-stabilising the slope further. As a result of these constraints, the geotechnical advice is that soil nails and shotcrete is the only viable solution.

Whilst the use of shotcrete is not the preferred option, from a heritage perspective, its application and ability to match natural rock colours and the texture of rock outcrops has greatly improved over the last decade. As can be seen in Figure 7.2, the mock-rock textured finish is highly effective and often unrecognisable when compared with the surrounding rock. The challenge for the subject site, will be to create a realistic rock face on a slope that is largely colluvial soil. There is a significant colour difference between the soil and natural rock. However, through the selection of a highly skilled contractor, the use of test panels and an inspection of the first application of shotcrete during the construction program, there should be a sufficient level of control over the final appearance of the repair to ensure a realistic finish. A staged approach, with notification and approval by Heritage NSW, TfNSW, the Jenolan Caves Reserve Trust (JCRT) and NPWS, would further ensure that the final product matches the natural rock colour, geological pattern and texture of rock outcrops in the surrounding area and does not result in a significant impact on the landscape heritage values of the Reserve or the views from Caves House. These mitigation measures are considered sufficient to avoid impacting the heritage significance of 'Jenolan Caves Reserve', as recognised by its SHR Listing.

Table 7.1 below provides a response to general questions posed by the Statement of Heritage Impact guidelines (Department of Urban Affairs and Planning, 1996 and revised 2002). 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 Statements of Heritage Impact guideline Questions	*Response*
How has the impact of the new work on the heritage significance of the existing landscape been minimised?	The following mitigation measures have been formulated to minimise the impact of the proposed soil nail and shotcrete solution on the cultural landscape of 'Jenolan Caves Reserve': - The selection of a skilled contractor with previous experience in the application of a realistic mock rock finish. - The creation of test panels prior to the application of shotcrete for approval by TfNSW in consultation with Heritage NSW, JCRT and NPWS. - A final inspection and approval of the mock rock finish by TfNSW, Heritage NSW, JCRT and NPWS prior to the completion of works.
Has evidence (archival and physical) of previous landscape work been investigated? Are previous works being reinstated?	Yes. The history of the 2-Mile section of Jenolan Caves Road is well documented and the remnant and more modern landscaping in the Grand Arch Precinct viewed and considered. Given that the failed slope is colluvial soil, it is not possible to reinstate former works.
Has the advice of a consultant skilled in the conservation of heritage landscape been sought? If so, have their recommendations been implemented?	No. The advice of skilled heritage consultant has been sought in this instance. The recommendations of the chosen heritage consultant and Heritage NSW have been implemented.
Are any known or potential archaeological deposits affected by the works? If so, what alternatives have been considered?	No. There are no known or potential archaeological deposits likely to be affected by the works.
How does the work impact on views to, and from the heritage item?	If the mock rock finish is realistic, it should not have a significant impact on the views from Caves House. It the mock rock finish is not applied correctly it will be not be approved by TfNSW, Heritage NSW, JCRT and NPWS and an alternate solution would be sought.

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	95% of the original cutting for the 2-Mile Section of Jenolan Caves Road will be retained and conserved. Only some minor excavation for the crest drain and strip drain.

	compliance with contemporary building codes, safety and engineering standards.	
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. Gabion or modern wall solutions are not possible due to the steep, narrow road and risk of de-stabilising the slope to create terracing.
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.	If the mock rock finish is realistic, it should be unrecognisable compared with the surrounding rock. 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.	If the mock rock finish is realistic, it should not impact on the views from Caves House and not impact on the broader landscape character and fabric of the reserve.
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. If the mock rock finish is realistic, it should not impact on the views from Caves House or its setting.

7.4 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 failed slope on the 2-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. 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 Agriculture, Water and the Environment is not required.

7.5 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 failed slope on the 2-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. 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 Agriculture, Water and the Environment is not required.

8. Conclusions and Recommendations

8.1 Conclusions

- The failed slope on the 2-Mile section of Jenolan Caves Road is located within 'Jenolan Caves Reserve' listed on the NSW SHR (SHR No. 01698). The Reserve attracts more than 230, 000 visitors annually, 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 (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. It was inscribed on the World Heritage List in 2000 for its natural values (Criteria 9 and 10).
- The failed slope is in close proximity to Caves House and, due to the steep terrain and topography, is highly visible from the upstairs and downstairs windows of Caves House as well as from other vantage points directly north east and east of the slope failure.
- Five (5) options were considered to remediate the slope. However, due its poor access and narrow width, only soil nails and shotcrete were found to be a viable solution. Following consultation with Heritage NSW and TfNSW Heritage, mitigation measures and hold points were recommended to provide further control over the final appearance and finish of the proposed mock rock finish.

