Interim Reopening of Wolgan Road

Geotechnical Report

Lithgow City Council

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→ The Power of Commitment

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Executive summary

This report sets out an interim strategy to restore controlled access to Wolgan Road while managing geotechnical risk. Recent investigations (boreholes, field and laboratory testing) have been used to develop a two-stage mitigation program. Stage 1 introduces immediate measures for restricted access with targeted traffic management, barrier adjustments, drainage restoration, local earthworks, and pothole repairs. Stage 2 delivers upgrades for broader use, including full-length barrier repairs, pavement rehabilitation, localised widening, and advisory signage. A Swept Path Assessment confirms the corridor is generally navigable for a representative Heavy Rigid Truck (12.5 m length, 4.3 m height, 2.5 m width), with the primary constraints located in segments awaiting pavement remediation under the Stage 1 works.

The proposed risk mitigation measures are twofold, comprising operational controls and road safety upgrades. Operational controls during the interim reopening are set out in the Trigger Action Response Plan (TARP), which defines triggers from visual inspections and rainfall monitoring and initiates actions ranging from heightened inspection to temporary or full closure in general alignment with ALARP principles (As Low As Reasonably Practicable). The premise of the TARP is to reduce risk to road users to ALARP by increasing vigilance regarding developing geotechnical hazards and rainfall conditions. Secondly, the road safety improvements aim to reduce geotechnical and road safety related risks through a combination of repairs and improvements to the road and associated road furniture. These works include traffic management/ control, hazard warning/ advisory signage, drainage and culvert clearance, repairs to the road surface and localised embankment and cutting repairs.

Reopening Wolgan Road is critical for community connectivity and access to services and local businesses within Wolgan Valley. GHD remains available to assist Council and the Wolgan Valley community throughout the interim reopening and subsequent stages.

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1. Introduction

1.1 Purpose of this report

The purpose of this report is to document the interim design solution for the controlled, interim reopening of the closed section of Wolgan Road. It sets out the minimal works, operational controls and risk-management framework required to reinstate limited access in a cost-effective manner. The interim measures are intended to reduce road-user risk exposure through enhanced monitoring and operational controls.

The work has been carried out in accordance with our proposal dated 9 October 2025 (Your Ref: TEN 03/25 and LCC004G).

1.2 Scope and limitations

This report has been prepared by GHD for Lithgow City Council and may only be used and relied on by Lithgow City Council for the purpose agreed between GHD and Lithgow City Council as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Lithgow City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report and outlined in Section 1.3. GHD disclaims liability arising from any of the assumptions being incorrect. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

1.3 Assumptions

This report should be read in conjunction with our geotechnical standard notes included in Appendix A and Appendix I.

2. Site description

The Wolgan Road project site is located in the Wolgan Valley, approximately 23 km north of Lithgow, NSW. Wolgan Road is an important access route for the Wolgan Valley community and provides the primary vehicular access to the Emirates One&Only Resort. The road has been closed to general traffic since 2022 due to perceived landslide risks and associated pavement damage.

In response, a temporary four-wheel-drive-only access track known as the Donkey Steps has been constructed and opened for resident use. However, due to its steep gradients, this track is unsuitable for two-wheel-drive vehicles, vehicles towing trailers, and many heavy vehicles. As such, it does not represent a practical long-term access solution for the Wolgan Valley.

The section of Wolgan Road discussed in this report is approximately 1.95 km long, beginning at the locked gate near the Wolgan Valley Lookout and ending near the intersection with the Donkey Steps track towards the toe of the escarpment. This section of road has been colloquially referred to as “The Gap” for many decades.

2.1 Regional geology

Wolgan Valley is situated near the western edge of the Sydney Basin within the Blue Mountains Plateau. The Sydney Basin is comprised of Carboniferous to Triassic aged strata that extends north towards Newcastle, south towards Batemans Bay and westwards to the Lachlan Fold Belt near Lithgow.

The route of Wolgan Road traverses geological formations from both the Narrabeen Group and the Illawarra Coal Measures. The approximate extent of each geological unit with respect to the road alignment is summarised in Table 1 based on publicly available geological data (NSW Seamless Geology data package). The site is located within an area broadly known as the Western Coalfield in the Lithgow region. The Western Coalfield contains minimal structural disturbance, with a regional dip in the Lithgow area of less than one degree with a dip direction towards approximately 65 degrees.

Table 1 Summary of geological units along Wolgan Road

Group	Formation	Description	Section of Wolgan Road
Narrabeen (Grose Subgroup)	Banks Wall Sandstone	Fine- to coarse-grained, cross-bedded quartz sandstone with numerous lenticular grey-green claystone bands.	Prominent cliff forming unit at the top of Wolgan Road (i.e. cliffs adjacent to road near the lookout).
Narrabeen (Grose Subgroup)	Burra-Moko Head Sandstone	Quartzose to quartz-lithic sandstone with common cross-bedding. Minor green to grey claystone horizons.	Prominent cliff forming unit at the top of Wolgan Road (i.e. cliffs adjacent to road near the lookout).
Narrabeen	Caley Formation	Claystone, shale, fine- to coarse-grained, quartz-lithic sandstone with common cross-bedding.	Only exposed in lower few metres of cliff near the top of “The Gap”. This unit is then covered by colluvium above the road and not exposed.
Illawarra Coal Measures - Cullen Bullen Subgroup, Charbon Subgroup & Wallerawang Subgroup	NA	Mudstone, siltstone, claystone, sandstone, conglomerate, coal, torbanite, siliceous claystone.	Wolgan Road is directly underlain by this unit for the majority of the site area, starting from the upper section of the road, before the first gully. Unit is exposed in numerous upslope road cuts, particularly along the lower section of the road.

The Grose Subgroup is undifferentiated in the publicly available geological mapping, meaning that the contact between the Banks Wall Sandstone and the Burra-Moko Head Sandstone is not known. The Mount York Claystone unit is typically located between the two abovementioned sandstone units however the presence of this unit at the site is uncertain. It is possible the Mount York Claystone is exposed near the crest of the prominent

near-vertical cliff face at the top of The Gap where thinly bedded reddish claystone units form a recessive horizon beneath a thickly bedded sandstone unit that caps the cliff.

The Banks Wall Sandstone is reported to have a maximum thickness of about 115 m and typically comprises quartzose sandstone with a small percentage of lithic fragments. It contains numerous lenticular greenish claystone horizons. Near surface exposures of the Banks Wall Sandstone are often described as ‘friable’ due to unusual behaviour whereby the sandstone rapidly breaks down following excavation. TfNSW have experienced this behaviour following the construction of cuttings that have been laid back at shallow angles. The sandstone exposed in the cuttings reportedly breaks down and is prone to erosion. Consequently, we understand TfNSW funded a research project into the behaviour of the Banks Wall Sandstone with some of the results published in Khoshini et al. (2020).

Khoshini et al. (2020) studied the upper parts of the Banks Wall Sandstone which they describe as a very weak and friable sandstone comprising mostly of sub-rounded to sub-angular quartz grains embedded in a clay matrix reacted with lime with occasional yellow iron oxidation. Mineralogically it is reported to be composed of 84 to 91% of quartz, 7 to 12% of Kaolinite and 2 to -4% of Aragonite.

The Mt York Claystone is the lowermost widespread ‘redbed’ unit in the Narrabeen Group. The maximum reported thickness is up to about 13 m. The claystone usually comprises two red-brown claystone layers separated by a quartz-lithic sandstone, however in some locations only one claystone layer is present. The claystone typically comprises a red-brown siltstone and claystone that is mottled green and grey in parts.

The literature also suggests that the claystone can be laterally quite variable with any variations to the general appearance and make-up of the claystone. At some locations the Mt York Claystone may not be present at all. McHugh (2013) notes that the average thickness of the Mt York Claystone in the vicinity of the nearby Spingvale Collery is about 22 m and the unit has a gradational lower boundary with the Burra-Moko Sandstone below. That is, thick claystone bands also occur within the underlying formation, and it is sometimes debatable where the boundary should be defined.

The Burra-Moko Head Sandstone is the most prominent cliff forming unit in the Blue Mountains. It is typically cross bedded and displays well developed jointing. It comprises medium to coarse grained quartzose to quartz-lithic sandstones. Claystone horizons are reported to be common but thick claystone beds are rare.

The Caley Formation is made up of five members of alternating fine and coarse-grained units and has a reported maximum thickness of up to about 46 m. The sandstones of the Caley Formation are fine to coarse grained and quartz lithic with some lithic pebbles. The claystone units consist of grey and greenish grey claystone with interbedded shale and siltstone.

The Illawarra Coal Measures have a reported maximum thickness of up to about 230 m and are divided into two subgroups in the project area, the Nile Sub-Group and the Charbon Sub-Group. The Nile Sub-Group comprises various interbedded sedimentary units including coal, sandstone, claystone, shale and conglomerate. The Charbon Sub-Group comprises siltstone, claystone and major coal seams such as the Katoomba Seam. Coal seam thicknesses vary markedly and are reported to have thicknesses of between 2 m and 12.5 m.

3. Geotechnical investigation

3.1 Preliminaries

Prior to attending site and in accordance with GHD's occupational health and safety policy, a Job Safety and Environmental Assessment (JSEA) and Health and Safety Plan (HSE) was prepared for the site work. The site staff were briefed on the requirements set out in the JSEA, prior to commencing fieldwork.

A project safety briefing for site personnel was completed prior to commencement of the field investigation. Relevant plans of buried utilities were obtained from the 'Before You Dig Australia' service.

3.2 Scope of work

The geotechnical investigation comprised six boreholes as summarised in Table 2, represented on plans in Appendix E.

Table 2 Borehole investigation summary

Borehole ID	Easting (m)	Northing (m)	Wolgan Road Chainage (m)	Depth (m BGL)	Termination reason
BH201	230951.56	6310596.52	CH 0 + 715	7.00	Target depth, bedrock encountered
BH202	230948.87	6310579.13	CH 0 + 694	4.70	Target depth, bedrock encountered
BH203	230939.09	6310551.99	CH 0 + 666	9.30	Target depth, bedrock encountered
BH204	231068.59	6309982.45	CH 0 + 034	3.18	Target depth, bedrock encountered
BH205	231062.37	6309984.72	CH 0 + 037	3.25	Target depth, bedrock encountered
BH206	231071.21	6309982.08	CH 0 + 045	2.50	Target depth, bedrock encountered

3.3 Investigation methodology and execution

The geotechnical site investigation was carried out over the 19th and 20th November 2025. The investigation was designed to assess the depth to bedrock and assess subsurface conditions.

The fieldwork was carried out under full-time supervision of a suitably qualified GHD geotechnical engineer. The encountered soil and rock profiles were logged by an experienced geotechnical engineer in accordance with Australian Standards (AS 1726:2017) and GHD's standard procedures. Logs were reviewed by a Senior Geotechnical Engineer. Borehole logs and core photographs are presented in Appendix C and should be read in conjunction with GHD standard sheets provided in Appendix A.

Borehole coordinates were recorded on site using a handheld Garmin inReach with a typical accuracy of +/- 5 m as well as chainage and offset measured from the concrete V-drain located along the uphill edge of the roadway.

3.3.1 Drilling

Boreholes were drilled using a Hanjin DB8 track-mounted drill rig, operated by LP Drilling. Boreholes were advanced using solid flight auger with a Tungsten Carbide (TC) blade bit in conjunction with Standard Penetrometer Tests (SPTs) through the soil profile. Upon practical refusal, the hole was cased with HWT and the drilling method switched to HQ3 coring for rock recovery.

Upon completion of drilling, boreholes were grouted, topped with bitumen cold mix and tamped at surface level.

3.3.2 Field mapping

Concurrent with the drilling works, a GHD engineering geologist established a chainage along the road alignment to guide reference during the remediation planning. Mapping was undertaken along the road, encompassing nearfield upslope and downslope areas, identifying key geological and geomorphological features such as boulders, colluvium, embankment failures, and drainage issues. Structures requiring repair or maintenance, such as damaged culverts, eroded embankments, and compromised retaining elements were recorded.

To support observations, photographs and video footage documented road cuttings, exposed formations, failure zones, and structural defects. Observations included exposures of the Caley Formation and Illawarra Coal Measures, as well as evidence of retrogressive slumping in side-cast embankments and damaged caused by instability as well as poor drainage. The mapping provided input for remediation strategies, including scaling, drainage improvements, and targeted repairs to the road infrastructure.

3.4 Investigation Results

3.4.1 Groundwater

Groundwater was not observed in any borehole during the drilling investigation.

3.4.2 Ground profile

The main geotechnical units encountered during the drilling are summarised in Table 3.

Table 3 Ground Profile Encountered

Origin	Description	Depth Range to base of Unit (m bgl^)					
		BH201	BH202	BH203	BH204	BH205	BH206
Asphalt Pavement	Dark grey	0.02	0.02	-	0.02	0.02	0.02
Fill	Gravelly SAND, brown, fine to coarse grained, subrounded to subangular, dry, medium dense	2.20	1.20	0.5	0.40	1.00	0.50
Colluvium	Varies between Gravelly SAND, Sandy CLAY and Clayey SAND. Generally brown, fine grained, with trace rootlets, with fine angular gravel	4.10	3.80	1.20	0.58	-	-
Extremely weathered rock	Clayey SAND, fine to medium grained, brown grey	-	-	8.27	-	1.15	-
Bedrock	Coal seam, recovered as clayey SAND with gravels, black.	6.2	-	-	-	-	-
Bedrock	Moderately to highly weathered sandstone, fine grained, orange brown	6.65	-	-	-	2.72	0.60
Bedrock	Sandstone (pale grey, fine grained) or siltstone (dark grey)	7.0	4.70	9.30	3.18	3.25	2.50

^mbgl = metres below ground level

3.4.3 Cross sections

Cross section sketches at three key areas along the site were completed for CH040, CH408 and CH715. These show graphical interpretations of the site conditions and are included in Appendix B.

3.4.4 Standard Penetrometer Testing (SPT)

Standard Penetrometer Tests (SPTs) were conducted at 1.5 m depth intervals commencing at 0.5 m bgl. In the fill materials (0.5 m to approximately 1.5 m bgl), SPT N-values typically range between 12–20, indicating a loose to medium-dense consistency. Within the underlying colluvium (>1.5 m bgl), the N-values range between 20–54, reflecting a generally medium-dense to very dense profile. There is no consistent correlation between depth and N-value within either material unit (Figure 1). The results suggest the colluvium is denser and more compact than the overlying fill.

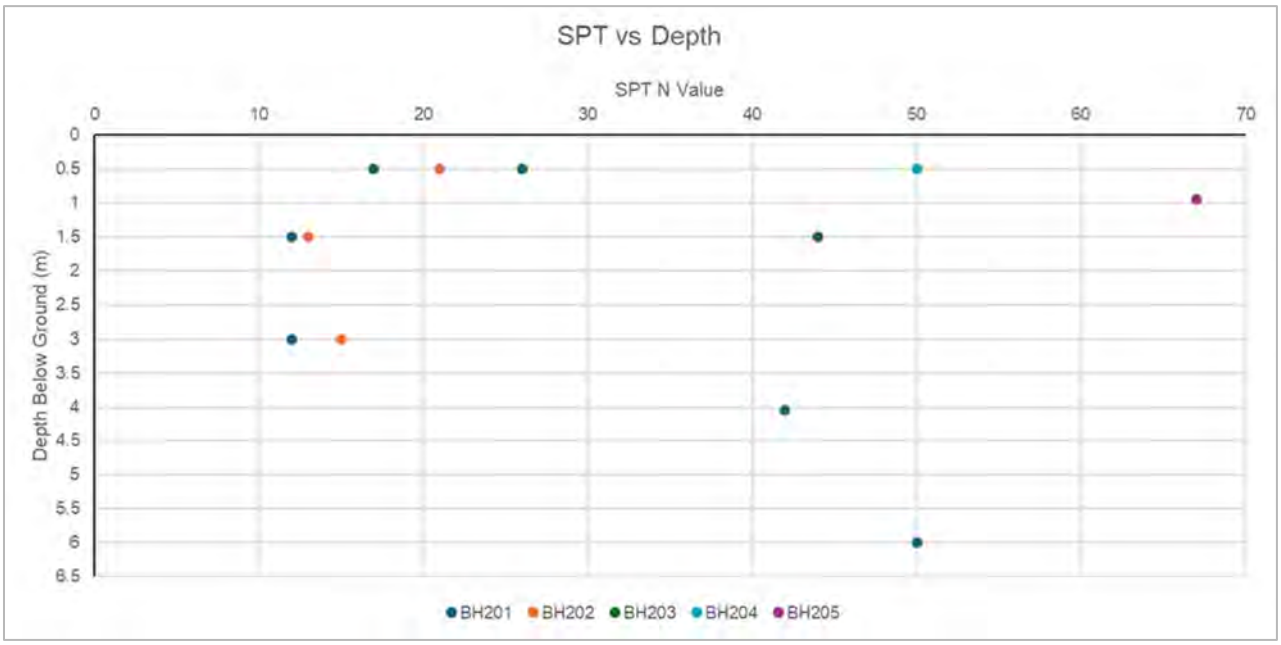

Figure 1 SPT results with depth

3.4.5 Laboratory testing

Point Load Strength testing (PLT) was the only laboratory testing conducted for this investigation. One pair (axial and diametral) of PLTs were completed on the rock core in each borehole except for BH201 as there were no suitable samples. The summary of PLT results is shown in Figure 2 with full results presented in Appendix D.

A range of strengths are reported, with the Is_{50} values ranging between 0.05 MPa and 2.5 MPa, corresponding to “Very Low” to “High” strength rock. All boreholes except BH206 had strengths of “Medium” to “High”. Many results show medium to high strength rock found at a shallow depth.

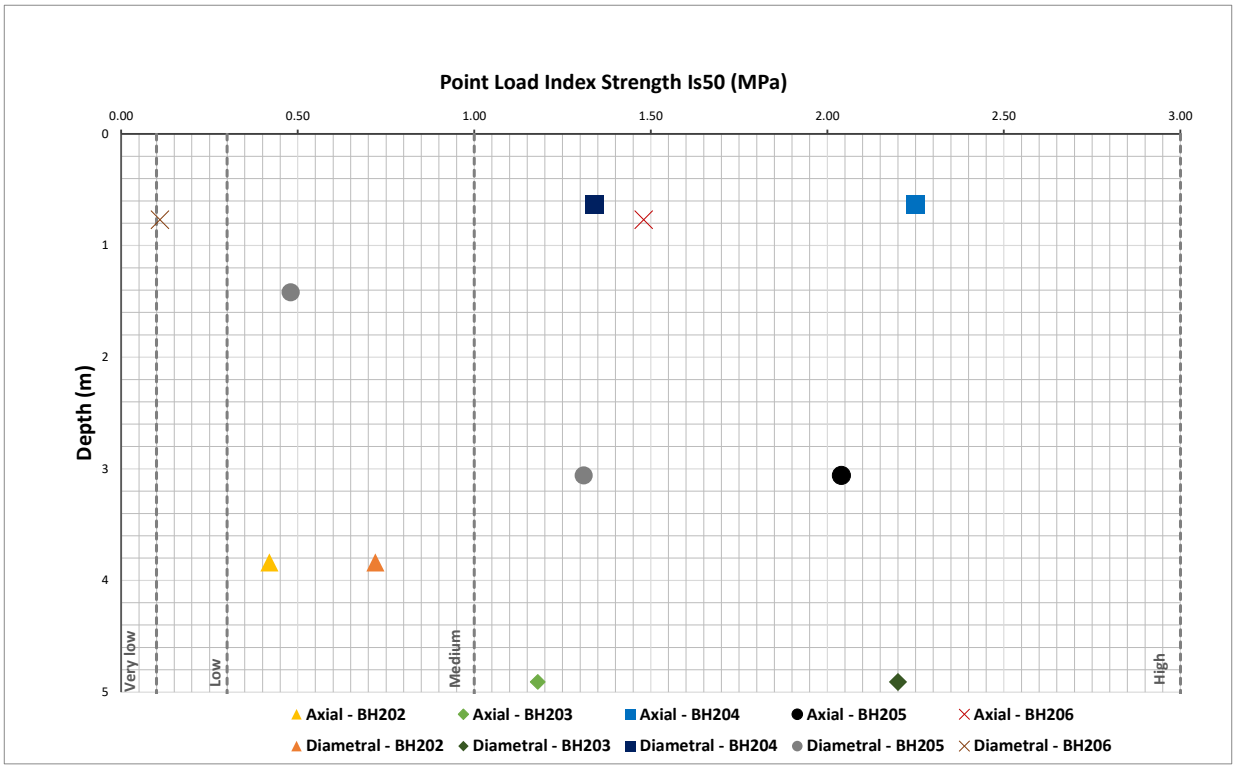

Figure 2 *Point Load Test Results with depth*

3.5 Inferred geotechnical profile

Table 4 summarise material units for the soils and rock encountered during the geotechnical investigations. 2D cross sections have been sketched to assist design and interpretation. Visual and tactile assessment and SPT data were used for lithology classification of assigned unit material design properties and strength correlations. 2D cross sections are provided in Appendix B. Cross section locations are identified in Appendix E.