8.2 Recommendations

Based on the results of this assessment, it is recommended that:

- A copy of this report be provided to the Jenolan Caves Reserve Trust (JCRT) and NPWS for their 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.
- TfNSW include the following specifics in construction documentation and contracts for the 2-Mile Slope Remediation:
    - A requirement in the contract for the construction contractor to supply details for the contractor who will be applying the mock rock finish, to ensure they are suitably qualified and experienced;
    - For the mock rock finishing contractor to provide evidence and examples of previously completed work that utilised realistic mock rock finish;
    - Stipulate that the mock rock finish is to be coloured, sculpted and textured in a manner which provides a finish that replicates the natural rock textures adjacent to the area and in accordance with the TfNSW Shotcrete design guidelines.
- Following the issues of a S.60 Approval, the mock rock finishing contractor provide at least three (3) test panels prior to the first application of shotcrete to show the colour and texture to be used, to demonstrate suitability and realistic outcomes to be achieved. The test panels must measure at least 750 mm x 750 mm with an applied shotcrete thickness of the sculpted layer, showing both the colours and textures proposed to be used. The test panels must be viewed on site and approved by TfNSW, in consultation with Heritage NSW, NPWS and JCRT, prior to the application of shotcrete.

- Once the shotcrete has been applied, the mock rock finish on the failed slope must be viewed and approved by TfNSW, Heritage NSW, NPWS and JCRT prior to the completion of works.
- That the following Hold and Witness Points be included in the Construction Program:

  HOLD POINT 1 – Contractor to Commence Panel Trial at agreed location with TfNSW.

  The Contractor is to provide at least 7 days notification for *in situ* inspections of the three (3) test panels by the TfNSW Project Manager and the TfNSW Senior Manager, Environment and Sustainability.

  WITNESS POINT 1 - Suitable Finish – Texture and Colour.

  Release via the TfNSW Project Manager and the TfNSW Senior Manager, Environment and Sustainability

  HOLD POINT 2 - Sufficient completion of remaining surfaces for each section via TfNSW

  WITNESS POINT 2 – Endorsement of Finish

  On completion of suitable realistic finish on all sections via TfNSW with consultation from DPC, NPWS, JCRT and Heritage NSW.
- TfNSW ensure that TfNSW, Department of Premier and Cabinet (Heritage NSW), NPWS and JCRT personnel are available within the notification dates to physically attend site at the relevant times required and sufficiently delegated to provide context on behalf of their relevant agencies for the witness point on the day.
- In the 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.

Transport for NSW, 2016, *Unexpected Heritage Finds Guideline*, V2.

Transport for NSW, 2016, *Shotcrete design guideline*.

Urbis, 2017, *Jenolan Caves Karst Reserve: Conservation Management Plan*. Unpublished report to Jenolan Caves Reserve Trust.

Internet Sources

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

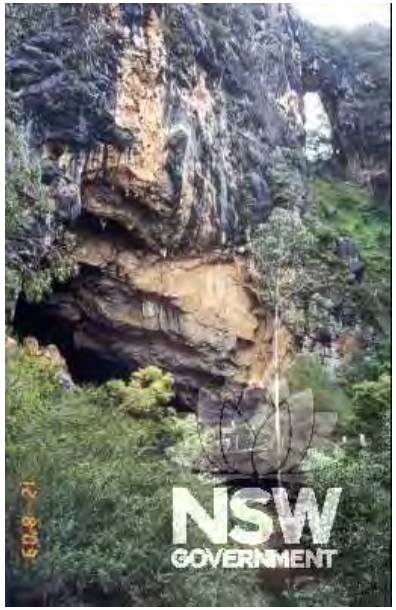
Date: 8/12/2003 12:00:00 AM

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

Annexure B: Final Design Drawings

JENOLAN CAVES RD-2-MILE
SLOPE REMEDIATION DETAILED DESIGN
SLOPE 17552
12548561

SITE OF WORKS

LOCALITY PLAN
SCALE NTS

DRAWING LIST		
DRAWING No.	EDMS No.	DRAWING TITLE
12548561-17552-01		COVER SHEET, DRAWING LIST & LOCALITY PLAN
12548561-17552-02		GENERAL NOTES
12548561-17552-03		INDICATIVE SOIL NAIL ARRANGEMENT - ELEVATION
12548561-17552-04		INDICATIVE SECTION DETAILS - SHEET 1 OF 2
12548561-17552-05		INDICATIVE SECTION DETAILS - SHEET 2 OF 2
12548561-17552-06		SUB-HORIZONTAL DRAIN PIPE DETAILS
12548561-17552-07		SOIL NAIL SHOTCRETE AND DRAINAGE DETAILS

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
0	100% DETAILED DESIGN ISSUE	J.S 14.10.21	S.M 14.10.21	A.H 14.10.21

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

GHD GEOTECHNICAL

DRAWN	J. MCMILLAN	14.10.2021
DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD
JENOLAN CAVES RD-2-MILE SLOPE 17552
GEOTECHNICAL
SLOPE REMEDIATION DETAILED DESIGN
COVER SHEET, DRAWING LIST & LOCALITY PLAN

FILE No. 12548651 | SHEET: 1 OF 1 | A1
STATUS: 100% DETAILED DESIGN ©
DRG No. 12548561-17552-01 | 0 | EDMS No. - | 0

DF 801*554

Plot Date & Time: 10/14/2021 9:57 AM
Plotted by: JMCMILLAN

GENERAL NOTES

1. THESE DESIGN DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE JENOLAN CAVES 2-MILE SLOPE REMEDIATION 100% DETAILED DESIGN REPORT -Rev 0, REF: 12548561-RPT-GE-002-0.
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 TO ENSURE SUITABILITY FOR 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. METHODOLOGY OF SELF DRILLING SOIL NAIL INSTALLATION SHALL BE PROVIDED.
5. SITE COMPOUND, ACCESS OR OTHER AREAS OUTSIDE OF THE TREATMENT WORKS EXTENTS ARE TO BE REINSTATED TO THE ORIGINAL CONDITION OR BETTER POST CONSTRUCTION.
6. REFER DISCREPANCIES TO THE PRINCIPAL BEFORE PROCEEDING WITH WORK.
7. NOMINATION OF PROPRIETARY ITEMS DOES NOT INDICATE EXCLUSIVE PREFERENCE, BUT INDICATES REQUIRED PROPERTIES OF ITEM. SIMILAR ALTERNATIVES HAVING REQUIRED PROPERTIES MAY BE OFFERED FOR APPROVAL. APPROVAL DOES NOT AUTHORISE A VARIATION TO THE CONTRACT. INSTALL PROPRIETARY ITEMS IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
8. GIVE TWO WORKING DAYS (48 HOURS) NOTICE SO THAT INSPECTION MAY BE MADE OF CRITICAL STAGES OF WORK INCLUDING BUT NOT LIMITED TO WITNESS POINTS.
9. INSPECTIONS AND REVIEWS UNDERTAKEN BY THE PRINCIPAL OR OTHERS DO NOT RELIEVE THE CONTRACTOR OF RESPONSIBILITY FOR COMPLIANCE WITH DRAWINGS.
10. DO NOT OBTAIN DIMENSIONS BY SCALING FROM DRAWINGS.
11. EXISTING STRUCTURES SHOWN ON DRAWINGS ARE IN APPROXIMATE LOCATIONS ONLY.
12. CONTRACT SOIL NAIL LENGTHS 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 LENGTH CHANGES TO ACHIEVE THE MINIMUM SOCKET REQUIREMENTS NOMINATED.
13. NO KNOWN SERVICES ARE LOCATED WITHIN THE WORK SITE. CONTRACTOR TO CONFIRM BY ADOPTING INDEPENDENT SERVICES SEARCHES AND CONSTRUCTION PROTOCOLS.

SCHEDULE OF QUANTITIES.

1	SLOPE PREPARATION WORKS (INCL. SCALING, GROOMING, EXCAVATION AND DE-VEGETATION).	m^3	325
2	SUPPLY AND INSTALLATION OF 8m LONG R51N-33 SOIL NAILS.	No.	88
3	SUPPLY AND INSTALLATION OF 6m LONG R51N-33 SOIL NAILS.	No.	105
4	SUPPLY AND INSTALLATION OF 5.5m LONG R51N-33 SOIL NAILS	No.	66
5	SUPPLY AND INSTALLATION OF REINFORCED SHOTCRETE FACING (225mm MIN STRUCTURAL THICKNESS).	m^2	650
6	SUPPLY AND INSTALLATION OF MOCK-ROCK FACING (THICKNESS TO BE DETERMINED BY THE CONSTRUCTION CONTRACTOR).	m^2	650
7	SUPPLY AND INSTALLATION OF R40 HORIZONTAL DRAINS	Linear m	103
8	SUPPLY AND INSTALLATION OF 150mm HDPE STRIP FILTER DRAINS	Linear m	231
9	SUPPLY AND INSTALLATION OF CREST DRAIN AT CREST OF SLOPE.	Linear m	70

THE ABOVE QUANTITIES ARE INDICATIVE AND DO NOT MAKE ALLOWANCE FOR WASTAGE, DAMAGE DURING CONSTRUCTION OR CONTINGENCY. SUCH APPROPRIATE ALLOWANCES FOR WASTAGE, DAMAGE DURING CONSTRUCTION OR CONTINGENCY SHOULD BE CONSIDERED BY THE CONTRACTOR AS NECESSARY AND SHALL NOT CONSTITUTE A VARIATION.

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. REFER TO DESIGN REPORT FOR DETAILS.
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 ANDESITE BEDROCK, BOULDERS, COBBLES, LOOSE TO HARD GRAVELLY CLAY, CLAYEY GRAVEL OR SANDY CLAY COLLUVIUM. SELECTION OF DRILLING EQUIPMENT TO BE SUITABLE FOR EXPECTED GROUND CONDITIONS.
4. FOR ALL SOIL NAILS, CONSTRUCTION CONFORMITY RECORDS ARE TO BE COMPLETED AS PER R64.
5. 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.

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.

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 - MOCK-ROCK FACING.

DRAINAGE

1. 150mm HDPE STRIP FILTER DRAIN TO BE IN ACCORDANCE WITH TfNSW R3557.
2. HORIZONTAL DRAINS TO BE 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.

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 SL72 IS 225mm AND SL81 IS 125mm. LAP LENGTHS ARE TO BE BASED ON THE LARGEST MESH SPACING.