Table 4 *Material Units*

Soil / Rock Unit	Unit Reference	Depth to layer base, m	Strength / Consistency	Typical Description
Asphalt pavement	Unit 1	0.02	-	Asphalt, dark grey
FILL	Unit 2	0.40 – 4.10	Medium Dense	Gravelly SAND/SILT, dark brown, fine to coarse grained, dry
EXTREMELY WEATHERED MATERIAL	Unit 3A	0.58 to 6.20	Medium Dense	Clayey SAND / SILT, with gravel, pale brown to black, fine to medium grained, dry
	Unit 3B	3.80	Dense	Coal Seam, recovered as clayey SAND with gravels, black.
Sandstone	Unit 4A	0.60 to 6.65	HW to MW	Sandstone, pale grey, fine to medium grained
	Unit 4B	2.50 to 3.25	Fresh	
Siltstone	Unit 5	0.90 to 7.90 (Ultimate unit depth not determined)	SW to Fresh	Siltstone, dark grey

4. Mitigation strategy for temporary road access

4.1 Overview

This mitigation strategy is structured in two sequential stages. Stage 1 focuses on immediate, interim controls to allow limited use of the road by authorised personnel (the community currently relying on the steep *"Donkey Steps"* corridor). Stage 2 introduces broader upgrades to open the road for intermediate use with appropriate safety measures. Stage 3 is the final design phase following interim (Stage 1) and intermediate (Stage 2) mitigation works. The objective of Stage 3 is to deliver permanent engineering solutions for the road corridor, aimed at long term safety, stability, and serviceability, noting that Stage 3 works are outside the scope of this current report.

Table 5 presents a summary of the staged approach with the sections below showing a detailed outline and proposed interventions.

Table 5 Summary of staged approach

Stage 1 - Interim restricted access	Stage 2 – Intermediate access with minor upgrades	Stage 3 - Full access, unrestricted (outside the scope of this report)
Immediate road safety measures enabling limited use by authorised personnel, focusing on traffic control, structural safety, drainage clearance, road surface fixes and earthworks embankment reconstruction.	Additional improvements to open the road for intermediate use, including more extensive earthworks, full-length barrier upgrades, pavement restoration, and cautionary signage.	Permanent engineering solutions for the road corridor, aimed at long-term road safety, stability, and serviceability.

4.2 Stage 1 - Interim restricted access

In Stage 1, the road is open only to authorised personnel. The objective is to implement safety enhancements and prepare the corridor for low-volume, controlled traffic. Measures in this stage are largely temporary, addressing needs in traffic management, structural safety, drainage, and surface repair. The key interventions for Stage 1 are detailed in Table 6

Table 6 Stage 1 - Interim restricted access - remediation measures

ID	Stage 1 – Proposed Measure	~ Chainage (m)	Type of Intervention	Description and Purpose
1.01	Weather Station	TBC by supplier and stakeholders	Weather Monitoring	Requirement of Trigger Action Response Plan outlined in Section 5 and Appendix F.
1.02	Locked gate	0	Traffic Management	Remains as currently installed.
1.03	Advisory Signage at Road Entrance	0	Traffic Management	Install prominent advisory signage at the top (entrance) of the road. The signage will inform drivers of key hazards, warning of narrow winding conditions ahead, remind about the 30 km/hr speed limit (no stopping), and indicate that certain segments are single-lane with traffic lights or yield requirements. The purpose is to immediately make road users aware of the road's limitations/ dangers and the need for cautious driving. Include contact details for reporting hazards. This acts as the first line of communication about the road's status as a mitigated (but not typical) route.

ID	Stage 1 – Proposed Measure	~ Chainage (m)	Type of Intervention	Description and Purpose
				Similar warning signs are displayed at other roads in NSW such as at the commencement of the Bridle Track in NSW. The sign clearly highlights advisory information required to proceed (Figure 3).
1.04	Speed Limit 30 km/hr	0 - 1950	Traffic Management	Impose a 30 km/hr speed limit along the road. This lower speed helps drivers maintain control on narrow or potentially unstable sections, significantly reducing the risk of accidents and allowing more reaction time for unexpected conditions and oncoming vehicles.
1.05	Uphill Traffic Priority	20 - 70	Traffic Management	Grant right-of-way to uphill traffic at a selected narrow location(s). Vehicles traveling uphill (ascending) will have priority, meaning downhill drivers must yield.
1.06	Temporary Traffic Lights	460 - 800	Traffic Management	Install traffic lights at a specific single-lane section of the road. These portable or interim signals will regulate alternating one-way traffic where the road is too narrow for two vehicles to pass safely.
1.07	Localised Armco Barrier Adjustments / Installations	30 - 60 375 - 395 465 - 475 520 - 550 600 - 610 650 - 740 (after earthworks)	Structural Safety	Adjust or install Armco guardrail barriers at specific locations where encroachment from landslide back-scarps or eroded edges threatens the roadway. The adjustments might include moving existing barriers or bolting new sections to existing barriers in areas previously unprotected. The use of semi-permanent temporary concrete barriers has been elected for use between chainage 30 – 60 (refer Appendix H). *Note - Concrete barriers may be used as an interim solution for the Armco barrier repairs/ replacement. The downside for this solution is the loss of transitable road width associated with the barrier. Armco is the preferred solution.*
1.08	L-block retaining Barriers (pending inspection)	480 - 540	Slope Stabilisation	Pending geotechnical inspection and effectiveness of scaling and grooming of the slope: supply and install L-shaped concrete barriers along certain edges of the road to retain upslope colluvium. These precast L-profile barriers will be placed on the uphill side of the road where landslip debris needs to be retained. Their weight and shape provide immediate lateral support to the toe of slopes or the road edge, helping to retain soil and rocks. This prevents further slope collapse into the drain and/or onto the roadway, enabling water to be diverted back into the existing surface drain system. The L-blocks will require anchors to tie them to the surface and assist resistance to mobilised material. With regard to the L blocks at CH 480 – 540, how far these L-blocks can safely be recessed into the slope will determine the need for temporary traffic management (ID1.06). It is ideal that the L-blocks reside behind the V drain, a geotechnical representative should be present during this portion of excavation. L-blocks will require to be cleared out (0.5 m

ID	Stage 1 – Proposed Measure	~ Chainage (m)	Type of Intervention	Description and Purpose
				from top of block) periodically and should be factored into the maintenance schedule for this road.
1.09	Culvert Cleaning x 16	305 338 417 473 585 748 850 1000 1110 1260 1340 1447 1522 1737 1818 1950	Drainage Restoration	Clean out existing culverts that run beneath the road to ensure they function properly. Over time, culverts (pipes or channels under the road) have become clogged with silt, gravel, vegetation, or debris. In Stage 1, maintenance crews will remove these obstructions, restoring each culvert's capacity to carry stormwater. Some of the culvert grates are also to be replaced with a less restrictive grill to limit future potential blockages.
1.10	V-Drain Clearing	0 - 480 540 - 1950	Drainage Maintenance	Clear and re-establish the V-shaped side drains (V-drains) along the full length of the road. Work will involve removing accumulated sediment, leaf litter, and rocks from these drains. Localised concrete repairs will be required where damage has occurred to the drain. Note CH 480-540 has been buried by landslip material, reassessment during construction will determine the feasibility of uncovering and installing L blocks behind (upslope) of the V- drain.
1.10	Minor Earthworks and Slope Regrading	530 – 550 downslope 650 - 740 downslope 720 - 740 upslope	Earthworks/ Slope Stabilization	Conduct localised earthworks to remove failed section of road embankment encroaching into the road corridor (upslope). Remove and disposal of material within the road corridor. Areas specified for repair within the road corridor will require a temporary asphalt spray to seal the surface, link the existing and new surfaces and prevent water ingress into the road.
1.11	Pothole Repairs on Path/Road	0 - 1950 general potholes 650 - 740 after earthworks 900 - 950 full width pavement	Road Surface Maintenance	Patch and repair potholes and surface depressions along full length of the road corridor. All significant potholes will be filled or levelled using appropriate road base material or cold patch asphalt.
1.12	Boulder removal	915	Scaling	Remove/ scale boulder identified (upslope).
1.13	Scaling and grooming	480 - 540 900 - 930 960 - 970 1070 - 1095	Scaling	Remove loose material from slope to reduce potential rock fall hazards that will impact the road.

Upon completion of Stage 1 measures, the road should be more suitable for use by a limited number of vehicles. Authorised personnel will be able to navigate the corridor at slow speeds, with clear right-of-way rules, physical protections (Armco) and improved drainage. Stage 1 should also allow the use of the HRT trucks outlined in the swept path assessment to utilise the corridor.

4.2.1 No guard rail (alternative option)

As an alternation option for Council to consider, the road may be opened to authorised personnel only without reinstating or modifying the existing failed/ removed Armco barriers. Consistent with the Bridle Track (NSW) approach and the advisory signage used there (e.g., “No Guard Rail,” “4WD Only,” “Steep Edges/Inclines,” “Falling Rocks,” “Narrow Winding Road,” “Slippery When Wet”), risk communication would rely on advisory signs at both ends of Wolgan Road. Implementation of this option would preclude HRT (heavy rigid trucks) and any vehicles towing trailers. To manage edge risk, a sprayed boundary/road-edge line can delineate the allowable proximity to exposed edges around failed sections of the road. Ultimately, acceptance of this option rests with the stakeholder (Council), noting the Bridle Track near Bathurst as a current and pragmatic example of this type of application. GHD have not included this option in Stage 1 as it is our understanding that Heavy Rigid Truck (HRT) access is a priority for the community.

Figure 3 Example of advisory signage at the commencement of the Bridle Track, NSW.

4.3 Stage 2 – Increased intermediate access

Stage 2 can be initiated to upgrade the road for intermediate access. This stage can commence in conjunction with Stage 1 for expedience. In Stage 2, the road will be prepared for regular traffic, meaning the interventions are more extensive and suitable for general purpose light vehicles and rigid heavy vehicles.

At the start of Stage 2, advisory signage shall be installed at the road entrance (the top of the road) to alert drivers to conditions ahead. This signage will caution that although the road is open, it remains a mountain pass with hazardous conditions typically associated with these environments. Drivers are warned to proceed carefully, heed the new traffic controls (like the one-way sections or speed limits), and be aware of ongoing works if any.

The focus of Stage 2 is to ensure that the pavement is suitable for normal vehicles. This means that there are no significant steps or sharp edges in the pavement that could damage tyres (particularly on standard road going thin wall tyres) and that there are no steps or bumps in the pavement that would cause ground clearance issues for normal passenger cars. In addition, the Armco railing should be reinstated along the full length of the road to prevent cars from leaving the roadway. The Stage 2 remediation measures are presented in Table 7.

Table 7 Stage 2 – Intermediate access with minor upgrades - remediation measures

ID	Stage 2 – Proposed Measure	~ Chainage (m)	Type of Intervention	Description and Purpose
2.01	Advisory Signage at Road Entrance	-20 - 0	Safety Communication/ Traffic management	Update the signage at the commencement of the road to include information on rockfall risk and further information gathered from Stage 1.
2.02	Full-Length Armco Barrier Upgrade	70 -350 370 - 480 1030 - 1040 1060 - 1150 1160 - 1390 1570 - 1800	Structural Safety	Repair or replace safety barriers along the entire length of the road. In Stage 2, a comprehensive barrier program will be executed: all existing Armco guardrails will be inspected, and any damaged segments will be fixed or replaced. Moreover, new guardrail sections will be installed in stretches that currently lack protection, thereby establishing a continuous safety barrier from start to end. This builds upon Stage 1's targeted barrier placements by ensuring no part of the road is left exposed. The guardrails provide a consistent defence against vehicles leaving the roadway on curves or steep embankment edges. Additionally, proper end-terminals or anchor points will be installed as needed. By the end of this step, the road will have a uniform barrier system meeting standard safety criteria for roads in such terrain.
2.03	Localised Earthworks	1640 - 1700	Slope/Geometry Improvement	Localised earthworks to widen a section of road that has been narrowed with spoil from previous remedial works.
2.04	Pavement Rehabilitation	950 - 1060 1140 - 1260 1275 - 1440 1460 - 1510 1525 - 1870	Road Surface Rehabilitation	Carry out pavement repairs and restoration. All the road's driving surface will be assessed and any remaining issues addressed. This includes repairing any remaining potholes, sealing cracks, and regrading uneven sections, as well as possibly resurfacing with new asphalt where the old pavement has been removed or has been extensively worn or damaged. In Stage 1, only urgent pothole patching was done; Stage 2 ensures the entire road surface is brought up to a reasonable standard.

Implementing Stage 2 measures will transition the road to a functional access route for increased traffic, albeit with safety advisories and remaining restrictions. Stage 2 moves the road from a temporary roadway into a suitable corridor for everyday use under normal weather conditions.

Refer Appendix E for sketches of proposed Stage 1 and Stage 2 works.

4.4 Stage 3 – Permanent road solution

Stage 3 is anticipated to include the detailed design and construction of a permanent road solution. This stage lies outside the scope of this work and is not addressed within this report.

5. Trigger action response plan (TARP)

The Trigger Action Response Plan (TARP) has been designed to provide a risk-based operational framework for managing slope hazards along Wolgan Road during its interim reopening. The TARP defines specific trigger conditions such as, rainfall thresholds and visible ground movement that will initiate predefined actions ranging from inspection frequency to full road closure. Refer to Appendix F for the TARP.

6. Bill of quantities

This Bill of Quantities (BoQ) outlines the measured scope for the interim reopening of Wolgan Road. The quantities are based on our observations and recommendations within this report. The BoQ is split into Stage 1 (Table 8) and Stage 2 (Table 9) outlining reinstatement requirements defined within the drawing set provided within Appendix E. Please note quantities within the below tables have been estimated and should not solely be relied upon for contractor tendering.

6.1 Stage 1 - Restricted access

Table 8 Bill of quantities for Stage 1 interim reopening

No.	Description of item	Units	~ Quantity
1	Supply and install weather station	No.	1
2	Supply and install Road closure/ advisory sign	No.	2
3	Supply and install 30 km/hr R4-1 Speed Sign	No.	2
4	Supply and install R2-4 Priority over oncoming traffic sign	No.	2
5	Clean and repair concrete V-drain	m (meter)	1,940
6	Spot Devegetation/ trimming required for line of sight between CH 0 +10 and 0 +060	m	50
7	Patch and repair pavement to TfNSW M3 Routine Service specification	m	1,940
8	Repair/ replace G4 W beam guardrail barrier (option - concrete temporary barrier)	m	200
9	Clean culvert and supply new inlet grate (Grille opening 100 – 150 mm)	No.	16
10	Supply and install temporary traffic light (battery and or solar). Install dependant on L-Block install from CH 0 + 480 – CH 0 +540.	No.	2
11	Supply and install L-Block (2 m vertical height). *Number dependant on elected L – Block length*	m	60
12	Remove/ scale boulder at CH 0 + 910	No.	1
13	Supply and install rock anchor 28mm diameter, 1 m minimum embedment depth. 2 per barrier. *Number estimated based on 3 m L- block length*.	No.	44
14	Undertake embankment re-construction to R44 Specification (down slope) and small debris cleanup (upslope). Include supply of fill, free draining material and disposal of nonrequired excess material.	m^3	900
15	Seal road surface at the conclusion of earthworks to Transport for NSW (TfNSW). QA Specification R106 – Sprayed Bituminous Surfacing (with Cutback Bitumen).	m^3	450
16	Scaling and grooming of nominated areas	m^2	890

6.2 Stage 2 – Intermediate access

Table 9 Bill of quantities for Stage 2 interim reopening

No.	Description of item	Units	~ Quantity
1	Supply and install updated advisory road closure sign	No.	2
2	Supply and install or repair/ replace G4 W beam guardrail barrier, number assumed no repairs have been undertaken in Stage 1 (210 m)/	m^3	1400
3	Supply and install compatible G4 W beam guardrail barrier terminal	No.	3
4	Undertake earthworks to R44 Specification including removal of bund.	m^3	350
4	Pavement rehabilitation (full corridor width) to Transport for NSW (TfNSW). QA Specification R106 – Sprayed Bituminous Surfacing (with Cutback Bitumen).	m	1490

7. Swept path assessment

The Swept Path Assessment evaluates the ability of vehicles to safely navigate the temporarily reopened section of Wolgan Road. For this assessment, a Heavy Rigid Truck (HRT) was selected, reflecting its likely use for freight transport into the valley. This vehicle type is representative of the largest vehicles expected to require access, with dimensions of 12.5 meters in length, 4.3 meters in height, and 2.5 meters in width. The assessment identifies whether such vehicles can manoeuvre through turns and constrained areas without encroaching on barriers or infrastructure in both directions of travel. This assessment also assumes that oncoming traffic can pull over in discrete areas to allow the heavy rigid to pass. The assessment has been conducted assuming that a vehicle does not have to drive over the V drain that is situated on the upslope side of the corridor.

The swept path assessment indicates that the section of Wolgan Road is mostly usable for vehicle access. However, the primary restrictions for the HRT are associated with areas that require pavement remediation, as outlined in the Stage 1 and Stage 2 remediation. Until these remediation works are completed, some sections may present limitations for HRT vehicle types or under specific conditions.

Refer to Appendix G for the Swept Path Assessment.

8. Constructability assessment

A constructability assessment has been completed by Trodon Pty Ltd. This reviews the design and project requirements to identify pragmatic strategies for efficient construction. It considers worker safety, environmental and sustainability factors, and potential constraints such as utility services, and traffic management. The assessment also evaluates opportunities for construction optimisation, value engineering, and risk mitigation to ensure the project can be delivered safely, cost-effectively, and with minimal community impact. Refer to Appendix H for the Constructability Assessment report.

9. Closure

This report provides an overview of the geotechnical conditions, mitigation strategies, and operational controls for the temporary reopening of Wolgan Road. The findings and recommendations presented herein are based on the investigations and assessments completed to date and are intended to support informed decision-making by Lithgow City Council. GHD remains committed to supporting the safe and effective restoration of access to Wolgan Valley. If you require further clarification or additional information regarding this report, please contact the report author(s).

Appendices

Appendix A

Geotechnical standard sheets

GENERAL NOTES

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The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water depths presented on the test hole logs are the depths of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater depth may differ from this recorded depth depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this depth could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities such as a change is ground surface level. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate surveys, instrumentation techniques and monitoring programmes.

Ref: 5.5.1 Rev 1 Date: 03/05/2024

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in ground conditions do occur in the natural environment, particularly between discrete test hole locations or available observation sites. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural processes.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to GHD for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

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FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

Ref: 5.5.1 Rev 2 Date: 03/05/2024

CORE LOG SHEET NOTES

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The intention of Core Log Sheets is to present factual information measured from the core or as recorded in the field. Some interpretative information is inevitable in the location of core loss, description of weathering and identification of drilling induced fractures. This should be noted in the use of Core Log Sheets and remembered in their utilisation.

DRILLING AND CASING

The types of drilling used to advance the drill hole are recorded for relevant intervals. The types of drilling may include: NMLC coring, NQTT (NQ triple tube wire line), HW, HX, NW and NX casing, wash boring (tri-cone roller bit, TC drag bit, TC blade bit), or auger drilling (V-bit, TC drag bit).

The relevant progress is shown by abbreviated dates in the column.

WATER

Water lost or water made during drilling is recorded and subsequent readings of water levels in the borehole or piezometers are recorded here with dates of observation.

DRILL DEPTH AND CORE LOSS

Drilling intervals are shown by depth increments and horizontal marker lines. Core loss is measured as a percentage of the drill run. If the location of the core loss is known or strongly suspected, it is shown in a region of the column bounded by dashed horizontal lines. If unknown, core loss is assigned to the bottom of a coring run.

SAMPLES AND FIELD TESTS

The location of samples taken for testing or the location of field tests are indicated by the appropriate symbol from the GLOSSARY OF SYMBOLS Standard Sheet (or as applicable for the project) and are shown at the relevant location or over the relevant depth interval.