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. HOLD POINT - EXTENT OF WORKS AND SET OUT OF NAIL LOCATIONS. (INCLUDING SURVEY OF THE LOCAL SITE CHAINAGE SYSTEM)
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. HOLD POINT - SUBMISSION OF MOCK-ROCK PROPOSALS FOR FINAL PROFILE
16. WITNESS POINT - SHOTCRETE MESH PLACEMENT AND WALL DRAINAGE (TfNSW R68 CL. 5.5 AND CL. 5.6).
17. WITNESS POINT - SHOTCRETE PLACEMENT (TfNSW R68 CL. 7).
18. HOLD POINT - SUBMISSION OF SHOTCRETE TEST RESULTS (TfNSW R68 CL. 8.5).

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

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 THE CONCRETE JERSEY KERB TYPE BARRIERS ENSURE LOCAL PROJECT CHAINAGE IS SETOUT. CONFIRM THE EXTENT OF WORKS WITH THE PRINCIPAL.
6. CONDUCT FACE SCALING, EXCAVATION AND GENERAL DE-VEGETATION (INCLUDING STUMP GRINDING) OF THE SLOPE OF VEGETATION WHICH MAY IMPACT THE INSTALLATION OF SOIL NAILS, REINFORCING MESH AND SHOTCRETE UNDER SUPERVISION OF THE PRINCIPAL OR THE PRINCIPAL'S GEOTECHNICAL REPRESENTATIVE.
7. SET OUT SYSTEMATIC SOIL NAIL LOCATIONS AT HORIZONTAL AND VERTICAL SPACING NOMINATED. SOIL NAILS MAY BE RELOCATED BY THE PRINCIPALS REPRESENTATIVE TO INTERSECT GEOTECHNICAL HAZARDS IDENTIFIED.
8. INSTALL SUITABILITY NAILS. NAILS SUBJECT TO SUITABILITY TESTING ARE ADDITIONAL TO THE PERMANENT NAILS AS DIRECTED BY THE PRINCIPALS REPRESENTATIVE.
9. CONDUCT SUITABILITY TESTING IN ACCORDING WITH TfNSW R64.
10. CONFIRM SUITABILITY TEST RESULTS WITH THE PRINCIPAL.
11. INSTALL PRODUCTION NAILS. IT IS RECOMMENDED THAT SOIL NAILS ARE INSTALLED IN A "TOP TO BOTTOM" APPROACH. HOWEVER THIS IS AT THE DISCRETION OF THE CONSTRUCTION CONTRACTOR.
12. CONDUCT ACCEPTANCE TESTING .
13. SET-OUT HORIZONTAL DRAINS.
14. INSTALL HORIZONTAL DRAINS AND STRIP DRAINS.
15. INSTALL INITIAL SHOTCRETE LAYER
16. INSTALL STEEL WIRE MESH IN ACCORDANCE WITH TfNSW R64 & R68 AND THE DRAWINGS. INSTALL FACE PLATES AND TENSION NAILS.
17. APPLY INTERMEDIATE LAYER OF SHOTCRETE.
18. APPLY FINAL LAYER OF SHOTCRETE AND FINISH AS DIRECTED BY THE PRINCIPAL.
19. CONDUCT SUITABILITY TESTING Of SHOTCRETE.
20. RESTORE SITE TO ITS ORIGINAL CONDITION, OR BETTER, REPAIRING ANY DAMAGE TO ROAD PAVEMENT OR FURNITURE (E.G. GUARD RAILS/POSTS, SIGNPOSTS, ETC.).

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CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: AHD Datum | SCALE: NTS

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DESIGNED	J. SCOGNAMIGLIO	14.10.2021
DRG CHECK	H. WARR	14.10.2021
DESIGN CHECK	S. MORTIMER	14.10.2021
APPROVED	A. HUNTER	14.10.2021

JENOLAN CAVES ROAD

JENOLAN CAVES RD-2-MILE SLOPE 17552

GEOTECHNICAL

SLOPE REMEDIATION DETAILED DESIGN

GENERAL NOTES

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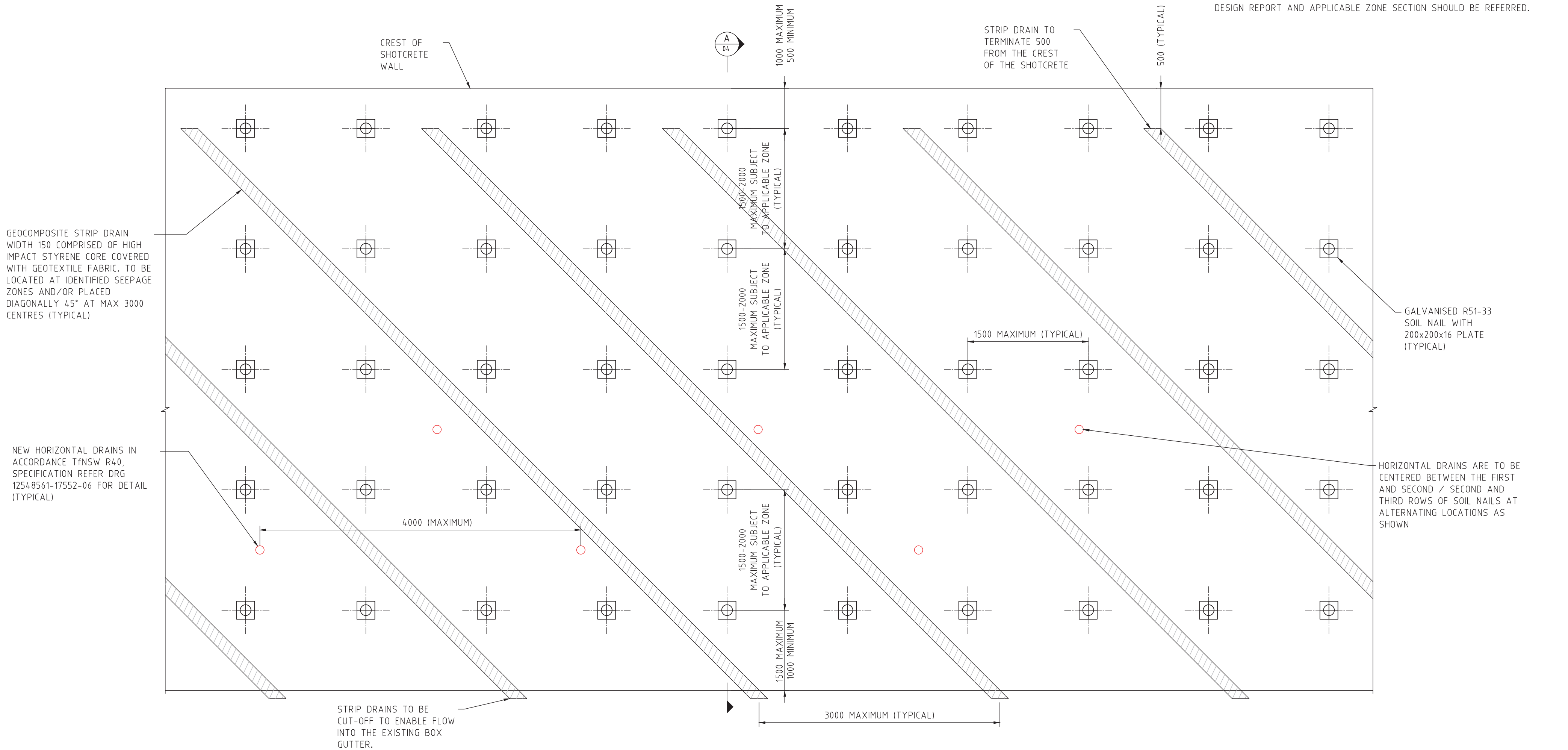
Plot Date & Time: 10/14/2021 10:18 AM
Plotted by JMCMILLAN

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.
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.



LEGEND

SOIL NAIL

HORIZONTAL DRAIN

SOIL NAIL WALL - TYPICAL ELEVATION

SCALE: NTS

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SLOPE REMEDIATION DETAILED DESIGN

INDICATIVE SOIL NAIL ARRANGMENT - ELEVATION

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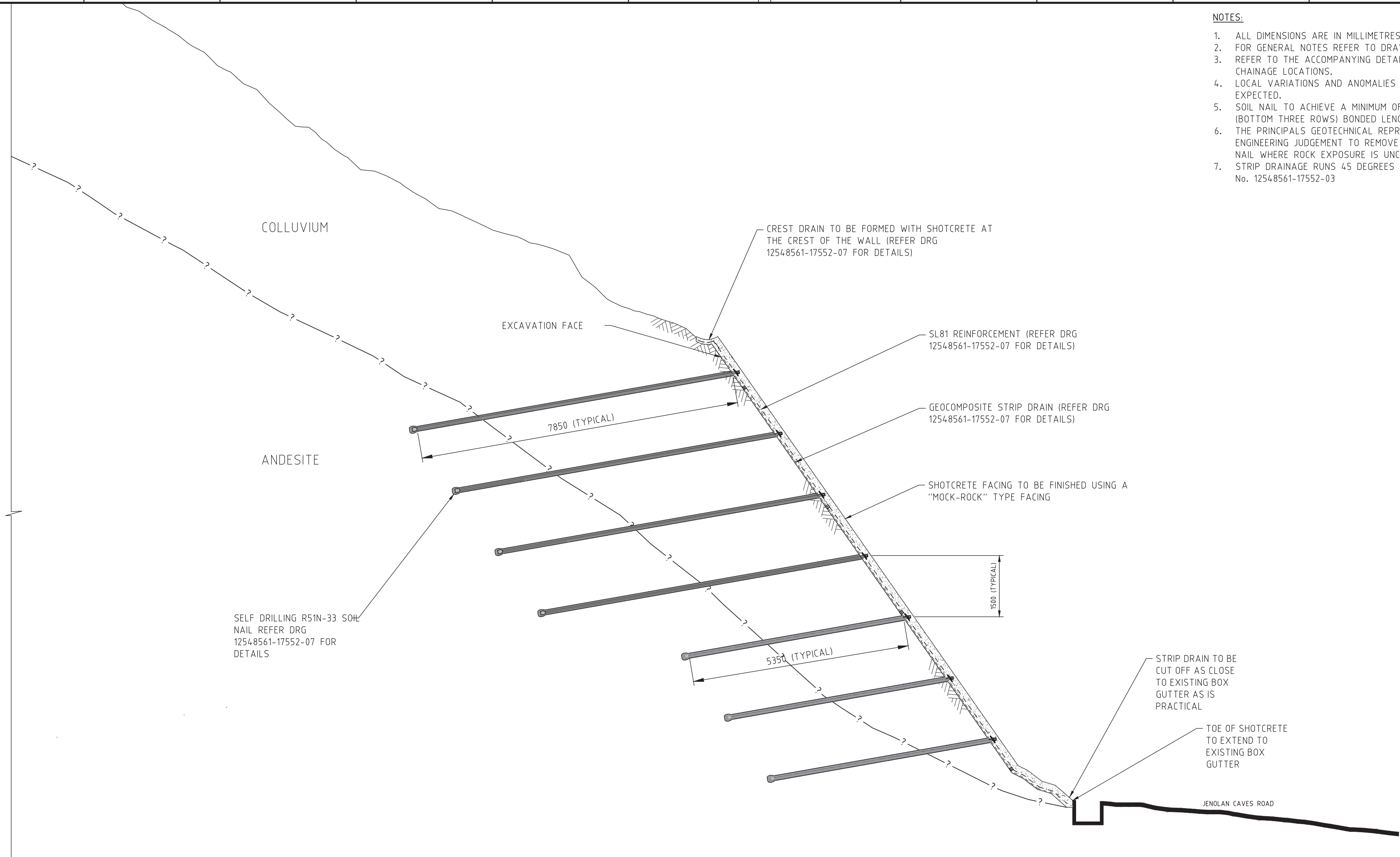