Ref: DS6.2.1 Issue 2.0 Date: 03/03/2023

DEPTH (RL)

Changes in rock types or the locations of piezometer tips, samples, test intervals or other depths are shown as appropriate in terms of depth from the hole collar or in terms of RL.

For inclined holes the depths shown on the log refer to the drilled length along the borehole. The RL, where used, is the only transformed reference to true vertical depth.

STRATA

Rock types are presented graphically using the symbols shown on the GLOSSARY OF SYMBOLS Standard Sheet or as assigned for the project.

DESCRIPTION

The rock type is described in accordance with the ROCK DESCRIPTION AND CLASSIFICATION Standard Sheet.

WEATHERING

Weathering is described, by code letters, in accordance with the ROCK DESCRIPTION AND CLASSIFICATION Standard Sheet. A weathering term or range of terms is usually assigned to various strata.

It is noted, however, that the assignment of a term of weathering is subjective and is normally used for identification and does not imply engineering behaviour (such behaviour being controlled principally by rock substances strength and defect frequency - collectively, rock mass strength). Consequently, boundaries are often not shown and weathering may even not be reported where potentially misleading.

ESTIMATED STRENGTH

The strength of the rock substance is estimated by a combination of Point Load testing and tactile appraisal in accordance with the ROCK DESCRIPTION AND CLASSIFICATION Standard Sheet. The estimated strength is presented in a histogram form. Both axial and diametric point load test results can be presented using the symbols on the GLOSSARY OF SYMBOLS Standard Sheet and the variation between axial and diametric values is indicative of anisotropy or fissility of the rock unit.

NATURAL FRACTURES

The identification of natural fractures requires an endeavour to exclude drilling induced breaks in the core and, as such, can be somewhat subjective. Natural fractures exist prior to coring the rock, whereas artificial fractures occur either during coring, during placing core in the core boxes, or during examination or transportation, or core after being boxed.

The log of Natural Fractures is presented as a combination of Fracture Spacing, Visual and Description columns. Coding is presented on the GLOSSARY OF SYMBOLS Standard Sheet.

SOIL DESCRIPTION AND CLASSIFICATION

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Soil is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical Site Investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines soil as particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking. Classification of the soil is undertaken following description. The terms provided herein are reproduced summaries from Clause 6.1, AS1726-2017, Geotechnical investigations, which should be referred to for further detail.

SOIL DESCRIPTION

The soil description includes a) Composition, b) Condition, c) Structure, d) Origin and e) Additional observations. 'FILL', 'TOPSOIL' or a 'MIXTURE OF SOIL AND COBBLES / BOULDERS' (with dominant fraction first) is denoted at the start of a soil description where applicable.

a. Soil Composition (soil name, colour, plasticity or particle characteristics, secondary and then minor components)

Soil Name: A soil is termed a coarse grained soil where the dry mass of sand and gravel particles exceeds 65% of the total. Soils with more than 35% fines (silt or clay particles) are termed fine grained soils. The soil name is made up of the primary soil component (in BLOCK letters), prefixed by applicable secondary component qualifiers. Minor components are applied as a qualifiers to the soil name (using the words 'with' or 'trace').

Particles are differentiated on the basis of size. 'Boulders' and 'cobbles' are outside the soil particle range, though their presence (and proportions) is noted. While individual particles may be designated as silt or clay based on grain size, fine grained soils are characterised as silt or clay based on tactile behaviour or Atterberg Limits, and not the relative composition of silt or clay sized particles.

Colour: The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Roughly equally proportioned colours are prefixed by (spotted, mottled, streaked etc.). Colour is described in its moist condition, though both wet and dry colours may also be provided if appropriate.

Plasticity: Fine grained soils are designated within standard ranges of plasticity based on tactile assessment or laboratory assessment of the Liquid Limit.

Particle Characteristics: The particle shape, particle distribution and particle size range within a coarse grained soil is described using standard terms. Particle composition may be described using rock or mineral names, with specific terms for carbonate soils.

Secondary and Minor Components: The primary soil is described and modified by secondary and minor components, with assessed ranges as tabulated.

Carbonate Soils: Carbonate content can be assessed by use of dilute '10%' HCl solution. Resulting clear sustained effervescence is interpreted as a Carbonate soil (approximately >50% carbonate), while weak or sporadic effervescence indicates Calcareous soil (< 50% carbonate). No effervescence is interpreted as a non-calcareous soil.

Organic and Peat Soils: Where identified, organic content is noted. Organic soil (2% to 25% organic matter) is usually identified by colour (usually dark grey/black) and odour (i.e. 'mouldy' or hydrogen sulphide odour). Peat (>25% organic matter) is identified by a spongy feel and fibrous texture. Peat soils' decomposition may be described as 'fibrous' (little / no decomposition), 'pseudo- fibrous' (moderate decomposition) or 'amorphous' (full decomposition).

Fraction	Components		Particle Size (mm)
Oversize	BOULDERS		> 200
	COBBLES		63 - 200
Coarse grained soil particles	GRAVEL	Coarse	19 – 63
		Medium	6.7 – 19
		Fine	2.36 – 6.7
	SAND	Coarse	0.6 – 2.36
		Medium	0.21 – 0.6
		Fine	0.075 – 0.21
Fine grained soil particles	SILT		0.002 – 0.075
	CLAY		< 0.002

Plasticity Terms (Fine Grained Soils)		Laboratory Liquid Limit Range
Silt	**Clay**	
N/A	N/A	(Non Plastic)
Low Plasticity	*Low Plasticity*	≤ 35%
	Medium Plasticity	> 35% and ≤ 50%
High Plasticity	*High Plasticity*	> 50%

Particle Distribution Terms (Coarse Grained Soils)	
Well graded	Good representation of all particle sizes
Poorly graded	One or more intermediate sizes poorly represented
Gap graded	One or more intermediate sizes absent
Uniform	Essentially of one size

Particle Shape Terms (Coarse Grained Soils)		
Rounded	*Sub-angular*	*Flaky or Platy*
Sub-rounded	*Angular*	*Elongated*

Secondary and Minor Components for Coarse Grained Soils			
Fines (%)	**Modifier (as applicable)**	**Accessory coarse (%)**	**Modifier (as applicable**
≤ 5	*'trace silt/clay'*	≤ 15	*'trace sand/gravel'*
> 5, ≤ 12	*'with clay/silt'*	> 15, ≤ 30	*'with sand/gravel'*
> 12	*prefix 'silty/clayey'*	> 30	prefix '*gravelly/ sandy*'

Secondary and Minor Components for Fine Grained Soils	
% Coarse	**Modifier (as applicable)**
≤ 15	Add "*trace sand/gravel*"
> 15, ≤ 30	Add "*with sand/gravel*"
> 30	Prefix soil "*sandy/gravelly*"

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b. Soil Condition (moisture, relative density or consistency)

Moisture: Fine grained soils are described relative to plastic or liquid limits, while coarse grained soils are assessed based on appearance and feel. The observation of seepage or free water is noted on the test hole logs.

Moisture - Coarse Grained Soils		
Term		**Tactile Properties**
Dry	D	Non-cohesive, free running
Moist	M	Feels cool, darkened colour, tends to stick together
Wet	W	Feels cool, darkened colour, tends to stick together, free water forms when handling

Moisture - Fine Grained Soils		
Term		**Tactile Properties**
Moist, dry of plastic limit	*('w < PL')*	Hard and friable or powdery
Moist, near plastic limit	*('w ≈ PL')*	Can be moulded
Moist, wet of plastic limit	*('w > PL')*	Weakened, free water forms on hands with handling
Wet, near liquid limit	*('w ≈ LL')*	Highly weakened, tends to flow when tapped
Wet, wet of liquid limit	*('w > LL')*	Liquid consistency, soil flows

Relative Density (Non Cohesive Soils): The Density Index is inherently difficult to assess by visual or tactile means, and is normally assessed by penetration testing (e.g. SPT, DCP, PSP or CPT) with published correlations. Assessment may be affected by moisture and *in situ* stress conditions. Density Index assessment may be refined by combination of *in situ* density testing and laboratory reference maximum and minimum density ranges.

Consistency (Cohesive Soils): May be assessed by direct measurement (shear vane, CPT etc.), or approximate tactile correlations. Cohesive soils include fine grained soils, and coarse grained soils with sufficient fine grained components to induce cohesive behaviour. A 'design shear strength' must consider the mode of testing, the *in situ* moisture content and potential for variations of moisture which may affect the shear strength.

Relative Density (Non-Cohesive Soils)		
Term and (Symbol)		**Density Index (%)**
Very Loose	*(VL)*	≤ 15
Loose	*(L)*	> 15 and ≤ 35
Medium Dense	*(MD)*	> 35 and ≤ 65
Dense	*(D)*	> 65 and ≤ 85
Very Dense	*(VD)*	> 85
Consistency assessment can be influenced by moisture variation		

Consistency (Cohesive Soils)			
Term and (Symbol)		**Tactile Properties**	**Undrained Shear Strength**
Very Soft	*(VS)*	Extrudes between fingers when squeezed	< 12 kPa
Soft	*(S)*	Can be moulded by light finger pressure	12 - 25 kPa
Firm	*(F)*	Can be moulded by strong finger pressure	25 - 50 kPa
Stiff	*(St)*	Cannot be moulded by fingers	50 - 100 kPa
Very Stiff	*(VSt)*	Can be indented by thumb nail	100 - 200 kPa
Hard	*(H)*	Can be indented with difficulty by thumb nail	> 200 kPa
Friable	*(Fr)*	Easily crumbled or broken into small pieces by hand	

c. Structure (zoning, defects, cementing)

Zoning: The *in situ* zoning is described using the terms below. '*Intermixed*' may be used for an irregular arrangement.

'layer' (a continuous zone across the exposed sample)

'lens' (a discontinuous layer with lenticular shape)

'pocket' (an irregular inclusion of different material).

'interbedded' or *"interlaminated'* (alternating soil types)

Defects: Described using terms below, with dimension orientation and spacing described where practical.

'*parting*' (an open or closed surface or crack sub parallel to layering with little / no tensile strength - open or closed)

'*fissure*' (as per a parting, though not parallel or sub parallel to layering – may include desiccation cracks)

'*sheared seam*' (zone of sub parallel near planar closely spaced intersecting smooth or slickensided fissures dividing the mass into lenticular or wedge shaped blocks)

'*sheared surface*' (a near planar, curved or undulating smooth, polished or slickensided surface, indicative of displacement)

'*softened zone*' (in clayey soils, usually adjacent to a defect with associated higher moisture content)

'*tube*' (tubular cavity, singly or one of a large number, often formed from root holes, animal burrows or tunnel erosion)

'*tube cast*' (an infilled tube – infill may vary from uncemented through to cemented or have rock properties)

'*infilled seam*' (sheet like soil body cutting through the soil mass, formed by infilling of open defects)

Cementation: Soils may be cemented by various substances (e.g. iron oxides and hydroxides, silica, calcium carbonate, gypsum), and the cementing agent shall be identified if practical. Cemented soils are described as:

'uncemented' (UNC)	Clean grains exhibiting soil properties
'weakly cemented' (WEK)	easily disaggregated by hand in air or water
'moderately cemented' (MOD)	effort required to disaggregate the soil by hand in air or water

Materials extending beyond '*moderately cemented'* are encompassed within the rock strength range. Where consistent cementation throughout a soil mass is identified as a duricrust, it is described in accordance with duricrust rock descriptors. Where alternate descriptors of cementation development are applied for consistency with regional practices or geology, or client requirements, these are outlined separately.

Ref: DS6.5.1.1 Rev 2 Date: 03/05/2024

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d. Origin

An interpretation is provided based on observations of landform, geology and fabric, and may further include assignment of a stratigraphic unit. The use of terms 'possibly' or 'probably' indicates a higher degree of uncertainty regarding the assessed origin or stratigraphic unit. Typical origin descriptors include:

Residual soil	Formed directly from in situ weathering with no visible structure or fabric of the parent soil or rock.
Extremely weathered material	Formed directly from in situ weathering, with remnant and/or fabric from the parent rock.
Alluvial soil	Deposited by streams and rivers (may be applied more generically as transported by water).
Estuarine soil	Deposited in coastal estuaries, including sediments from inflowing rivers, streams, and tidal currents.
Marine soil	Deposited in a marine environment.
Lacustrine soil	Deposited in freshwater lakes.
Aeolian soil	Transported by wind.
Colluvial soil	Soil and rock debris transported down slopes by gravity (with or without assistance of water). Colluvium is typically applied to thicker / localised deposits, and slopewash for thinner / widespread deposits.
TOPSOIL	Surficial soil, typically with high levels of organic material. Topsoils buried by other transported soils are termed 'remnant topsoil'. Tree roots within otherwise unaltered soil does not characterise topsoil.
FILL	Any material which has been placed by anthropogenic processes (i.e. human activity).

e. Additional Observations

Additional observations may be included to supplement the soil description. Additional observations may consist of notations relating to soil characteristics (odour, contamination, colour changes with time), inferred geology (with delineation of soil horizons or geological time scale) or notes on sampling and testing application (including the reliability, recovery, representativeness, or condition of samples or test conditions and limitations). If the material is assessed to be not representative, terms such as 'poor recovery', 'non-intact', 'recovered as' or 'probably' are applied.

SOIL CLASSIFICATION

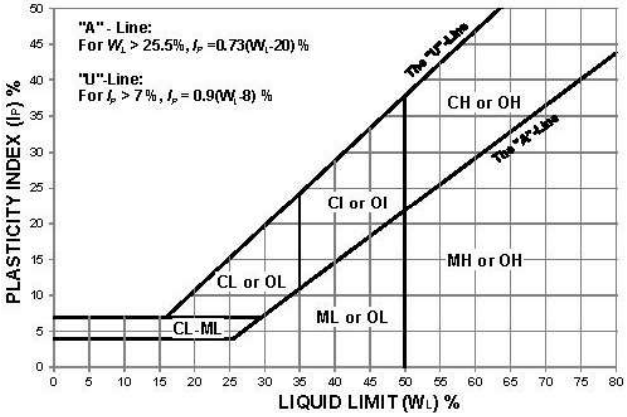
Classification allocates the material within distinct soil groups assigned a two character Group Symbol:

Coarse Grained Soils (sand and gravel: more than 65% of soil coarser than 0.075 mm)			**Fine Grained Soils** (silt and clay: more than 35% of soil finer than 0.075 mm)		
Major Division	**Group Symbol**	**Soil Group**	**Major Division**	**Group Symbol**	**Soil Group**
GRAVEL (more than half of the coarse fraction is > 2.36 mm)	GW	GRAVEL, well graded	SILT and CLAY (low to medium plasticity)	ML	SILT, low plasticity
	GP	GRAVEL, poorly graded		CL	CLAY, low plasticity
	GM	Silty GRAVEL		CI	CLAY, medium plasticity
	GC	Clayey GRAVEL		OL	Organic SILT
SAND (more than half of the coarse fraction is < 2.36 mm)	SW	SAND, well graded	SILT and CLAY (high plasticity)	MH	SILT, high plasticity
	SP	SAND, poorly graded		CH	CLAY, high plasticity
	SM	Silty SAND		OH	Organic CLAY / SILT
	SC	Clayey SAND	Highly Organic	Pt	PEAT

Coarse grained soils with fines contents between 5% and 12% are provided a dual classification comprising the two group symbols separated by a dash, e.g. for a poorly graded gravel with between 5% and 12% silt fines (poorly graded 'GRAVEL with silt'), the classification is GP-GM.

For the purpose of classification, poorly graded, uniform, or gap graded soils are all designated as poorly graded. Soils that are dominated by boulders or cobbles are described separately and are not classified.

Classification is routinely undertaken based on tactile assessment with the soil description. Refinement of soil classification may be applied using laboratory assessment, including particle size distribution and Atterberg Limits. Atterberg Limits testing is applied to the sample portion finer than 0.425 mm. Fine grained soil components are assessed on the basis of regions defined within the Modified Casagrande Chart.



ROCK DESCRIPTION AND CLASSIFICATION

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Rock is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical site investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines rock as any aggregate of minerals and/or organic materials that cannot be disaggregated by hand in air or water without prior soaking. The rock description and classification distinguishes between rock material, defects, structure and rock mass.

ROCK DESCRIPTION AND CLASSIFICATION

a. Description of rock material (rock name, grain size and type, colour, texture and fabric, inclusions or minor components, moisture content and durability)

Rock Name: Simple rock names are used to provide a reasonable engineering description rather than a precise geological classification. The rock name is chosen on the basis of origin, with common types summarised below. Additional, non-exhaustive, terminology is included in AS 1726. Rock names not described within AS 1726 may be adopted, with geological characteristics typically noted within accompanying text.

<table>
<tr><th rowspan="2">Grain Size (mm)</th><th colspan="4">Sedimentary</th><th colspan="2">Metamorphic</th><th colspan="3">Igneous</th></tr>
<tr><th colspan="2">Clastic or Detrital</th><th colspan="2">Carbonate</th><th rowspan="2">Pyroclastic</th><th rowspan="2">Foliated</th><th rowspan="2">Non-Foliated</th><th rowspan="2">Felsic</th><th rowspan="2">↔</th><th rowspan="2">Mafic</th></tr>
<tr><th colspan="2"></th><th>Low Porosity</th><th>Porous</th></tr>
<tr><td>>2.0</td><td colspan="2">CONGLOMERATE
(rounded grains in a finer matrix)
BRECCIA
(angular or irregular fragments in a finer matrix)</td><td rowspan="4">LIMESTONE (predominantly $CaCO_3$)
Or
DOLOMITE (predominantly $CaMgCO_3$)</td><td>CALCIRUDITE</td><td>AGGLOMERATE
(rounded grains in a finer matrix)
VOLCANIC BRECCIA
(angular fragments in a finer matrix)</td><td>GNEISS</td><td rowspan="4">MARBLE (carbonate)
QUARTZITE
SERPENTINITE
HORNFELS</td><td>GRANITE</td><td>DIORITE</td><td>GABBRO</td></tr>
<tr><td>2.0 – 0.06</td><td colspan="2">SANDSTONE</td><td>CALCARENITE</td><td>TUFF</td><td>SCHIST</td><td>MICRO-GRANITE</td><td>MICRO-GRANITE</td><td>DOLERITE</td></tr>
<tr><td>0.06 – 0.002</td><td rowspan="2">MUDSTONE (silt and clay)</td><td>SILTSTONE (mostly silt)</td><td>CALCISILTITE</td><td rowspan="2">Fine grained TUFF</td><td rowspan="2">PHYLLITE or SLATE</td><td rowspan="2">RHYOLITE</td><td rowspan="2">ANDESITE</td><td rowspan="2">BASALT</td></tr>
<tr><td><0.002</td><td>CLAYSTONE (mostly clay)</td><td>CALCILUTITE</td></tr>
</table>

Reproduced with modification from Tables 15, 16 and 17, Clause 6.2.3.1, AS 1726-2017, Geotechnical site investigations.

Grain size: For rocks with predominantly sand sized grains the dominant or average grain size is described as follows:

Rock type	Coarse grained	Medium grained	Fine grained
Sedimentary rocks	Mainly 0.6 mm to 2 mm	Mainly 0.2 mm to 0.6 mm	Mainly 0.06 mm (just visible) to 0.2 mm
Igneous and metamorphic rocks	Mainly >2 mm	Mainly 0.06 mm to 2 mm	Mainly <0.6 mm (just visible)

Colour assists in rock identification and interpolation. Rock colour is generally described in a “moist” condition, using simple terms (e.g. grey, brown, etc.) and modified as necessary by “pale”, “dark”, or “mottled”. Borderline colours may be described as a combination of these colours (e.g. red-brown).

Texture refers to the arrangement of, or the relationship between, the component grains or crystals (e.g. porphyritic, crystalline or amorphous).

Fabric refers to visible grain arrangement along a preferential orientation or a layering. Fabric may be noted as “indistinct” (little effect on strength) or “distinct” (rock breaks more easily parallel to the fabric). Common terms include “massive” or “flow banding” (igneous), “foliation” or “cleavage” (metamorphic). Sedimentary layering is described as “bedding” or (where thickness < 20 mm) “lamination”. The typical orientation, spacing or thickness of these structural features can be described directly in millimetres and metres. Further quantification of bedding thickness applied by GHD is as follows:

Bedding Term	Thickness
Very thickly bedded	>2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 to 200 mm
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	<6 mm

Features, Inclusions and Minor Components are typically only described when those features could influence the engineering behaviour of the rock. Described features may include: gas bubbles in igneous rocks; veins of quartz, calcite or other minerals; pyrite crystals and nodules or bands of ironstone or carbonate; cross bedding in sandstone; clast or matrix support in conglomerates and breccia.