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.
3. REFER TO THE ACCOMPANYING DETAILED DESIGN REPORT FOR CHAINAGE LOCATIONS.
4. LOCAL VARIATIONS AND ANOMALIES IN GROUND CONDITIONS MUST BE EXPECTED.
5. SOIL NAIL TO ACHIEVE A MINIMUM OF 7850 (TOP 4 ROWS) OR 5350 (BOTTOM THREE ROWS) BONDED LENGTH.
6. THE PRINCIPALS GEOTECHNICAL REPRESENTATIVE MAY USE ENGINEERING JUDGEMENT TO REMOVE OR SHORTEN THE BOTTOM SOIL NAIL WHERE ROCK EXPOSURE IS UNCOVERED DURING SCALING WORKS.
7. STRIP DRAINAGE RUNS 45 DEGREES TO THE FACE AS PER DRAWING No. 12548561-17552-03

TYPICAL SECTION AT CHAINAGE 10-40m
SCALE: 1:50

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0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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GEOTECHNICAL
SLOPE REMEDIATION DETAILED DESIGN
INDICATIVE SECTION DETAILS - SHEET 1 OF 2

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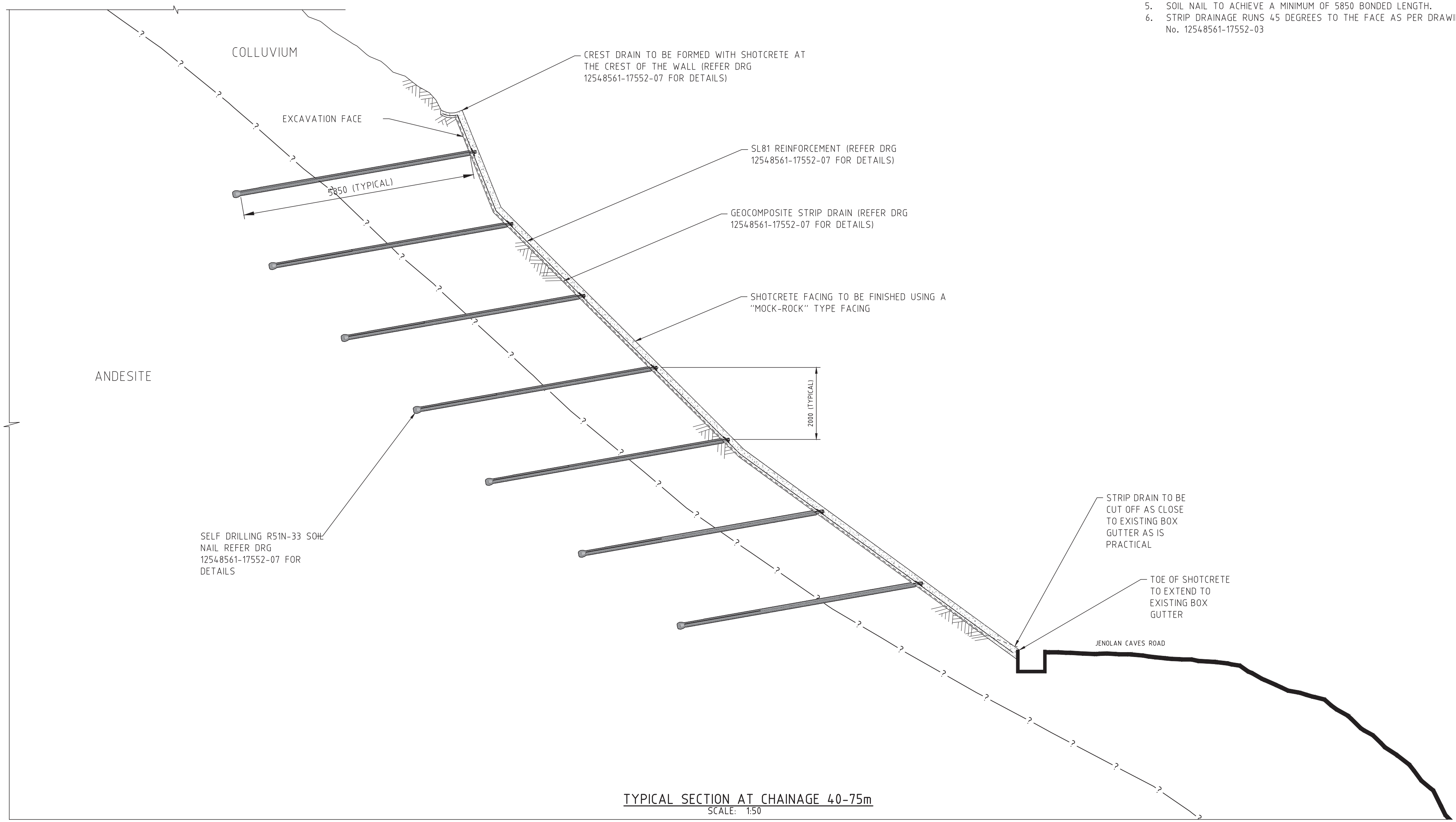
3. REFER TO THE ACCOMPANYING DETAILED DESIGN REPORT FOR CHAINAGE LOCATIONS.
4. LOCAL VARIATIONS AND ANOMALIES IN GROUND CONDITIONS MUST BE EXPECTED.
5. SOIL NAIL TO ACHIEVE A MINIMUM OF 5850 BONDED LENGTH.
6. STRIP DRAINAGE RUNS 45 DEGREES TO THE FACE AS PER DRAWING No. 12548561-17552-03



TYPICAL SECTION AT CHAINAGE 40-75m

SCALE: 1:50

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0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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NOTES:

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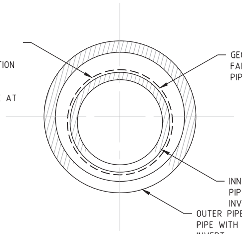
2. FOR GENERAL NOTES REFER TO DRAWING No. 12548561-17552-02.

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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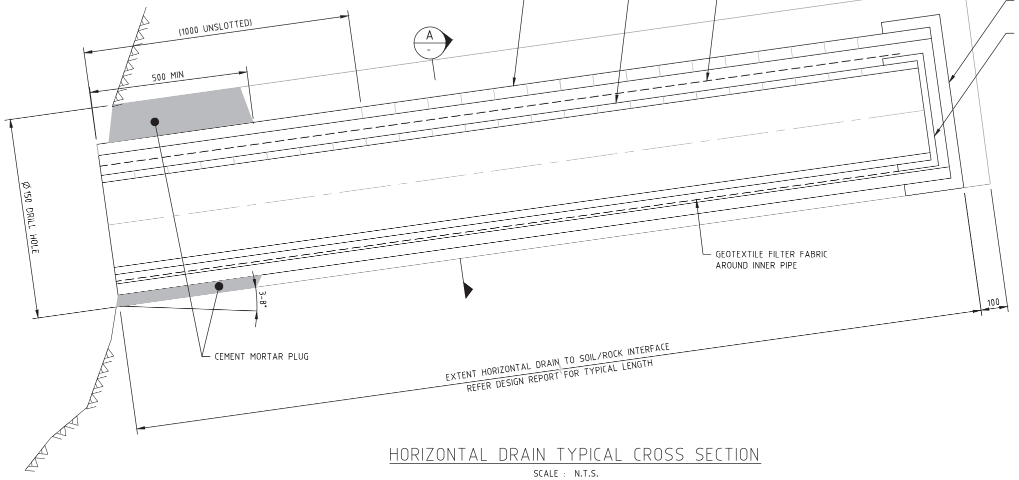

HORIZONTAL DRAIN TYPICAL CROSS SECTION

SCALE : N.T.S.

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SLOPE REMEDIATION DETAILED DESIGN