Moisture content may be described by the feel and appearance of the rock, as follows: “dry” (looks and feels dry), “moist” (feels cool, darkened in colour, but no water is visible on the surface), or “wet” (feels cool, darkened in colour, water film or droplets visible on the surface). The moisture content of rock cored with water may not represent in situ conditions.

Durability of rock samples is noted where there is an observed tendency of samples to crack, breakdown in water or otherwise deteriorate with exposure.

Ref: DS6.5.2.1 Rev 4 Date: 03/05/2024

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b. Classification of the rock material condition (strength, weathering and/or alteration)

Estimated Strength refers to the rock material and not the rock mass. The strength is defined in terms of uniaxial compressive strength (UCS), though is typically estimated by either tactile assessment or Point Load Strength Index (Is(50)) (measured perpendicular to planar anisotropy). A correlation between Is(50) and UCS is adopted for classification, though is not intended for design purposes without appropriate supporting assessment. A field guide follows:

Term and (Symbol)		UCS (MPa)	$Is_{(50)}$ (MPa)	Field Guide
Very Low	*(VL)*	0.6 – 2	0.03 - 0.1	Material crumbles under firm blows with sharp end of geological pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm thick can be broken by finger pressure.
Low	*(L)*	2 - 6	0.1 - 0.3	Easily scored with knife; indentations 1 to 3 mm show in the specimen with firm blows of a geological pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	*(M)*	6 - 20	0.3 - 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
High	*(H)*	20 - 60	1 - 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a geological pick with a single firm blow; rock rings under hammer.
Very High	*(VH)*	60 - 200	3 -10	Hand specimen breaks with geological pick after more than one blow; rock rings under hammer.
Extremely High	*(EH)*	>200	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Based on Table 19, Clause 6.2.4.1, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Material with strength less than "*very low*" is described using soil characteristics, with the presence of an original rock texture or fabric noted if relevant.

Weathering and Alteration: The process of weathering involves physical and chemical changes to the rock resulting from exposure near the earth's surface. A subjective scale for weathering is applied as follows:

Term and (Symbol)		Description
Residual Soil	*(RS)*	Material has weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered	*(XW)*	Material has weathered to such an extent that it has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Highly Weathered	*(HW)*	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered	*(MW)*	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered	*(SW)*	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	*(Fr)*	Rock shows no sign of decomposition of individual minerals or colour changes.

Modified based on Table 20, Clause 6.2.4.2, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Where physical and chemical changes to the rock are caused by hot gases or liquids at depth, the process is called alteration. Unlike weathering, the distribution of altered material may occur at any depth and show no relationship to topography. Where alteration minerals are identified the terms "extremely altered" (XA), "highly altered" (HA), "moderately altered" (MA) and "slightly altered" (SA) can be used to describe the physical and chemical changes described above.

Ref: DS6.5.2.1 Rev 4 Date: 03/05/2024

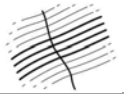
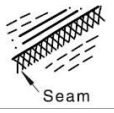
c. Description of defects (defect type, orientation, roughness and shape, coatings and composition of seams, spacing, length, openness and thickness, block shape)

Defects often control the overall engineering behaviour of a rock mass. AS 1726 defines a defect as “a discontinuity, fracture, break or void in the material or materials across which there is little or no tensile strength”. Describing the type, character and distribution of natural defects is an essential part of the description of many rock masses.

Commonly described characteristics of defects within a rock mass include type, orientation, roughness and shape, coatings and composition of seams, aperture, persistence, spacing and block shape.

The degree of detail required for defect descriptions depends on project requirements. All defects judged of engineering significance for the site and project are described individually. Where appropriate, generalised descriptions for less significant, or multiple similar, defects can be provided for delineated parts of rock core or exposures. A general description of delineated defect sets is provided when sufficient orientation data is available.

Defect Type is described using the terms summarised below. On core logs, only natural defects across which the core is discontinuous are described (i.e. inferred artificial fractures such as drill breaks are excluded). Incipient defects are described using the relevant texture or fabric terms. Healed defects (those that have been re-cemented by minerals such as chlorite or calcite) are described using the prefix “healed” (e.g. healed joint).

Type and (Symbol)		Description	Diagram
Parting	(P)	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (e.g. cleavage). May be open or closed.	
Joint	(J)	A surface or crack with no apparent shear displacement and across which the rock has little or no tensile strength, but which is not parallel or subparallel to layering or to planar anisotropy in the rock material. May be open or closed.	
Sheared Surface	(S)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.	
Sheared Zone	(SZ)	Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Sheared Seam	(SS)	Seam of soil material with roughly parallel almost planar boundaries, composed of soil materials with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Crushed Seam	(CS)	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.	
Infilled Seam	(IS)	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1 mm thick may be described as a veneer or coating on a joint surface.	
Extremely Weathered Seam	(EW)	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.	

Modified based on Table 22, Clause 6.2.5.2, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Defect Orientation is recorded as the “dip” (maximum angle of the mean plane, measured from horizontal) and the “dip direction” (azimuth of the dip, measured clockwise from true north). Dip and dip direction is expressed in degrees, with two-digit and three-digit numbers respectively, separated by a slash (e.g. 45/090). For vertical boreholes, the defect dip is measured as the acute angle from horizontal. Rock core extracted from vertical boreholes is generally not oriented, so the dip direction cannot be directly measured. For non-oriented inclined boreholes, a defect “alpha” (α) angle is measured as the acute angle from the core axis. For vertical and non-oriented inclined boreholes, the dip direction can sometimes be estimated from the relationship of the defect to a well-defined site structure such as fabric. For oriented inclined boreholes, the measurement of the defect orientation is carried out and recorded in a form suited to the particular device being used and later processed to report true dip and dip direction.

ROCK DESCRIPTION AND CLASSIFICATION

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Ref: DS6.5.2.1 Issue 3 Date: 15/03/2022

Roughness and Shape of the defect surface combine to have significant influence on shear strength. Standard descriptions and abbreviations include:

Roughness and (Symbol)		Description
Very Rough	(VR)	Many large surface irregularities (amplitude generally more than 1 mm). Feels like, or coarser than very coarse sand paper.
Rough	(RF)	Many small surface irregularities (amplitude generally less than 1 mm). Feels like fine to coarse sand paper.
Smooth	(SM)	Smooth to touch. Few or no surface irregularities.
Polished	(PO)	Shiny smooth surface.
Slickensided	(SL)	Grooved or striated surface, usually polished.

Shape and (Symbol)		Description
Planar	(PR)	The defect does not vary in orientation.
Curved	(CU)	The defect has a gradual change in orientation.
Undulating	(UN)	The defect has a wavy surface.
Stepped	(ST)	The defect has one or more well defined steps.
Irregular	(IR)	The defect has many sharp changes of orientation.

Although the surface roughness of defects can be described at small (10-100 mm) scales of observation, the overall shape of the defect surface can usually be observed only at medium (0.1-1 m) and large (>1 m) scale.

Where it is necessary to assess the shear strength of a defect, observations are generally made at multiple scales. Surface roughness may also be characterised by using the joint roughness coefficient (JRC) profiles established by Barton and Choubey (1977). Where large-scale observations are possible, further measurement of defect "waviness" (angle of the asperities relative to the overall dip angle of the plane) is made.

Coatings and Composition of Seams: Many defects have surface coatings, which can affect their shear strength. Standard descriptions include:

Coating and (Symbol)		Description
Clean	(CN)	No visible coating.
Stained	(SN)	No visible coating but surfaces are discoloured.
Veneer	(VN)	A visible coating of soil or mineral substance, but too thin to be measured may be patchy.
Coating	(CT)	A visible coating up to 1 mm thick. Soil material greater than 1 mm thick is described using defect terms (e.g. infilled seam). Rock material greater than 1 mm thick is described as a vein (Vn).

Common Minerals and (Symbol)	
Clay	(CLAY)
Calcite	(Ca)
Carbonaceous	(X)
Chlorite	(Kt)
Iron Oxide	(Fe)
Micaceous	(Mi)
Manganese	(Mn)
Pyrite	(Py)
Quartz	(Qz)

The composition of seams are described using soil description terms as given on the SOIL DESCRIPTION AND CLASSIFICATION Standard Sheet. Where possible the mineralogy of coatings is identified. Common mineral coatings include:

Aperture: Defects across which there is little or no tensile strength can be either "open" (Op) or "closed" (Cl). For rock core, the width of the "open" defect is measured whilst still in the core barrel splits. The descriptor "tight" (Ti) can only apply to healed or incipient defects (i.e. veins, foliation, etc.).

Persistence and Spacing of defects is described directly in millimetres and metres. If the measurement of defect persistence is limited by the extent of the exposure, the end conditions are noted (i.e. 0, 1 or 2 defect ends observed). The spacing between defects of similar orientation (i.e. within a specific defect set) is recorded when possible. The frequency of defects within rock core can be measured as either: the spacing between successive defects; or the "Fracture Index", which is the number of defects per metre of core.

Spacing Term	Thickness
Very wide	>2 m
Wide	0.6 to 2 m
Medium	0.2 to 0.6 m
Closely	60 to 200 mm
Very closely	20 to 60 mm
Extremely closely	6 to 20 mm

Block Shape: Where it is considered significant, block shape can be described using the subjective terms as follows:

Block Shape	Description
Polyhedral	Irregular discontinuities without arrangement into distinct sets, and of small persistence.
Tabular	One dominant set of parallel discontinuities, for example bedding planes, with other non-continuous joints; thickness of blocks much less than length or width.
Prismatic	Two dominant sets of discontinuities, approximately orthogonal and parallel, with a third irregular set; thickness of blocks much less than length or width.
Equidimensional	Three dominant sets of discontinuities, approximately orthogonal, with occasional irregular joints, giving equidimensional blocks.
Rhomboidal	Three (or more) dominant, mutually oblique, sets of joints giving oblique-shaped, equidimensional blocks.
Columnar	Several, usually more than three sets of continuous, parallel joints usually crossed by irregular joints; lengths much greater than other dimensions.

Modified based on Table 23, Clause 6.2.5.7, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

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d. Interpreted stratigraphic unit

Stratigraphic units may be interpreted and reported, in accordance with The Australian Stratigraphic Units Database (ASUD). The terms “possibly” or “probably” indicate increased uncertainty in this interpretation.

e. Geological structure

After describing the rock material and defects, an interpretation of the nature and configuration of rock mass defects may be presented in logs, charts, 2D sections and 3D models (e.g. dipping strata, folds, unconformities, weathering profiles, defect sets, geological faults, etc.).

PARAMETERS RELATED TO CORE DRILLING

Drill Depth and Core Loss: Drilling intervals are shown on GHD Core Log Sheets by depth increments and horizontal marker lines.

“Core loss”, or its inverse “total core recovery” (TCR), is measured as a percentage of the core run. If the location of the core loss is known, or strongly suspected, it is shown in a region of the column bounded by dashed horizontal lines. If unknown, core loss is assigned to the bottom of a core run.

Rock Quality Designation (RQD), described by Deere et al. (1989), may be recorded on GHD Core Log Sheets.

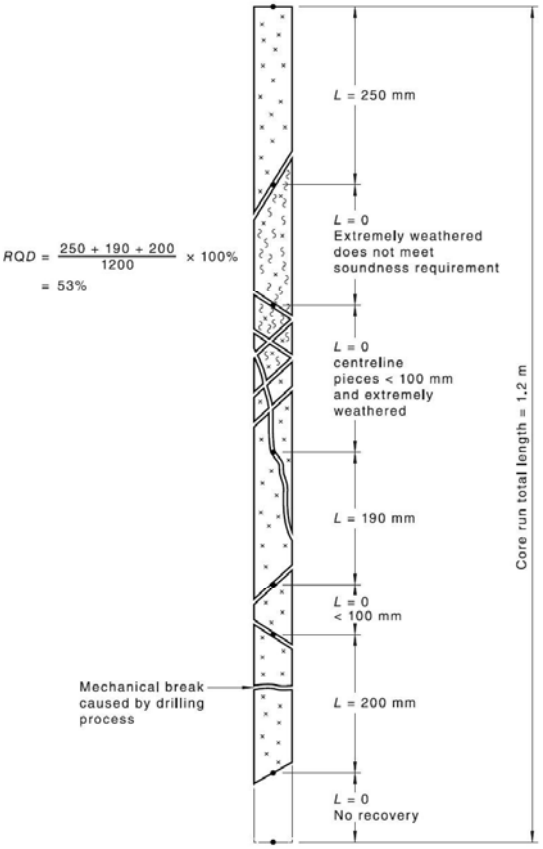
For certain projects, such as tunnelling or underground mining investigations, rock mass ratings or classifications can be required as part of the design process. The RQD forms a component of these rock mass ratings and provides a quantitative estimate of rock mass quality from rock core logs.

The rock core must be “N” sized (nominally 50 mm) or greater for derivation of RQD. The RQD is expressed as a percentage of intact rock core (excluding residual soil and extremely weathered rock) greater than 100 mm in length over the total selected core length.

Deere et al. (1989) recommends measuring lengths of core along the centreline, as shown right.

RQD is expressed as:

$$RQD = \frac{\sum Length\ of\ sound\ core\ pieces > 100\ mm\ in\ length}{Length\ of\ core\ run} \ x\,100\%$$



RQD measurement procedure
(reproduced from Figure 13, Clause 6.2.9.4, AS 1726- 2017, Geotechnical site investigations)

ROCK MASS CLASSIFICATION

Rock mass classification schemes may be used to represent the engineering characteristics of a rock mass. A large variety of classification schemes have been developed by various authors, ranging from simple to complex. All of the schemes are limited in their application and many rock mass classification systems assume that the rock mass is isotropic, which is rarely the case.

References

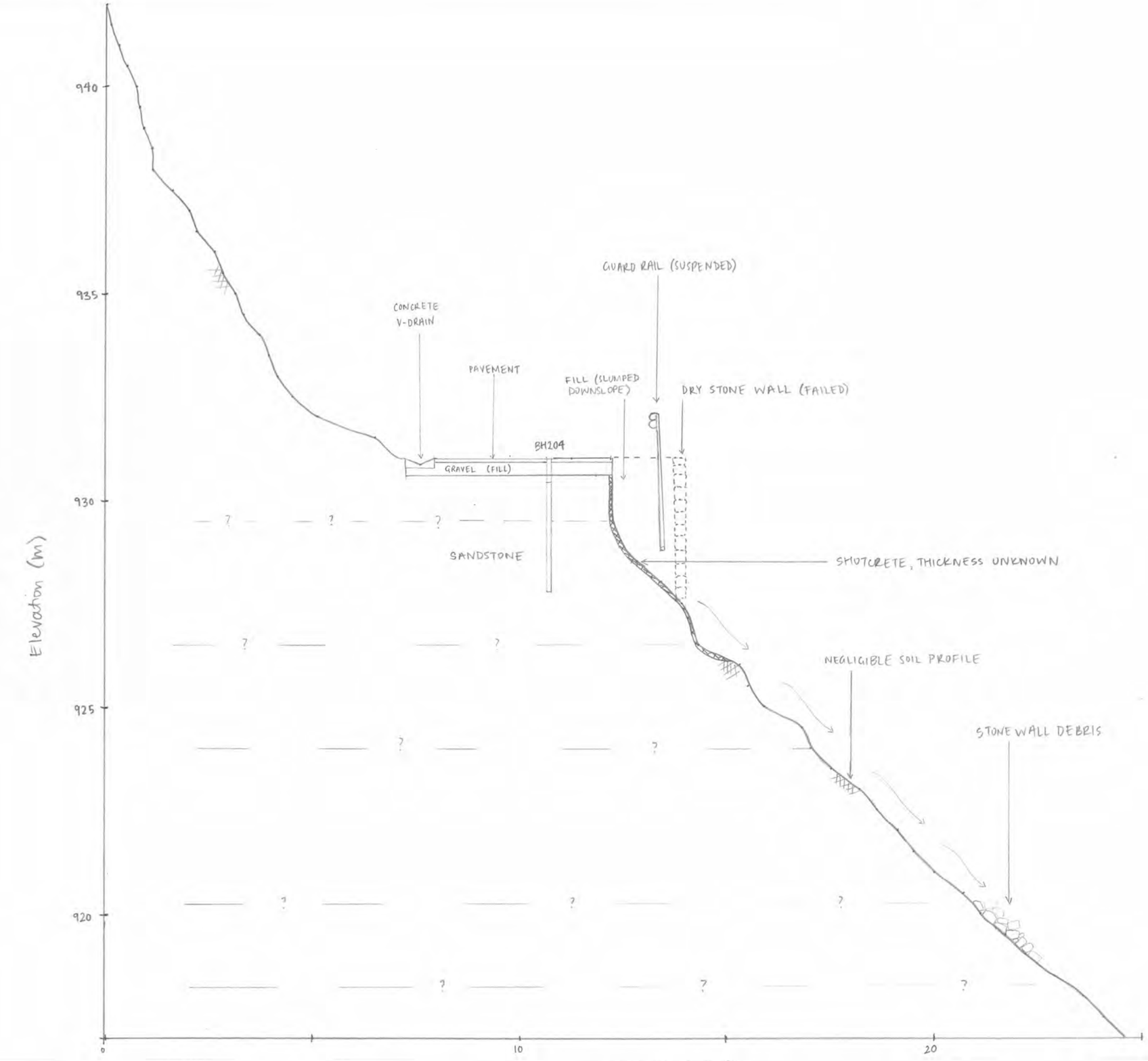
Standards Australia (2017). AS 1726-2017. Geotechnical Site Investigations.

Barton, N. and Choubey, V. (1977). The Shear Strength of Rock Joints in Theory and Practice. Rock Mechanics 10, 1-54. Springer. Deere, D.U. and Deere, D.W. (1989). Rock Quality Designation (RQD) After Twenty Years. Contract Report GL-89-1. Army Corps of Engineers. Washington DC, 1989.