SUB-HORIZONTAL DRAIN PIPE DETAILS

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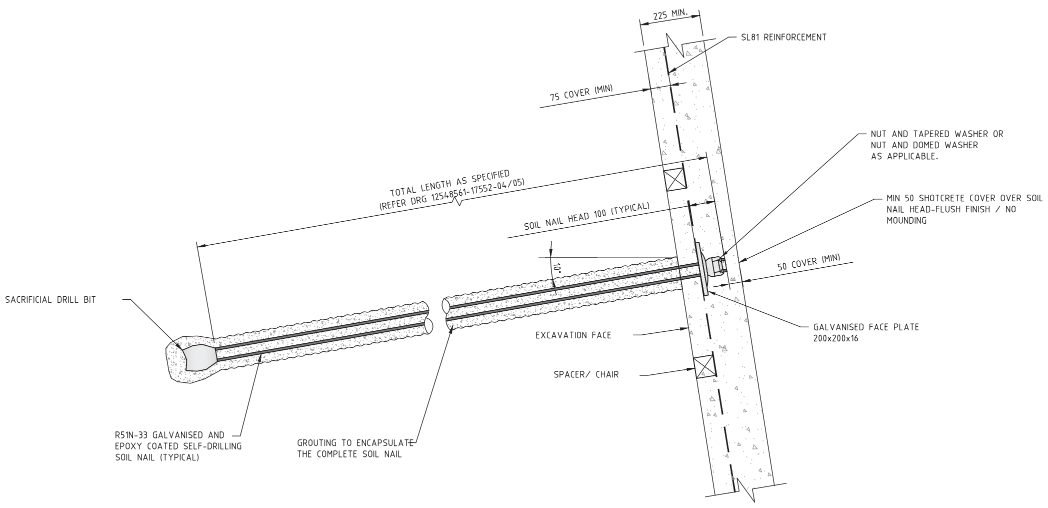
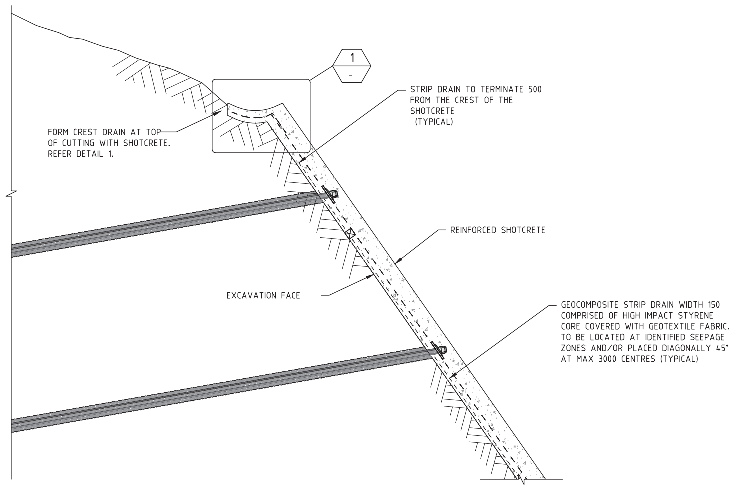


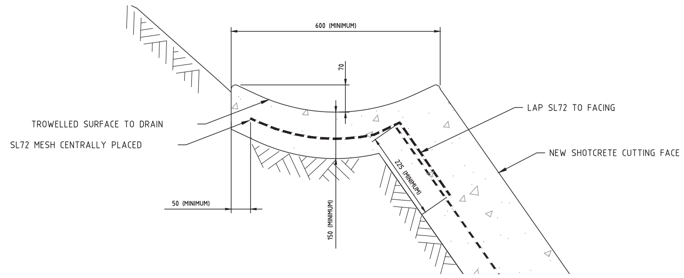
DECLINED GROUTED SOIL NAIL DETAIL

SCALE : N.T.S.



TYPICAL DRAINAGE DETAILS

SCALE : NTS



1 - DETAIL

SCALE : NTS

CREST DRAIN DETAILS (TYPICAL)

SCALE : NTS

SOIL AND ROCK MATERIAL PROPERTIES ASSUMED IN DESIGN

MATERIAL	BULK UNIT WEIGHT (kN/m^2)	EFFECTIVE FRICTION ANGLE (°)	EFFECTIVE COHESION (kPa)	NAIL DESIGN WORKING LOAD (kN/m)
COLLUVIUM	19	32	7	38.75
ANDESITE	26	50	180	38.75

SOIL NAIL DETAIL

PARAMETER	REQUIREMENTS	REQUIREMENTS
ZONE	ZONE 1 (CH 10-40)	ZONE 2 (CH 40-75)
SOIL NAIL BAR SIZE	R51N-33	R51N-33
SOIL NAIL BAR LENGTH	8m (7.85m BONDED) 5.5m (5.35m BONDED)	6m (5.8m BONDED)
HORIZONTAL NAIL SPACING	1.5m (MAX)	1.5m (MAX)
VERTICAL NAIL SPACING	1.5m (MAX)	2.0m (MAX)
SOIL NAIL INCLINATION	10° BELOW HORIZONTAL	10° BELOW HORIZONTAL

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JENOLAN CAVES ROAD

JENOLAN CAVES RD-2-MILE SLOPE 17552

GEOTECHNICAL

SLOPE REMEDIATION DETAILED DESIGN

SOIL NAIL SHOTCRETE AND DRAINAGE DETAILS

FILE No. 12548651 SHEET: 1 OF 1 A1

STATUS: 100% DETAILED DESIGN ©

DRG No. 12548561-17552-07 0 EDMS No. - 0

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File Plotted: \\AU\Sydney\Projects\21\010120\Geo_gint projects\CURRENT PROJECTS\5_12548561_Jenolan Caves\Drawings\Geotech\12548561-17552-07.dwg

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Plot Date & Time: 10/14/2021 10:50 AM

Plotted by: JMCMILLAN

March 2022