Ref: DS6.5.2.1 Rev 4 Date: 03/05/2024

Appendix B

Site investigation cross sections

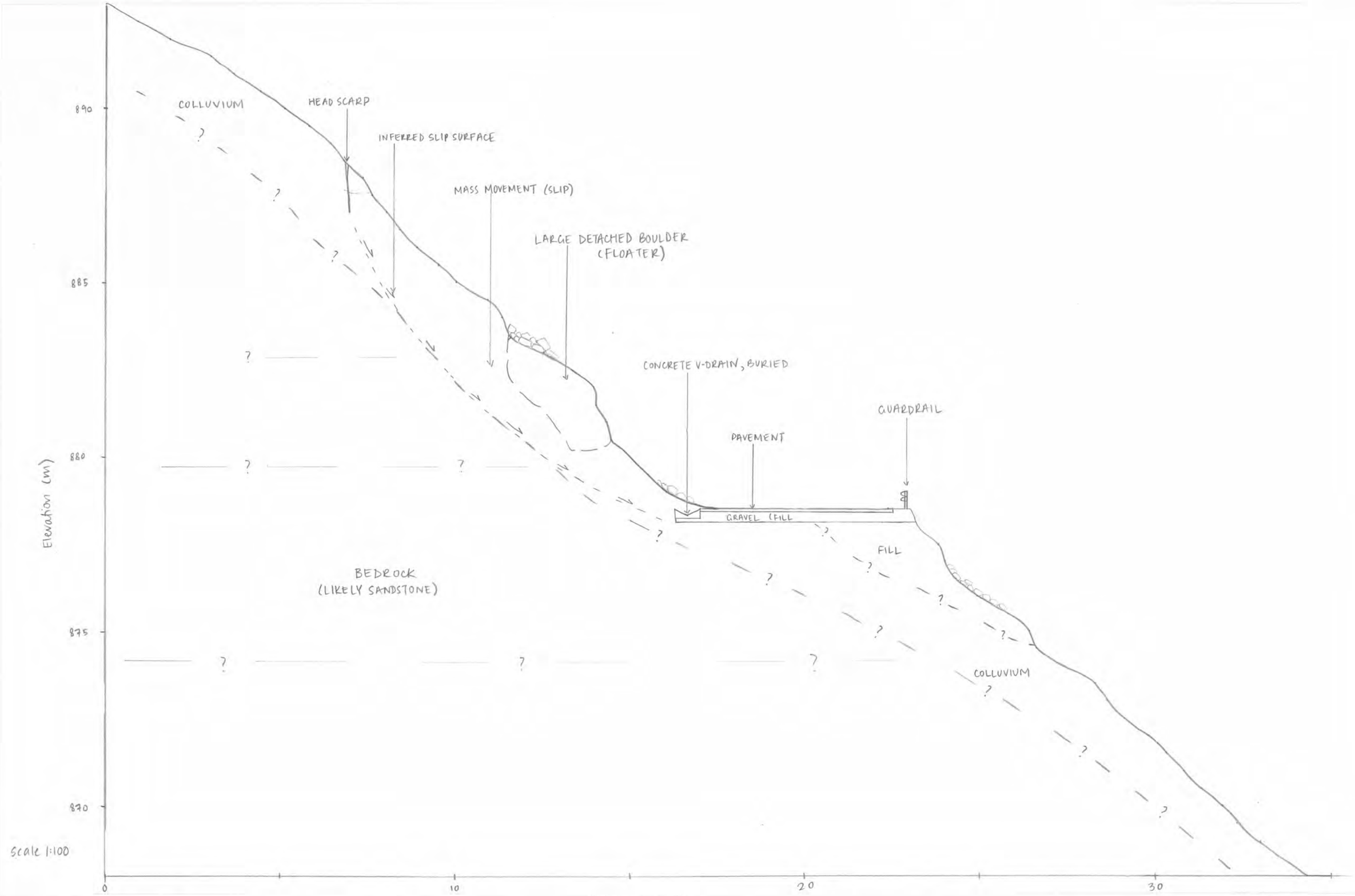


Scale 1:100

GHD

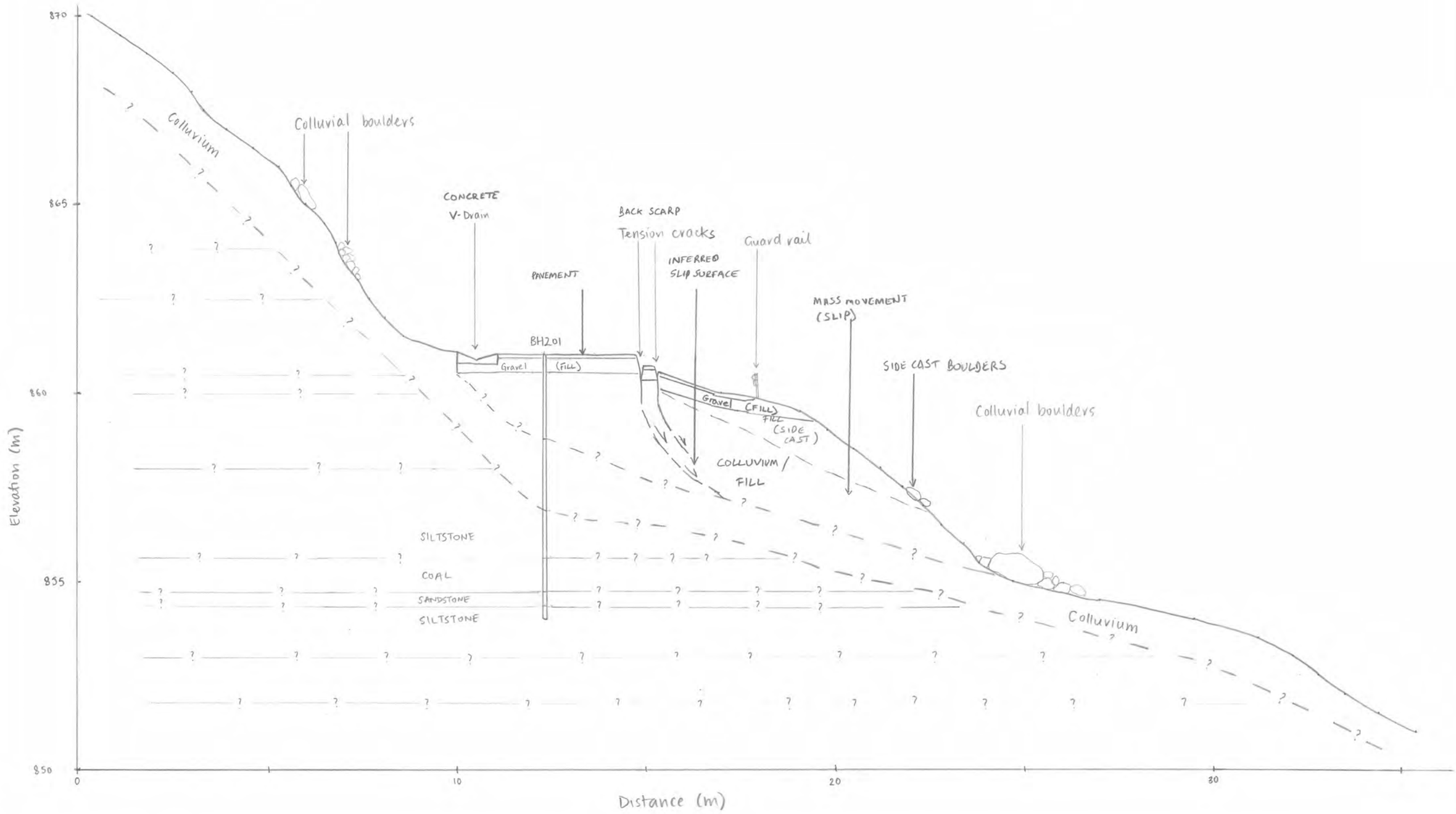
Client	Lithgow City Council	Job no.	12657881	Sheet	1 of 1
Project	Wolgan Road	Calcs by	SR	Date	19/12/2025
Subject	Cross section CH040	Checked by	DJ	Date	19/12/2025

CALCULATIONS



Client	Lithgow City Council	Job no.	12657881	Sheet	1 of 1
Project	Wolgan Road	Calcs by	SR	Date	19/12/2025
Subject	Cross Section CH508	Checked by	DJ	Date	19/12/2025

CALCULATIONS



Scale 1:100

Client	Lithgow City Council	Job no.	12657881	Sheet	1 of 1
Project	Wolgan Road	Calcs by	SR	Date	18/12/2025
Subject	Cross section CH715	Checked by	DJ	Date	18/12/2025

CALCULATIONS

Appendix C

Borehole logs and photographs

Client Name: Lithgow City Council

BOREHOLE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH201

Location: Wolgan Road CH 0+715

SHEET 1 OF 2

Position: 230951.6 E 6310596.5 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH **Date:** 18/12/2025

DRILLING					MATERIAL					COMMENTS
Scale (m)	Drilling Method	Casing	Water	Samples & Field Tests	Depth (m)	Graphic Log	USC Symbol	Description	Moisture Condition	Consistency / Relative Density	Comments & Observations
					0.02			ASPHALTIC CONCRETE: dark grey, 20mm thick.			
								[FILL] Gravelly SAND: fine to coarse grained, sub-rounded to sub-angular, orange brown; Gravel, fine to medium, angular, clasts of multiple origins.			
				SPT: 0.50-0.95 m 6/13/13 N=26							0.50 m, SPT recovery 450mm
1							-	1.20-1.30m sandstone boulder			
				SPT: 1.50-1.95 m 4/5/7 N=12							1.50 m, SPT recovery 450mm
2					2.20					MD	
								Gravelly SAND: fine grained, dark brown; Gravel, angular, brown, fine sandstone and siltstone; with trace rootlets (COLLUVIAL SOIL).			
				SPT: 3.00-3.45 m 7/7/5 N=12			SP		D		3.00 m, SPT recovery 450mm
3											
4					4.10			SILTSTONE: recovered as Sandy GRAVEL: fine to coarse, angular, dark grey; with iron staining.			
				SPT: 4.50-4.95 m 7/23/19 N=42			-				4.50 m, SPT recovery 450mm
5					5.30					D	
				D: 5.50-5.60m				COAL: recovered as Gravelly SAND: fine to coarse grained, black; Gravel, fine to coarse, sandstone.			
							-				
6				SPT: 6.00-6.20 m 27/30 for 50 mm HB N=ref	6.20						6.00 m, SPT recovery 200mm
								Start of coring. For cored interval, see Core Log Sheet.			
7											
8	AD/T	HWT Casing	Groundwater Not Encountered								

GHD St Leonards
Level 11, 558 Pacific Highway,
St Leonards, New South Wales, 2065

Logged to: AS1726:2017. See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number: 12657881

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH201

Location: Wolgan Road CH 0+715

Position: 230951.6 E 6310596.5 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** New **Date:** 18/12/2025

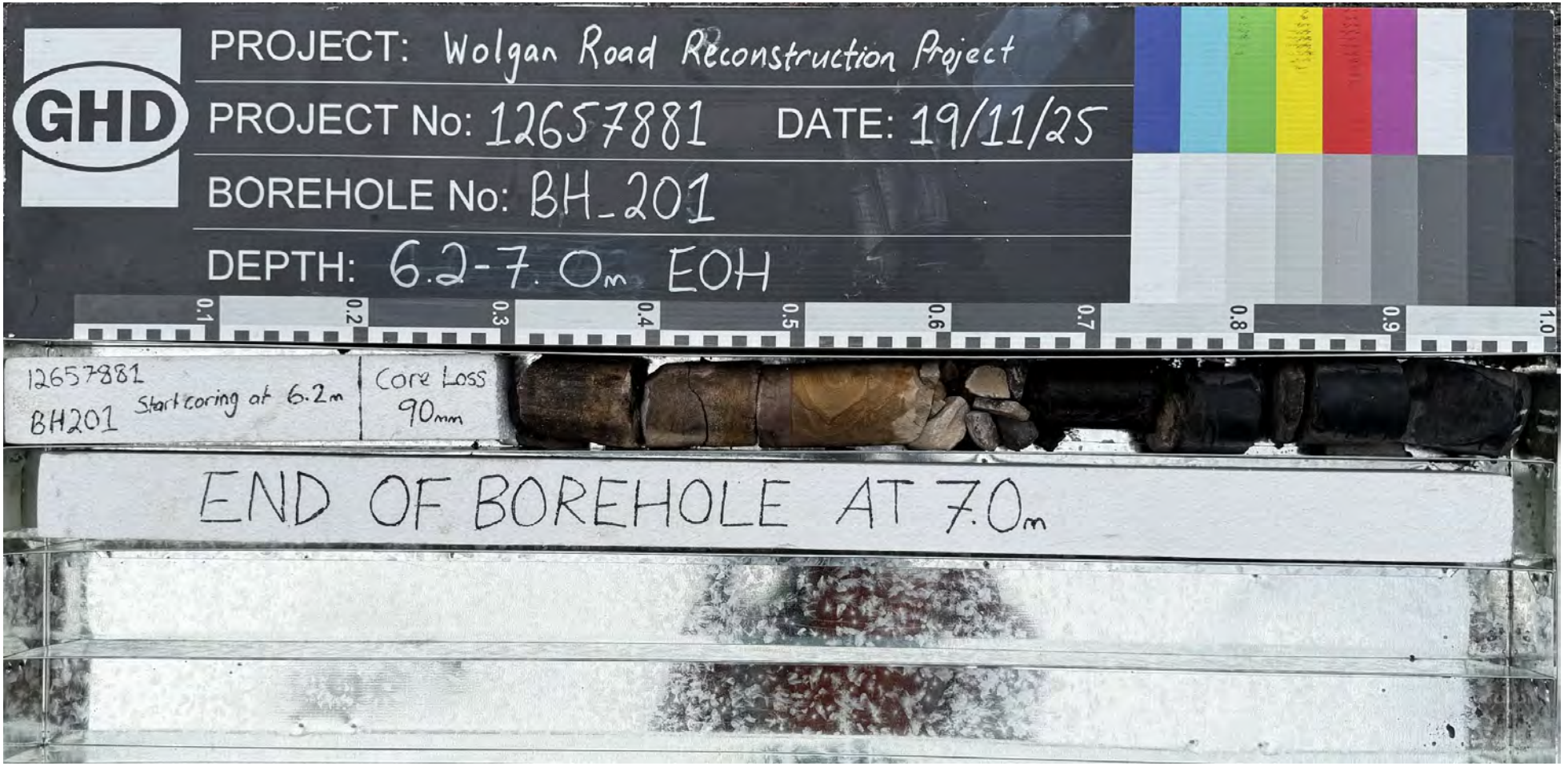
Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH

DRILLING							MATERIAL					DEFECTS	
Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests	Depth (m)	Graphic Log	**Description** [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral □ - Irregular Lump VL L M H VH EH	Spacing (mm) 20 40 100 300 1000	**Defect Descriptions & Additional Data** Type, orientation, roughness, shape, composition / coating, aperture / thickness, other
									Start of coring. For non-core interval, see Borehole Log Sheet.				
							6.20						
							6.29		CORE LOSS 90mm	-			
	HQ3		60-70% Water Return	89%	14				SANDSTONE: fine to medium grained, pale grey to orange, indistinctly bedded.	MW			6.39 m: J, 5°, RF, PR, CN 6.43 m: J, 30°, RF, CU, CN 6.48 m: J, 5°, RF, PR, CN 6.59-6.65 m: SZ, 15°, RF, PR, CN, 60 mm, rock fragments (1-30mm) 6.73 m: P, 20°, RF, UN, CN 6.80 m: J, 15°, RF, UN, CN
							6.65		SILTSTONE: dark grey, thinly laminated at 0-5°.	FR			
				7.00			7.00		BH201 terminated at 7.00m. Target depth				6.81 m: J, 10°, RF, UN, CN 6.83 m: J, 15°, RF, PR, CN 6.89 m: J, 50°, RF, PR, CN

GHD St Leonards
Level 11, 558 Pacific Highway,
St Leonards, New South Wales, 2065

Logged to: AS1726:2017. See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number: 12657881



Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH201
Depth Core: 6.2m to 7.0m

Figure 1

Client Name: Lithgow City Council

BOREHOLE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH202

Location: Wolgan Road CH 0+694

SHEET 1 OF 2

Position: 230948.9 E 6310579.1 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH **Date:** 18/12/2025

DRILLING					MATERIAL						COMMENTS
Scale (m)	Drilling Method	Casing	Water	Samples & Field Tests	Depth (m)	Graphic Log	USC Symbol	Description	Moisture Condition	Consistency / Relative Density	Comments & Observations
					0.02			ASPHALTIC CONCRETE: dark grey, 20mm thick.			
								[FILL] Gravelly SAND: fine to coarse grained, sub-rounded, pale grey; Gravel, fine to medium, sub-angular, sandstone, possibly reworked colluvium.			
				SPT: 0.50-0.95 m 6/11/10 N=21			-				0.50 m, SPT recovery 450mm
1					1.20			Clayey SAND: fine grained, pale brown; with gravel, fine to medium, sub-angular, of multiple origins (COLLUVIAL SOIL).			
	AD/T	HWT Casing	Groundwater Not Observed	SPT: 1.50-1.95 m 7/7/6 N=13					D	MD	1.50 m, SPT recovery 450mm
2							SC				
				SPT: 2.50-2.95 m 7/7/8 N=15							2.50 m, SPT recovery 450mm
3					3.00			Start of coring. For cored interval, see Core Log Sheet.			
4											
5											
6											
7											
8											

GHD St Leonards
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Logged to: AS1726:2017. See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number: 12657881

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH202

Location: Wolgan Road CH 0+694

Position: 230948.9 E 6310579.1 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** New **Date:** 18/12/2025

Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH

DRILLING

Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests
3	HQ3		50-60% Water Return	100% 4.15	20	3.84 m Is(50) D=0.72 MPa 3.84 m Is(50) A=0.42 MPa
				100% 4.70	31	

MATERIAL

Depth (m)	Graphic Log	Description	Weathering	Estimated Strength Is(50) MPa ● - Axial ○ - Diametral □ - Irregular Lump (VL L M H VH EH)
		Start of coring. For non-core interval, see Borehole Log Sheet.		
3.00		Sandy CLAY: low to medium plasticity, brown; Sand, fine to coarse grained, orange brown; with variable sub-angular to sub-rounded gravel sized clasts of extremely weathered sandstone, hematite stained sandstone, with limonite staining (COLLUVIAL SOIL).	-	
3.80		SILTSTONE: dark grey, indistinctly laminated at 5-10°. 4.38-4.58m iron staining	SW	●
4.70		BH202 terminated at 4.70m. Target depth		

DEFECTS

Spacing (mm) (20 40 100 300 1000)	Defect Descriptions & Additional Data (Type, orientation, roughness, shape, composition / coating, aperture / thickness, other)
	3.94 m: J, 20°, RF, CU, SN Fe 4.00 m: J, 10°, RF, IR, CN 4.07 m: J, 40°, RF, PR, CN 4.24-4.62 m: SZ, 15°, RF, UN, rock fragments (5-50mm), SN Fe, 380 mm

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Logged to: AS1726:2017. See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number: 12657881

Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH202
Depth Core: 3.0m to 4.7m

Figure 2

Client Name: Lithgow City Council

BOREHOLE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH203

Location: Wolgan Road CH 0+666

SHEET 1 OF 3

Position: 230939.1 E 6310552.0 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH **Date:** 18/12/2025

DRILLING					MATERIAL						COMMENTS
Scale (m)	Drilling Method	Casing	Water	Samples & Field Tests	Depth (m)	Graphic Log	USC Symbol	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Moisture Condition	Consistency / Relative Density	Comments & Observations
0	AD/T	HWT Casing	Groundwater Not Observed				-	[FILL] Sandy GRAVEL: fine to coarse grained, brown; roadbase.	D	VD	
				SPT: 0.50-0.95 m 3/7/10 N=17	0.50		GP	Sandy GRAVEL: fine to coarse grained, sub-angular to sub-rounded, multiple origins, with ferruginous nodules (COLLUVIAL SOIL).		MD	0.50 m, SPT recovery 450mm
1					1.20		-	SANDSTONE: recovered as Gravelly SAND: fine to coarse grained, yellow brown; with gravel, fine to coarse (HIGHLY WEATHERED ROCK).			
				SPT: 1.50-1.95 m 10/19/25 N=44							1.50 m, SPT recovery 450mm
2										D	
					2.90			Start of coring. For cored interval, see Core Log Sheet.			
3											
4											
5											
6											
7											
8											

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH203

Location: Wolgan Road CH 0+666

SHEET 2 OF 3

Position: 230939.1 E 6310552.0 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** Good **Date:** 18/12/2025

Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH

DRILLING							MATERIAL						DEFECTS	
Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests	Depth (m)	Graphic Log	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral □ - Irregular Lump (VL L M H VH EH)	Spacing (mm) (20 40 100 300 1000)	Defect Descriptions & Additional Data Type, orientation, roughness, shape, composition / coating, aperture / thickness, other
1									Start of coring. For non-core interval, see Borehole Log Sheet.				
2							2.90						
3									Clayey SAND: medium to coarse grained, brown-yellow (EXTREMELY WEATHERED MATERIAL).	XW			
4				100%	9		4.66						
5	HQ3		30-40% Water Return	5.17		4.91 m Is(50) D=2.20 MPa 4.91 m Is(50) A=1.18 MPa	5.17		SANDSTONE: medium to coarse grained, pale grey mottled orange brown.	MW	●○		4.69 m: J, 60°, RF, ST, SN Fe 4.74-4.77 m: EW, 40°, RF, UN, SN Fe, CLAY, 300 mm 4.97-5.17 m: SZ, 30°, RF, UN, SN Fe, rock fragments (1-50mm), 200 mm
6									CORE LOSS 2380mm	-			
7				23%	0		7.55						
8									Clayey SAND: medium to coarse grained, yellow-brown (EXTREMELY WEATHERED MATERIAL).	XW			

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Project Number: 12657881

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH203

Location: Wolgan Road CH 0+666

SHEET 3 OF 3

Position: 230939.1 E 6310552.0 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** Good **Date:** 18/12/2025

Date Started: 19/11/2025 **Date Completed:** 19/11/2025 **Logged:** SH

DRILLING							MATERIAL						DEFECTS	
Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests	Depth (m)	Graphic Log	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral □ - Irregular Lump VL L M H VH EH	Spacing (mm) 20 40 100 300 1000	Defect Descriptions & Additional Data Type, orientation, roughness, shape, composition / coating, aperture / thickness, other
9	HQ3		30-40% Water Return	8.27			8.27		Clayey SAND: medium to coarse grained, yellow-brown (EXTREMELY WEATHERED MATERIAL).	XW			
				90%	80		8.37		CORE LOSS 100mm	-			
									SILTSTONE: dark grey, indistinctly laminated.				8.55 m: J, 20°, RF, ST, CN
									8.80-8.96m iron stained	MW			8.80 m: J, 20°, RF, ST, SN Fe 8.96-9.12 m: SZ, 10°, RF, UN, rock fragments (1-40mm), 160 mm
				9.30			9.30						9.25 m: J, 10°, RF, UN, SN Fe
									BH203 terminated at 9.30m. Target depth				
10													
11													
12													
13													
14													
15													
16													

Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH203
Depth Core: 2.9m to 5.0m

Figure 3

Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH203
Depth Core: 6.0m to 9.3m

Figure 4

Client Name: Lithgow City Council

BOREHOLE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH204

Location: Wolgan Road CH 0+034

SHEET 1 OF 2

Position: 231068.6 E 6309982.5 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Date Started: 20/11/2025 **Date Completed:** 20/11/2025 **Logged:** SH **Date:** 18/12/2025

DRILLING					MATERIAL						COMMENTS
Scale (m)	Drilling Method	Casing	Water	Samples & Field Tests	Depth (m)	Graphic Log	USC Symbol	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Moisture Condition	Consistency / Relative Density	Comments & Observations
	AD/T	HWT Casing	Groundwater Not Encountered	SPT: 0.50-0.58 m 30 for 80 mm HB N=ref	0.02		-	ASPHALTIC CONCRETE: dark grey.			
								[FILL] Gravelly SAND: fine to coarse grained, sub-angular to angular, brown.	D	MD	
					0.40		SC	Clayey SAND: pale grey, brown; with gravel, fine to medium, sub-rounded (EXTREMELY WEATHERED MATERIAL).		VD	0.50 m, SPT recovery 80mm
					0.58			Start of coring. For cored interval, see Core Log Sheet.			
1											
2											
3											
4											
5											
6											
7											
8											

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Logged to: AS1726:2017.
See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number:
12657881

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH204

Location: Wolgan Road CH 0+034

SHEET 2 OF 2

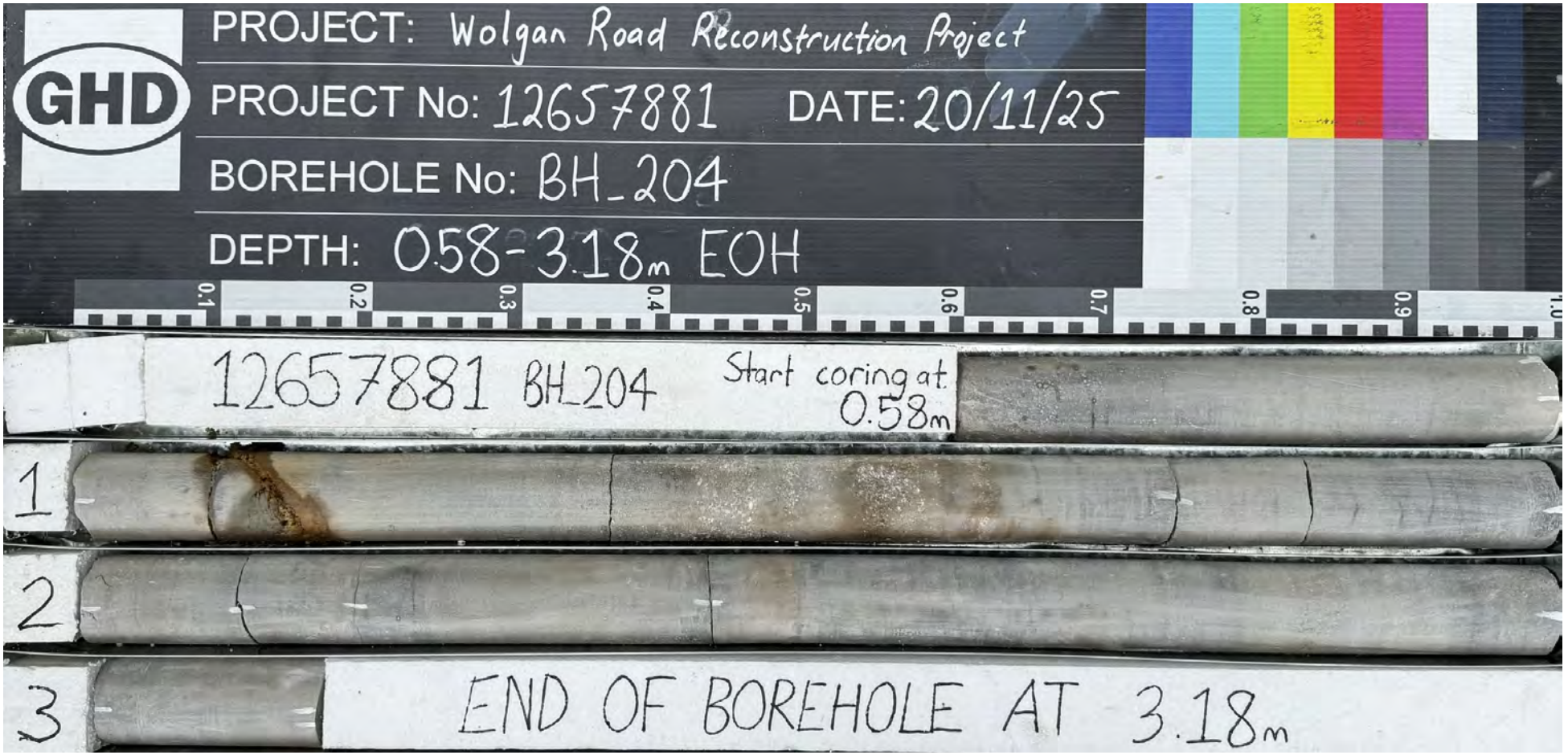
Position: 231068.6 E 6309982.5 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** Good **Date:** 18/12/2025

Date Started: 20/11/2025 **Date Completed:** 20/11/2025 **Logged:** SH

DRILLING							MATERIAL					DEFECTS	
Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests	Depth (m)	Graphic Log	**Description** [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral □ - Irregular Lump VL L M H VH EH	Spacing (mm) 20 40 100 300 1000	**Defect Descriptions & Additional Data** Type, orientation, roughness, shape, composition / coating, aperture / thickness, other
									Start of coring. For non-core interval, see Borehole Log Sheet.				
							0.58						
1	HQ3		95-100% Return	100%	98	0.63 m Is(50) D=1.34 MPa 0.63 m Is(50) A=2.25 MPa			SANDSTONE: fine to medium grained, grey, massive to indistinctly bedded at 0-10°. 1.41-1.62m coarse sandstone interbed	FR	○●		1.10 m: J, 5°, RF, UN, VN CLAY 1.14-1.15 m: EW, 35°, RF, PR, CT Fe CLAY, 10 mm 1.36 m: J, 5°, RF, PR, CN 1.83 m: J, 0°, RF, PR, CN
2													
3				3.18			3.18						
									BH204 terminated at 3.18m. Target depth				
4													
5													
6													
7													
8													



Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH204
Depth Core: 0.58m to 3.18m

Figure 5

Client Name: Lithgow City Council

BOREHOLE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH205

Location: Wolgan Road CH 0+037

SHEET 1 OF 2

Position: 231062.4 E 6309984.7 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Date Started: 20/11/2025 **Date Completed:** 20/11/2025 **Logged:** SH **Date:** 18/12/2025

DRILLING					MATERIAL						COMMENTS
Scale (m)	Drilling Method	Casing	Water	Samples & Field Tests	Depth (m)	Graphic Log	USC Symbol	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Moisture Condition	Consistency / Relative Density	Comments & Observations
1	AD/T	HWT Casing	Groundwater Not Encountered	SPT: 0.50-0.95 m 13/24/30 N=54	0.02		-	ASPHALTIC CONCRETE: dark grey, 20mm. [FILL] Gravelly SAND: fine to coarse grained, sub-angular to angular, pale brown.	D	VD	0.50 m, SPT recovery 450mm
					1.00			Start of coring. For cored interval, see Core Log Sheet.			
2											
3											
4											
5											
6											
7											
8											

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Project Number:

12657881

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH205

Location: Wolgan Road CH 0+037

SHEET 2 OF 2

Position: 231062.4 E 6309984.7 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** Good **Date:** 18/12/2025

Date Started: 20/11/2025 **Date Completed:** 20/11/2025 **Logged:** SH

DRILLING							MATERIAL						DEFECTS	
Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests	Depth (m)	Graphic Log	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Weathering	Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral □ - Irregular Lump VL L M H VH EH	Spacing (mm) 20 40 100 300 1000	Defect Descriptions & Additional Data Type, orientation, roughness, shape, composition / coating, aperture / thickness, other
									Start of coring. For non-core interval, see Borehole Log Sheet.					
							1.00							
1	HQ3		80-90% Water Return				1.15		Clayey SAND: fine to medium grained, brown-grey (EXTREMELY WEATHERED MATERIAL).	XW				1.15-1.31 m: SZ, 15°, RF, PR, SN Fe, rock fragments (1-20mm), 160 mm
						1.42 m Is(50) D=0.48 MPa			SANDSTONE: fine grained, orange-brown, massive, with pervasive iron staining.	HW	○			1.35 m: J, 45°, RF, UN, SN Fe 1.49 m: J, 10°, RF, PR, SN Fe 1.52 m: J, 10°, RF, CU, SN Fe 1.54 m: J, 10°, RF, CU, SN Fe
2				100%	45					MW				1.59-1.80 m: SZ, 20°, RF, UN, SN Fe, rock fragments (1-30mm), 210 mm 2.00 m: J, 5°, RF, IR, SN Fe 2.10 m: J, 45°, RF, PR, SN Fe 2.11 m: J, 10°, RF, UN, SN Fe 2.22 m: J, 45°, RF, PR, SN Fe 2.32 m: J, 5°, RF, IR, SN Fe 2.41 m: J, 10°, RF, UN, SN Fe 2.45 m: EW, 40°, RF, PR, CLAY, 10 mm 2.52 m: J, 30°, RF, IR, SN Fe 2.56 m: J, 30°, RF, PR, SN Fe 2.65 m: J, 45°, RF, PR, SN Fe 2.72 m: J, RF, UN, SN Fe
							2.72		SANDSTONE: fine to medium grained, grey, massive.	SW	●			
3				3.25		3.06 m Is(50) D=1.31 MPa	3.25							
						3.06 m Is(50) A=2.04 MPa			BH205 terminated at 3.25m. Target depth					2.75 m: J, 20°, RF, PR, SN Fe 2.85 m: J, 20°, RF, PR, CN
4														
5														
6														
7														
8														

GHD St Leonards
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Logged to: AS1726:2017. See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number: 12657881

Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH205
Depth Core: 1.0m to 3.25m

Figure 6

Client Name: Lithgow City Council

BOREHOLE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH206

Location: Wolgan Road CH 0+045

SHEET 1 OF 2

Position: 231071.2 E 6309982.1 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Date Started: 20/11/2025 **Date Completed:** 20/11/2025 **Logged:** SH **Date:** 18/12/2025

DRILLING					MATERIAL						COMMENTS
Scale (m)	Drilling Method	Casing	Water	Samples & Field Tests	Depth (m)	Graphic Log	USC Symbol	Description [FILL / TOPSOIL / COBBLES / BOULDERS / -] SOIL NAME: primary component plasticity / particle / behavioural characteristics, colour, secondary component, minor component, structure (ORIGIN) OR ROCK NAME: grain size and type, colour, fabric, texture, inclusions or minor components, strength, weathering, alteration, defects (INTERPRETED STRATIGRAPHIC UNIT / GEOLOGICAL STRUCTURE)	Moisture Condition	Consistency / Relative Density	Comments & Observations
	AD/T	HWT Casing	Groundwater Not Encountered		0.02 0.50		-	ASPHALTIC CONCRETE: dark grey. [FILL] Gravelly SAND: fine to coarse grained, sub-angular to angular, brown. Start of coring. For cored interval, see Core Log Sheet.	D	D	

Client Name: Lithgow City Council

CORE LOG SHEET

Project Name: Wolgan Road Reconstruction Project - Technical Subject Matter Experts

HOLE No. BH206

Location: Wolgan Road CH 0+045

Position: 231071.2 E 6309982.1 N GDA2020 / MGA zone 56 **Surface RL:** m AHD **Angle from Horizontal/Azimuth:** 90°/-

Rig Type: Hanjin DB8 **Mounting:** Track **Contractor:** LP Drilling **Driller:** LP **Checked:** SR

Casing Type: HWT **Barrel:** 3.00 m **Bit:** 7-step surface set **Bit Condition:** Good **Date:** 18/12/2025

Date Started: 20/11/2025 **Date Completed:** 20/11/2025 **Logged:** SH

DRILLING

Scale (m)	Drilling Method	Casing	Water	TCR (%) DRILL DEPTH (m)	RQD (%)	Samples & Field Tests
1	HQ3		90-95% Water Return	100%	94	0.77 m Is(50) D=0.11 MPa 0.77 m Is(50) A=1.48 MPa
2				2.50		
3						
4						
5						
6						
7						
8						

MATERIAL

Depth (m)	Graphic Log	Description	Weathering	Estimated Strength $Is_{(50)}$ MPa (● - Axial, ○ - Diametral, □ - Irregular Lump) VL L M H VH EH
		Start of coring. For non-core interval, see Borehole Log Sheet.		
0.50				
0.60		SANDSTONE: medium to coarse grained, grey, iron stained.	MW	
		SILTSTONE: dark grey, thinly laminated at 0-5°.	SW	
0.90		SANDSTONE: fine to medium grained, grey, massive.		
		1.40-1.67m becoming coarse grained	FR	
2.50		BH206 terminated at 2.50m. Target depth		

DEFECTS

Spacing (mm): 20 40 100 300 1000

Defect Descriptions & Additional Data

Type, orientation, roughness, shape, composition / coating, aperture / thickness, other

- 0.53 m: J, 10°, RF, PR, CN
- 0.60 m: J, 5°, RF, PR, CN
- 0.71 m: J, 5°, RF, PR, CN
- 0.90 m: J, 45°, RF, UN, SN Fe
- 1.20 m: J, 0°, RF, PR, CN
- 2.35-2.39 m: EW, 45°, RF, PR, SN Fe, rock fragments (1-10mm), 20 mm

GHD St Leonards
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St Leonards, New South Wales, 2065

Logged to: AS1726:2017. See GHD standard sheets for details of abbreviations & basis of descriptions

Project Number: 12657881

Project: Interim Reopening Wolgan Road
Job No. 12657881
Client: Lithgow City Council
Borehole: BH206
Depth Core: 0.5m to 2.5m

Figure 7

Appendix D

Laboratory test results

Point Load Strength Index - Report

Client:	Lithgow City Councill
Project:	Wolgan Road
	Geotechnical Investigation
Job No.:	12657881
Borehole / Sample No.:	BH202
Test Method:	AS 4133.4.1-2007

	By	Date
Tested:	LS	03/12/2025
Processed:	CE	08/12/2025
Checked:	SR	19/12/2025

Test Results

Depth (m)	Test Type (D,A,I)	Dimensions				Results				Sample Description			
		D (mm)	L (mm)	W (mm)	De (mm)	Load, P (kN)	Failure Mode (1,2,3..)	Is (MPa)	Is_{50} (MPa)	Rock Type	Struc-ture	Moisture	Note
3.84	D	60.7	35.1		60.7	2.43	4(M)	0.66	**0.72**	SS/ST	IB	AR	
3.84	A	35.1		60.7	52.0	1.12	3	0.41	**0.42**	SS/ST	IB	AR	

Comments (if applicable):

MOISTURE
(W) Wet
(M) Moist
(AD) As Drilled
(D) Dry
(AR) As Received

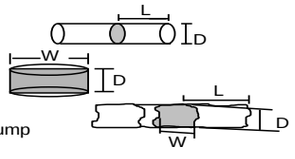
ROCK TYPE
(SS) Sandstone
(ST) Siltstone
(CG) Conglomerate
(SS/ST) Sandstone/Siltstone
(IG) Ignimbrite
(TF) Tuff
Tuff/Siltstone

STRUCTURE
(MA) Massive
(IB) Interbedded
(BE) Bedded
(IL) Interlaminated
(LA) Laminated
(CR) Crystalline

FAILURE MODE
1 = Fracture through fabric oblique to bedding
2 = Fracture along bedding
3 = Fracture through rock mass
4 = Fracture influenced by pre-existing:
(J) Joint plane, (M) Microfracture, (F) Foliation, (V) Vein
5 = Partial fracture or chip (Invalid result)

TEST TYPES

D = Diametral
A = Axial
I = Irregular Lump



L > 0.5 D
0.6W < D < W
0.6W < D < W

Elapsed Time Since Drilling = 8-9 Days

- [X] CORE BOX
- [ ] WRAPPED
- [X] UNWRAPPED
- [ ] UNDER COVER
- [ ] OPEN AIR
- [ ] UNKNOWN

Point Load Strength Index - Report

Client:	Lithgow City Counciil
Project:	Wolgan Road
	Geotechnical Investigation
Job No.:	12657881
Borehole / Sample No.:	BH203
Test Method:	AS 4133.4.1-2007

	By	Date
Tested:	LS	03/12/2025
Processed:	CE	08/12/2025
Checked:	SR	19/12/2025

Test Results

Depth (m)	Test Type (D,A,I)	Dimensions				Results				Sample Description			
		D (mm)	L (mm)	W (mm)	De (mm)	Load, P (kN)	Failure Mode (1,2,3..)	Is (MPa)	Is_{50} (MPa)	Rock Type	Struc-ture	Moisture	Note
4.91	A	30.2		60.6	48.3	2.52	3	1.08	**1.06**	SS/ST	IB	AR	D<0.6W
4.91	D	60.6	30.2		60.6	2.79	3	0.76	**0.83**	SS/ST	IB	AR	L<0.5D

Comments (if applicable):

MOISTURE
(W) Wet
(M) Moist
(AD) As Drilled
(D) Dry
(AR) As Received

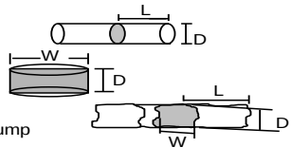
ROCK TYPE
(SS) Sandstone
(ST) Siltstone
(CG) Conglomerate
(SS/ST) Sandstone/Siltstone
(IG) Ignimbrite
(TF) Tuff
Tuff/Siltstone

STRUCTURE
(MA) Massive
(IB) Interbedded
(BE) Bedded
(IL) Interlaminated
(LA) Laminated
(CR) Crystalline

FAILURE MODE
1 = Fracture through fabric oblique to bedding
2 = Fracture along bedding
3 = Fracture through rock mass
4 = Fracture influenced by pre-existing:
(J) Joint plane, (M) Microfracture, (F) Foliation, (V) Vein
5 = Partial fracture or chip (Invalid result)

TEST TYPES

D = Diametral
A = Axial
I = Irregular Lump



L > 0.5 D
0.6W < D < W
0.6W < D < W

Elapsed Time Since Drilling = 8-9 Days

- [X] CORE BOX
- [ ] WRAPPED
- [X] UNWRAPPED
- [ ] UNDER COVER
- [ ] OPEN AIR
- [ ] UNKNOWN

Point Load Strength Index - Report

Client:	Lithgow City Councill
Project:	Wolgan Road
	Geotechnical Investigation
Job No.:	12657881
Borehole / Sample No.:	BH204
Test Method:	AS 4133.4.1-2007

	By	Date
Tested:	LS	03/12/2025
Processed:	CE	08/12/2025
Checked:	SR	19/12/2025

Test Results

Depth (m)	Test Type (D,A,I)	Dimensions				Results				Sample Description			
		D (mm)	L (mm)	W (mm)	De (mm)	Load, P (kN)	Failure Mode (1,2,3..)	Is (MPa)	Is_{50} (MPa)	Rock Type	Struc-ture	Moisture	Note
0.63	D	60.0	31.4		60.0	4.45	3	1.23	**1.34**	SS/ST	IB	AR	
0.63	A	31.4		60.0	49.0	5.46	3	2.27	**2.25**	SS/ST	IB	AR	

Comments (if applicable):

MOISTURE
(W) Wet
(M) Moist
(AD) As Drilled
(D) Dry
(AR) As Received

ROCK TYPE
(SS) Sandstone
(ST) Siltstone
(CG) Conglomerate
(SS/ST) Sandstone/Siltstone
(IG) Ignimbrite
(TF) Tuff
Tuff/Siltstone

STRUCTURE
(MA) Massive
(IB) Interbedded
(BE) Bedded
(IL) Interlaminated
(LA) Laminated
(CR) Crystalline

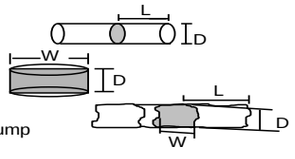
FAILURE MODE
1 = Fracture through fabric oblique to bedding
2 = Fracture along bedding
3 = Fracture through rock mass
4 = Fracture influenced by pre-existing:
(J) Joint plane, (M) Microfracture, (F) Foliation, (V) Vein
5 = Partial fracture or chip (Invalid result)

TEST TYPES

D = Diametral — L > 0.5 D

A = Axial — 0.6W < D < W

I = Irregular Lump — 0.6W < D < W



Elapsed Time Since Drilling = 8-9 Days

- [X] CORE BOX
- [ ] WRAPPED
- [X] UNWRAPPED
- [ ] UNDER COVER
- [ ] OPEN AIR
- [ ] UNKNOWN

Point Load Strength Index - Report

Client:	Lithgow City Councill
Project:	Wolgan Road
	Geotechnical Investigation
Job No.:	12657881
Borehole / Sample No.:	BH205
Test Method:	AS 4133.4.1-2007

	By	Date
Tested:	LS	03/12/2025
Processed:	CE	08/12/2025
Checked:	SR	19/12/2025

Test Results

Depth (m)	Test Type (D,A,I)	Dimensions				Results				Sample Description			
		D (mm)	L (mm)	W (mm)	De (mm)	Load, P (kN)	Failure Mode (1,2,3..)	Is (MPa)	Is_{50} (MPa)	Rock Type	Struc-ture	Moisture	Note
1.42	D	60.5	35.3		60.5	1.63	4(M)	0.44	**0.48**	SS/ST	IB	AR	
1.42	A			60.5	0.0					SS/ST	IB	AR	
3.06	D	60.6	59.3		60.6	4.42	3	1.20	**1.31**	SS/ST	IB	AR	
3.06	A	59.3		60.6	67.7	8.15	3	1.78	**2.04**	SS/ST	IB	AR	

Comments (if applicable):

MOISTURE
(W) Wet
(M) Moist
(AD) As Drilled
(D) Dry
(AR) As Received

ROCK TYPE
(SS) Sandstone
(ST) Siltstone
(CG) Conglomerate
(SS/ST) Sandstone/Siltstone
(IG) Ignimbrite
(TF) Tuff
Tuff/Siltstone

STRUCTURE
(MA) Massive
(IB) Interbedded
(BE) Bedded
(IL) Interlaminated
(LA) Laminated
(CR) Crystalline

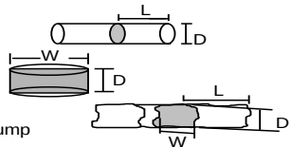
FAILURE MODE
1 = Fracture through fabric oblique to bedding
2 = Fracture along bedding
3 = Fracture through rock mass
4 = Fracture influenced by pre-existing:
(J) Joint plane, (M) Microfracture, (F) Foliation, (V) Vein
5 = Partial fracture or chip (Invalid result)

TEST TYPES

D = Diametral — L > 0.5 D

A = Axial — 0.6W < D < W

I = Irregular Lump — 0.6W < D < W



Elapsed Time Since Drilling = 8-9 Days

- [X] CORE BOX
- [ ] WRAPPED
- [X] UNWRAPPED
- [ ] UNDER COVER
- [ ] OPEN AIR
- [ ] UNKNOWN

Point Load Strength Index - Report

Client:	Lithgow City Counciil
Project:	Wolgan Road
	Geotechnical Investigation
Job No.:	12657881
Borehole / Sample No.:	BH206
Test Method:	AS 4133.4.1-2007

	By	Date
Tested:	LS	03/12/2025
Processed:	CE	08/12/2025
Checked:	SR	19/12/2025

Test Results

Depth (m)	Test Type (D,A,I)	Dimensions				Results				Sample Description			
		D (mm)	L (mm)	W (mm)	De (mm)	Load, P (kN)	Failure Mode (1,2,3..)	Is (MPa)	Is_{50} (MPa)	Rock Type	Struc-ture	Moisture	Note
0.77	D	60.4	32.8		60.4	0.41	2	0.11	**0.12**	SS/ST	IB	AR	
0.77	A	32.8		60.4	50.2	3.73	3	1.48	**1.48**	SS/ST	IB	AR	D<0.6W

Comments (if applicable):

MOISTURE
(W) Wet
(M) Moist
(AD) As Drilled
(D) Dry
(AR) As Received

ROCK TYPE
(SS) Sandstone
(ST) Siltstone
(CG) Conglomerate
(SS/ST) Sandstone/Siltstone
(IG) Ignimbrite
(TF) Tuff
Tuff/Siltstone

STRUCTURE
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(IB) Interbedded
(BE) Bedded
(IL) Interlaminated
(LA) Laminated
(CR) Crystalline

FAILURE MODE
1 = Fracture through fabric oblique to bedding
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3 = Fracture through rock mass
4 = Fracture influenced by pre-existing:
(J) Joint plane, (M) Microfracture, (F) Foliation, (V) Vein
5 = Partial fracture or chip (Invalid result)

TEST TYPES

D = Diametral — L > 0.5 D

A = Axial — 0.6W < D < W

I = Irregular Lump — 0.6W < D < W

Elapsed Time Since Drilling = 8-9 Days

- [X] CORE BOX
- [ ] WRAPPED
- [X] UNWRAPPED
- [ ] UNDER COVER
- [ ] OPEN AIR
- [ ] UNKNOWN

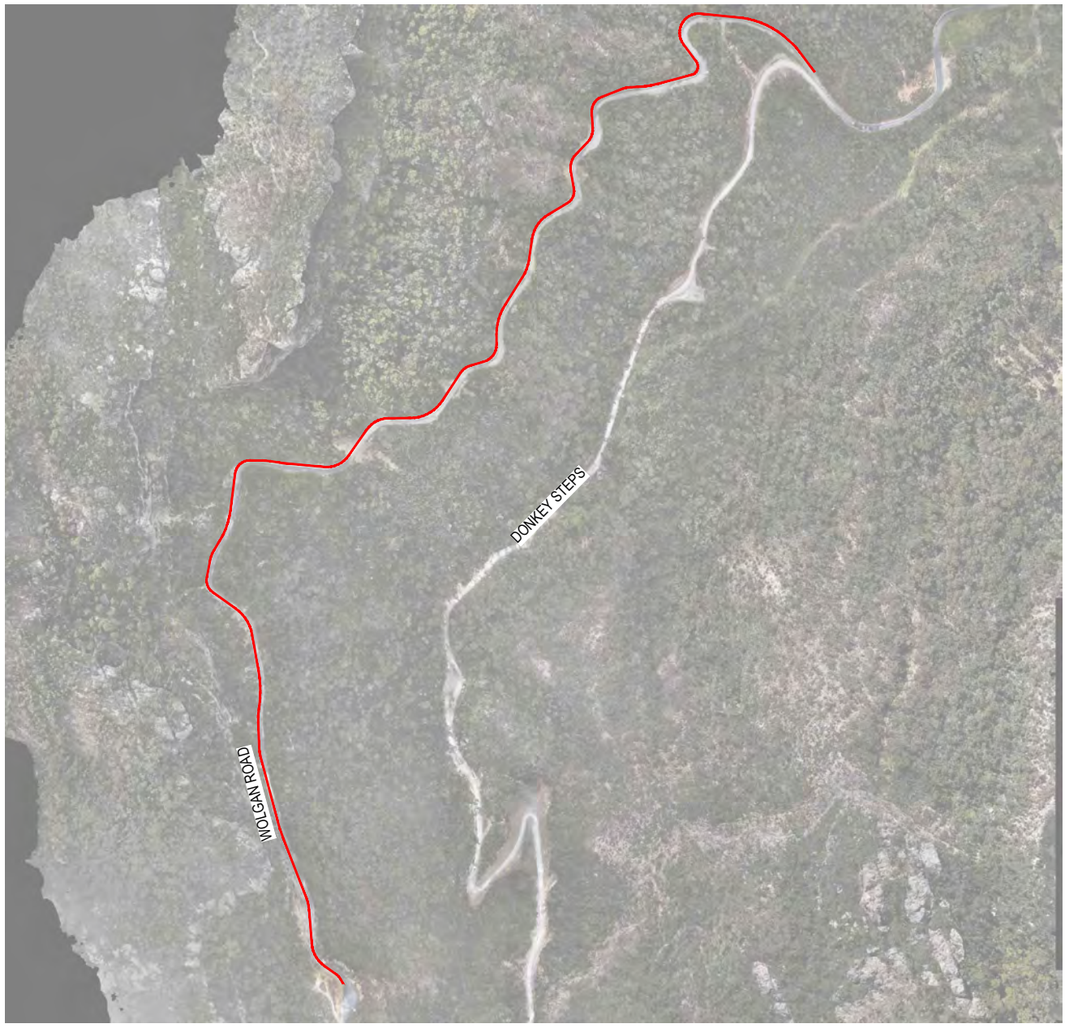
Appendix E

Sketches identifying proposed remediation

LITHGOW CITY COUNCIL

WOLGAN ROAD RECONSTRUCTION PROJECT

12670695



LOCALITY PLAN

NOT TO SCALE

DRAWING INDEX

DRG No.	DRAWING TITLE
12670695-GHD-00-00-DRG-GN-00001	COVER SHEET, LOCALITY PLAN & DRAWING INDEX
12670695-GHD-00-00-DRG-CI-00001	OVERALL SITE PLAN
12670695-GHD-00-00-DRG-CI-00002	GENERAL NOTES & LEGEND - SHEET 1 OF 2
12670695-GHD-00-00-DRG-CI-00003	GENERAL NOTES & LEGEND - SHEET 2 OF 2
12670695-GHD-00-00-DRG-CI-00010	GENERAL ARRANGEMENT PLAN - SHEET 1 OF 10
12670695-GHD-00-00-DRG-CI-00011	GENERAL ARRANGEMENT PLAN - SHEET 2 OF 10
12670695-GHD-00-00-DRG-CI-00012	GENERAL ARRANGEMENT PLAN - SHEET 3 OF 10
12670695-GHD-00-00-DRG-CI-00013	GENERAL ARRANGEMENT PLAN - SHEET 4 OF 10
12670695-GHD-00-00-DRG-CI-00014	GENERAL ARRANGEMENT PLAN - SHEET 5 OF 10
12670695-GHD-00-00-DRG-CI-00015	GENERAL ARRANGEMENT PLAN - SHEET 6 OF 10
12670695-GHD-00-00-DRG-CI-00016	GENERAL ARRANGEMENT PLAN - SHEET 7 OF 10
12670695-GHD-00-00-DRG-CI-00017	GENERAL ARRANGEMENT PLAN - SHEET 8 OF 10
12670695-GHD-00-00-DRG-CI-00018	GENERAL ARRANGEMENT PLAN - SHEET 9 OF 10
12670695-GHD-00-00-DRG-CI-00019	GENERAL ARRANGEMENT PLAN - SHEET 10 OF 10
12670695-GHD-00-00-DRG-CI-00040	CROSS SECTION A-A (CH715)
12670695-GHD-00-00-DRG-CI-00041	CROSS SECTION B-B (CH 508)

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
P03	FOR CLIENT REVIEW	BB	DJ	26.02.26
P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

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GHD Limited

www.ghd.com

Project No. 12670695

Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT COVER SHEET, LOCALITY PLAN AND DRAWING INDEX

Size A3

Drawing No. 12670695-GHD-00-00-DRG-GN-00001

Rev P04

Plot Date: 5 March 2026 - 8:52 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-GN-00001.dwg

OVERALL SITE PLAN

SCALE 1:4000

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
P03	FOR CLIENT REVIEW	BB	DJ	**26.02.26**
P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 40 80 120m

SCALE 1:4000 AT ORIGINAL SIZE

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Project No. 12670695

Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
OVERALL SITE PLAN

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00001

Rev P04

Plot Date: 5 March 2026 - 8:56 AM Plotted by: Roberto Balberan

File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-CI-00001.dwg

LEGEND:

- MAJOR CONTOUR - 10m INTERVAL (750)
- MINOR CONTOUR - 0.5m INTERVAL
- ROAD EDGE
- STAGE 2 NEW BARRIER
- EXISTING BARRIER
- STAGE 1 REPAIRS TO BARRIER
- SHRUBS & SMALL TREES (STAGE 1)
- GIVE WAY TO ONCOMING TRAFFIC / RIGHT OF WAY OVER ONCOMING TRAFFIC (STAGE 1)
- L - BLOCKS = 2m HEIGHT (STAGE 1)
- CULVERT (STAGE 1)
- INSTALL SOLAR POWERED / BATTERY BACK UP LINKED TRAFFIC LIGHTS (STAGE 1 / STAGE 2)
- STAGE 1 EARTHWORKS
- STAGE 2 EARTHWORKS
- COLLUVIUM / FILL
- COLLUVIUM FILL FROM SLOPE
- FREE DRAINING MATERIAL
- AREA TO BE SCALED/GROOMED

BOREHOLE COORDINATES

DESCRIPTION				
BOREHOLE ID	EASTING	NORTHING	ELEVATION	CHAINAGE
BH201	230951.563	6310596.525	7.00	0+715
BH202	230948.867	6310579.133	4.70	0+694
BH203	203939.096	6310551.998	9.30	0+666
BH204	231068.592	6309982.457	3.18	0+034
BH205	231062.377	6309984.727	3.25	0+037
BH206	231071.211	6309982.086	2.50	0+045

GENERAL NOTES:

1. READ THESE NOTES IN CONJUNCTION WITH MANUFACTURE SPECIFICATIONS, AND WITH SUCH OTHER WRITTEN INSTRUCTIONS ISSUED. IN CASE OF DISCREPANCY, PRECEDENCE IS GIVEN TO DRAWINGS, THEN NOTES, THEN SPECIFICATIONS.
2. THE FOLLOWING NOTES DO NOT CONTAIN ALL REQUIRED INFORMATION FOR COMPLIANT CONSTRUCTION IN ACCORDANCE WITH THE REPORT. DETAILS ARE CONTAINED IN THE SPECIFICATION AND RELATED REPORTING DOCUMENTATION. ALL DESIGN DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE LATEST EDITION OF THE WOLGAN ROAD INTERIM REOPENING GEOTECHNICAL REPORT AND RELATED MANUFACTURE SPECIFICATIONS.
3. THESE GENERAL NOTES REFER TO THE STRUCTURAL AND GEOTECHNICAL COMPONENT OF THE WORKS. GENERAL NOTES AND SPECIFICATION FOR CIVIL GEOTECHNICAL ELEMENTS, ARE CONTAINED IN THE RELEVANT REPORT APPENDIX.
4. INTERIM ROAD RECONSTRUCTION IS OF TEMPORARY NATURE; THEREFORE THESE DESIGN HAS BEEN PROVIDED PENDING COMPLETION OF THE PERMANENT PAVEMENT AND EMBANKMENT DESIGN. NO SPECIFIC DESIGN LIFE IS ASSOCIATED WITH THIS INTERIM DESIGN.
5. THE GEOLOGICAL PROFILE AND GEOTECHNICAL CONDITIONS SHOWN ON THE DRAWINGS ARE INDICATIVE AND HAVE BEEN INFERRED FROM LIMITED INVESTIGATIONS. SHOULD THE ENCOUNTERED GEOLOGICAL PROFILE DIFFER FROM THAT SHOWN, THE DESIGN SHALL BE REVIEWED TO ENSURE SUITABILITY OF THE DESIGN TO ENCOUNTERED CONDITIONS.
6. CARRY OUT WORK IN A SAFE MANNER IN ACCORDANCE WITH APPLICABLE LEGISLATION, STATUTORY REGULATIONS, BY-LAWS OR RULES. CONTRACTOR IS RESPONSIBLE FOR OCCUPATIONAL HEALTH AND SAFETY OF SITE PERSONNEL AND GENERAL PUBLIC IN ACCORDANCE WITH ALL CURRENT WORK HEALTH AND SAFETY ACTS, LEGISLATIVE REQUIREMENTS, ASSOCIATED REGULATIONS AND CODES OF PRACTICE, INDUSTRIAL AGREEMENTS AND ACCEPTED INDUSTRY PRACTICE.
7. REFER DISCREPANCIES TO GEOTECHNICAL REPRESENTATIVE BEFORE PROCEEDING WITH WORK
8. SUBMIT DETAILS OF PROPOSED CHANGES TO SCOPE, WORK METHODS OR MATERIALS FOR APPROVAL BEFORE PROCEEDING. APPROVAL DOES NOT AUTHORISE A VARIATION TO THE CONTRACT.
9. 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.
10. OBTAIN NECESSARY PERMITS AND APPROVALS FROM RELEVANT AUTHORITIES BEFORE COMMENCING WORK ON SITE. NOTIFY RELEVANT SERVICE AUTHORITIES BEFORE COMMENCING WORK ON SITE.
11. GIVE TWO WORKING DAYS (48 HOURS) NOTICE SO THAT INSPECTION OF CRITICAL STAGES OF WORK MAY BE CONDUCTED IF REQUESTED BY PRINCIPAL.
12. INSPECTIONS AND REVIEWS UNDERTAKEN BY SUPERINTENDENT OR OTHERS DO NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.
13. DO NOT OBTAIN DIMENSIONS BY SCALING FROM DRAWINGS.
14. VERIFY ON SITE SETTING OUT DIMENSIONS AND DIMENSIONS OF EXISTING ELEMENTS SHOWN ON DRAWINGS BEFORE SHOP DRAWINGS, CONSTRUCTION AND FABRICATION ARE COMMENCED. EXISTING ELEMENTS SHOWN ON DRAWINGS ARE IN APPROXIMATE LOCATIONS ONLY.
15. TAKE CARE OF HAZARDS ASSOCIATED WITH BURIED, CONCEALED OR OVERHEAD SERVICES. TAKE PRECAUTIONS AND WORKMANSHIP UNDERTAKE EXPLORATION TO ESTABLISH LOCATION OF AND PROTECT EXISTING SERVICES AT SITE. SERVICES SHOWN ON DRAWINGS ARE IN APPROXIMATE LOCATIONS ONLY. SERVICES OTHER THAN THOSE SHOWN MAY EXIST ON SITE. MARK LOCATIONS OF SERVICES CLEARLY ON SITE, AND ON AS-BUILT DRAWINGS. HAND EXCAVATE WITHIN ONE METRE OF IN-GROUND SERVICES.
16. DISPOSE OF SURPLUS MATERIAL OFF SITE IN ACCORDANCE WITH LOCAL AUTHORITY WASTE REGULATIONS
17. IMPLEMENT SOL AND WATER MANAGEMENT PROCEDURES TO AVOID EROSION, CONTAMINATION AND SEDIMENTATION OF SITE, SURROUNDING AREAS AND DRAINAGE SYSTEMS.
18. WORKMANSHIP AND MATERIALS TO COMPLY WITH REQUIREMENTS OF AUSTRALIAN STANDARDS, NATIONAL CONSTRUCTION CODE (NCC) AND BY-LAWS AND ORDINANCES OF RELEVANT BUILDING AUTHORITIES. ALL STANDARDS REFERRED TO ARE THOSE CURRENT (AS AMENDED) AT COMMENCEMENT OF CONTRACT.
19. PROTECT EXISTING STRUCTURES FROM DAMAGE OR CRACKING. MAKE GOOD ANY DAMAGE TO EXISTING ELEMENTS AT COMPLETION OF WORKS.
20. WHERE NEW WORK ABUTS EXISTING, PROVIDE SMOOTH TRANSITION FREE OF ABRUPT CHANGES.
21. HAVE TESTING PERFORMED BY AN INDEPENDENT NATA (NATIONAL ASSOCIATION OF TESTING AUTHORITIES) ACCREDITED AUTHORITY AND PROVIDE TEST REPORTS TO THE PRINCIPAL FOR REVIEW.
22. SEPARATE ELEMENTS MADE FROM INCOMPATIBLE METALS (eg STAINLESS STEEL GALVANIZED STEEL, UNGALVANIZED STEEL AND TREATED TIMBER etc) BY CONCEALED LAYERS OF SUITABLE INERT MATERIALS OF SUITABLE THICKNESSES
23. EXTERNAL ELEMENTS ARE THOSE EXPOSED TO WEATHER, RAIN AND WATER PENETRATION IN FINAL WORKS.
24. SUPPLY RELEVANT NOTES, DRAWINGS AND SPECIFICATIONS TO SUB-CONTRACTORS.
25. KEEP ON SITE A COMPLETE SET OF CONTRACT DOCUMENTS (INCLUDING DRAWINGS AND SPECIFICATIONS) AND SITE INSTRUCTIONS.
26. AT THE COMPLETION OF THE WORKS, THE CONTRACTOR SHALL PREPARE AND SUBMIT A' HANDOVER' PACKAGE TO THE PRINCIPAL FOR APPROVAL. THE PACKAGE SHALL INCLUDE AT A MINIMUM:
    - WORKS-AS-EXECUTED
    - UTILITIES (IF ANY] AND EARTHWORKS
    - DRILLING RECORDS
    - RFI's, NCR's, CERTIFICATES AND OTHER FORMS AS NOMINATED BY THE PRINCIPAL.
27. DUE TO THE NATURE OF THE WORKS, MATERIALS AND LIMITED ACCESS TO SOME AREAS IN ADVANCE OF CONSTRUCTION, SOME ASPECTS OF DESIGN WILL BE SUBJECT TO CHANGE
28. DURING THE CONSTRUCTION PROCESS. SUCH ELEMENTS INCLUDE BUT MAY NOT BE LIMITED. THE EXTENT OF L-BLOCK WALLS AND NUMBER OF L- BLOCKS WALLS REQUIRED WILL BE REVISED DEPENDING ON THE CONDITIONS REVEALED DURING CONSTRUCTION. ANCHOR LENGTHS FOR L BLOCKS MAY BE ADJUSTED DURING CONSTRUCTION PENDING CONFIRMATION FROM THE PRINCIPAL.
29. OBSERVATIONAL ADJUSTMENTS DURING CONSTRUCTION WILL BE INSTRUCTED BY THE PRINCIPAL IN CONSULTATION WITH THE CONTRACTOR AND VARIATIONS (UP OR DOWN) TO CONTRACT QUANTITIES AGREED ACCORDING TO ESTABLISHED CONTRACT RATES.
30. CONTRACTOR TO EMPLOY SUFFICIENT EXPERIENCED MANAGERIAL AND TECHNICAL PERSONNEL ON SITE TO EFFICIENTLY MANAGE THE EXTENSIVE USE OF OBSERVATIONAL METHODS ON THE PROJECT.
31. THESE DRAWINGS DETAIL TEMPORARY WORKS ONLY.
32. TEMPORARY WORKS CONSTRUCTION METHODS ARE THE RESPONSIBILITY OF THE CONTRACTOR. ALL TEMPORARY WORKS DESIGNS UNDERTAKEN BY THE CONTRACTOR SHALL BE CARRIED OUT IN ACCORDANCE WITH APPLICABLE STATUTORY REGULATIONS, BY LAWS OR RULES. THE WORKS SHALL COMPLY WITH THE NSW OCCUPATIONAL HEALTH AND SAFETY ACT INCLUDING ASSOCIATED REGULATIONS AND CODES OF PRACTICE.
33. THERE SHOULD BE NO ADVERSE EFFECT ARISING FROM THE TEMPORARY WORKS ON THE INTEGRITY OF THE PERMANENT WORKS.
34. MAINTAIN STRUCTURES IN A STABLE CONDITION DURING CONSTRUCTION AND PROVIDE TEMPORARY BRACING AND OR SUPPORT AS REQUIRED. SHOW TEMPORARY MEMBERS ON SHOP DRAWINGS. PROVIDE SPREADERS AT LOADS AND OR LIFTING POINTS WHERE REQUIRED. ENSURE NO PART IS OVERSTRESSED. DO NOT PLACE OR STORE BUILDING MATERIALS ON, SUPPORT FORMWORK OR PROP FROM STRUCTURAL MEMBERS WITHOUT THE PRINCIPAL'S PRIOR APPROVAL.
35. PROVIDE TEMPORARY BRACING WHERE REQUIRED FOR STRUCTURAL ELEMENTS OR FRAMES STABILISED BY TEMPORARY FOOTINGS, PRECAST CONCRETE OR OTHER ELEMENTS CONSTRUCTED AFTER ERECTION OF THE STRUCTURAL ELEMENT OR FRAME.
36. LEVELS AND CONTOURS ARE DERIVED FROM LIDAR DATA AND MAY BE AFFECTED BY IN-SITU VEGETATION.
37. EXTENT OF REMEDIATION TREATMENT AND CHAINAGES SHOWN ON PLANS ARE APPROXIMATE ONLY AND SHALL BE CONFIRMED ON SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION WORKS.
38. PRIOR TO CONSTRUCTION SITE SET-UP. THE CONTRACTOR SHALL SUBMIT THE FOLLOWING TO THE PRINCIPAL FOR REVIEW:
    a. ALL SAFE WORKING METHOD STATEMENTS AND PLANS.
    b. TRAFFIC CONTROL AND CONSTRUCTION STAGING PLANS.
    c. ALL SHOP DRAWINGS.
    d. ROCK BOLT PRODUCT DETAILS AND INSTALLATION METHOD.
    e. GROUT MIX PROPORTIONS, TYPES OF ADDITIVES/ADMIXTURES (IF USED) AND TEST RESULTS DEMONSTRATING COMPLIANCE WITH COMPRESSIVE STRENGTH REQUIREMENTS ON THESE DRAWINGS.
39. SITE TO BE RETURNED TO ORIGINAL CONDITION OR BETTER.
40. BOREHOLE COORDINATES AND LOCATIONS REPRESENTED ON DRAWINGS HAVE AN ACCURACY OF +-5m HORIZONTALLY.
41. INSTALLATION OF L - BLOCKS ARE OPTIONAL AND ARE A PROVISIONAL ITEM.

SCALING AND GROOMING

1. SCALING AND GROOMING INVOLVES EXCAVATION, REMOVAL AND OR RESHAPING OF MATERIALS PRESENT AT THE ROCK FACE OR CREST IN ORDER TO REDUCE OR REMOVE THE HAZARD PRESENTED BY THAT MATERIAL, OR PREPARE IT FOR SPECIALIST TREATMENT. IT COMPRISES OF THE REMOVAL OF POTENTIALLY UNSTABLE ROCK BLOCKS FROM THE ROCK FACE INCLUDING THE REMOVAL OF LEAF LITTER, SMALL ROCK FRAGMENTS AND SOIL ACCUMULATIONS FROM LEDGES.
2. SCALING AND GROOMING IS REQUIRED IN THE OUTLINED AREAS ON THE DRAWINGS.
3. ADDITIONAL AREAS REQUIRING SCALING/GROOMING MAY BE IDENTIFIED DURING THE DEVEGETATION OF THE ROCKFACE AND CREST, AND THESE ADDITIONAL AREAS IDENTIFIED BY THE GEOTECHNICAL REPRESENTATIVE SHALL BE SCALED/GROOMED AS REQUIRED.
4. SCALING AND GROOMING SHALL BE UNDERTAKEN AS A TOP - DOWN SEQUENCE OF WORK IN ORDER TO MINIMISE THE RISK OF POTENTIALLY UNSTABLE FEATURES BECOMING DISLODGED DIRECTLY ONTO AND/OR IMPACTING PERSONNEL AND/OR PLANT.
5. SCALING AND GROOMING IS TYPICALLY UNDERTAKEN BY HAND SCALING, MACHINE SCALING, SPECIALISED METHODS OR ANY COMBINATION OF THE ABOVE.
6. SPOIL SHALL BE REMOVED FROM THE FACES OR CREST IN A CONTROLLED AND SAFE MANNER. THE CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL OF ALL SPOIL AND WASTE MATERIAL OFF THE WORK SITE.
7. SCALING WORKS SHALL NOT COMMENCE IN ANY AREA WITHOUT APPROVAL FROM THE PRINCIPAL AS TO THE PROPOSED EQUIPMENT AND METHOD OF SCALING.
8. ANY DAMAGED OR DISRUPTION INCURRED TO EXISTING STRUCTURES AS A RESULT OF SCALING SHALL BE REPAIRED/REINSTATED TO THE ORIGINAL CONDITION OR BETTER.
9. HAND SCALING INCLUDES SPECIFIC AND/OR REMOVAL IDENTIFIED UNSTABLE ROCK BLOCKS OR ROCK MASSES OR AS DIRECTED BY THE PRINCIPAL'S GEOTECHNICAL REPRESENTATIVE. THE WORKS SHAL BE UNDERTAKEN BY A SPECIALIST CONTRACTOR. IT IS ANTICIPATED THAT ACCESS DURING SCALING WILL BE UNDERTAKEN USING METHODS SUCH AS BOOM LIFT OR USING TWIN ROPE ACCESS TECHNIQUES. THE WORKS MAY BE UNDERTAKEN BY A COMBINATION OF HAND SCALING (EG LARGE PINCH BARS, CROW BARS, PILICAN PICKS AND RAKES ETC.) THE WORKS SHALL INVOLVE THE SYSTEMATIC REMOVAL OF ALL LOOSE ROCK MATERIAL/BLOCKS THAT ARE LOOSE ENOUGH TO BE POTENTIALLY DISLODGED WITH HAND TOOLS OR AS NOMINATED ON THE DESIGN DRAWINGS, OR DIRECTED BY THE PRINCIPAL.
10. IF PARTICULAR BLOCKS ARE DEEMED TO REQUIRE REMOVAL AFTER FAILED ATTEMPTS BY HAND TOOLS, THE PRINCIPAL'S GEOTECHNICAL REPRESENTATIVE SHALL DETERMINE IF OTHER MEASURES SUCH AS JACK HAMMERS ROCK SPLITTING AIRBAG REMOVAL OR ROCKBOLTING MAY BE APPLIED/REQUIRED. IT SHALL NOT BE UNDERTAKEN WITHOUT PRIOR APPROVAL BY THE GEOTECHNICAL REPRESENTATIVE. SUITABILITY OF THE PROPSED PLANT AND SCALING REQUIREMENTS OF THE AREA ARE TO BE CONFIRMED PRIOR TO COMMENCEMENT. THIS ACTIVITY INCLUDES SPECIFIC SCALING AND/OR REMOVAL OF IDENTIFIED UNSTABLE ROCK BLOCKS OR ROCK MASSES BY PLANT OR POWER HAND TOOLS. ADDITIONAL HAND SCALING IS TYPICALLY REQUIRED AT THE COMPLETION OF MACHINE SCALING, TO REMOVE ACCUMULATIONS OF SOIL AND SMALL ROCK FRAGMENTS THAT CANNOT BE REMOVED USING LARGE PLANT.

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P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
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GHD Limited

Project No. 12670695

Client LITHGOW CITY COUNCIL
Project WOLGAN ROAD RECONSTRUCTION PROJECT
Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT GENERAL NOTES AND LEGEND SHEET 1 OF 2
Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00002
Rev P04

Plot Date: 5 March 2026 - 8:57 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-CI-00002.dwg

GEOTECHNICAL SAFETY IN DESIGN

1. THE SAFETY RISK MITIGATION ITEMS BELOW ARE BASED ON GHD'S DESIGN 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. PROVIDE SAFE WORKING PLATFORM AND / OR PROTECTION SYSTEMS WHEN WORKING AT HEIGHT WHERE REQUIRED.
3. REVIEW ADEQUACY OF WORKING SPACE AVAILABLE FOR CONSTRUCTION ACTIVITIES. ENSURE SEPARATION OF PLANT AND PERSONNEL ON SITE INCLUDING MOVEMENTS OF BOTH.
4. PROVIDE PROTECTION TO PERSONNEL FROM PLANT AND EQUIPMENT, INCLUDING ANCHOR INSTALLATION INSTALLATION WORKS.
5. ENSURE ISOLATION SAFE SYSTEMS OF WORK OR PROTECTIVE MEASURES ARE INSTALLED BEFORE WORKING NEAR LIVE ELECTRICAL INFRASTRUCTURE.
6. PROVIDE PROTECTION OF ELECTRICAL OVERHEAD WIRING SYSTEMS DURING CONSTRUCTION.

ANCHORS

1. ROCK BOLTS AND GROUT TO BE ACCORDANCE WITH THE SPECIFICATION SUPPLIED WITHIN THE LATEST EDITION OF THE WOLGAN ROAD INTERIM REOPENING GEOTECHNICAL REPORT.
2. SELECTION OF DRILLING EQUIPMENT TO BE SUITABLE FOR EXPECTED GROUND CONDITIONS.
3. PROVIDE CENTRALISER FOR ROCK BOLTS AT MANUFACTURES SPECIFICATION.
4. THE GROUT SHALL COMPROMISE WATER AND CEMENT IN A RATIO (BY WEIGHT) OF NOT MORE THAN 0.45.

SCHEDULE OF HOLD POINTS AND WITNESS POINTS

1. REFER TO THE SPECIFICATION IN THE LATEST EDITION OF THE WOLGAN ROAD INTERIM REOPENING GEOTECHNICAL REPORT, ROCK SCALING, ROCK BOLT AND SHOTCRETE SPECIFICATION AND RELATED MANUFACTURE SPECIFICATIONS

INDICATIVE CONSTRUCTION SEQUENCE

1. REFER TO THE LATEST EDITION OF THE WOLGAN ROAD INTERIM REOPENING GEOTECHNICAL REPORT FOR THE CONSTRUCTABILITY ASSESSMENT ASSOCIATED WITH THESE WORKS.

SPECIFICATIONS:

1. REFERENCE/SPECIFICATION ITEM 12657881-GHD-00-00-REP-GE-00001_INTERIM REOPENING GEOTECHNICAL REPORT, (LATEST VERSION OF).
2. TRANSPORT FOR NSW SPECIFICATION D&C R44 EARTHWORKS, EDITION 4/ REVISION 0, JUNE 2023.
3. TRANSPORT FOR NSW. (2022, JUNE). QA SPECIFICATION M3: ROUTINE SERVICES (EDITION 2 / REVISION 3). DOCUMENT ID: IC-QA-M3; ALSO REFERENCED AS TS 03364. TRANSPORT FOR NSW.
4. TRANSPORT FOR NSW (TfNSW). QA SPECIFICATION R106-SPRAYED BITUMINOUS SURFACING (WITH CUTBACK BITUMEN).
5. RMS (2018). SUPPLEMENT TO AUSTROADS GUIDE TO PAVEMENT TECHNOLOGY, PART 2: PAVEMENT STRUCTURAL DESIGN, RMS 11.050, VER. 3.0.

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P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL NOTES AND LEGEND
SHEET 2 OF 2

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00003

Rev P04

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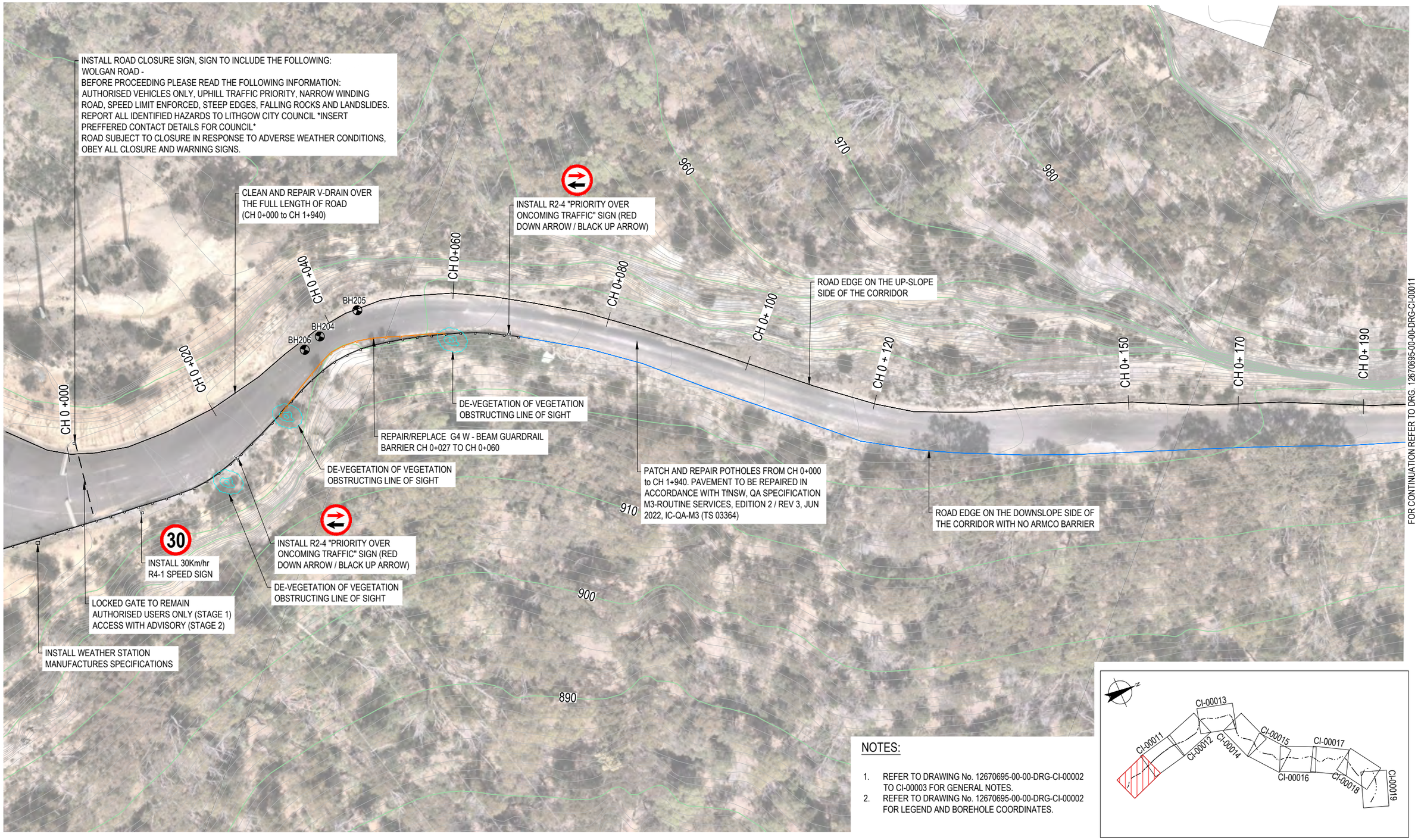

GENERAL ARRANGEMENT PLAN

SCALE 1:500

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.

KEY PLAN

NTS

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P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT
Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 1 OF 10

Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00010
Rev P04

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00010

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00013

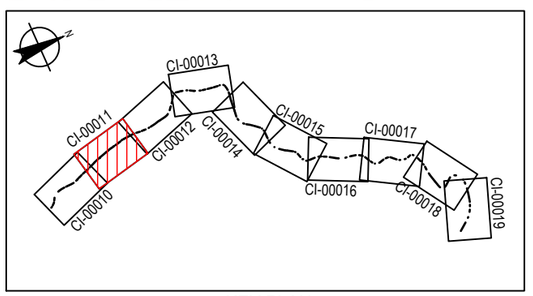
CH 0+ 190
CH 0 + 210
CH 0 + 230
CH 0 + 250
CH 0 + 270
CH 0 + 290
CH 0 + 310
CH 0 + 330
CH 0+ 350
CH 0 + 370

990
950
930
920
900
890
880

CLEAN CULVERT INLET, OUTLET AND PIPE. REPLACE GRATE WITH A GRILLE OPENING SIZE OF 100 - 150mm. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.



GENERAL ARRANGEMENT PLAN
SCALE 1:500

KEY PLAN
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0 5 10 15m
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Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 2 OF 10

Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00011
Rev P04

Plot Date: 5 March 2026 - 9:02 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00010_00019.dwg

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00011

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00013

CH 0 + 370

CH 0 + 390

CH 0 + 410

CH 0 + 430

CH 0+ 460

CH 0 + 480

CH 0 + 500

CH 0 + 520

CH 0 + 540

CH 0 + 560

910

900

890

880

REPAIR/REPLACE G4 -W - BEAM GUARDRAIL BARRIER, CH 0 + 360 TO CH 0 + 395

CLEAN CULVERT INLET, OUTLET AND PIPE. REPLACE GRATE WITH A GRILLE OPENING SIZE OF 100 - 150mm. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

WAITING AREA TO BE MARKED ON THE ROAD. INSTALLATION PENDING RESULTS OF EXCAVATION BETWEEN CH 0+480 AND CH 0+540

INSTALLATION OF TEMPORARY TRAFFIC LIGHTS CH 460 -800. ROAD MARKINGS TO DELINEATE MARK WAITING AREA - TRAFFIC LIGHT MUST BE BATTERY OPERATED OR SOLAR. INSTALLATION PENDING RESULTS OF EXCAVATION BETWEEN CH 0+480 AND CH 0+540

REPAIR/REPLACE G4 -W - BEAM GUARDRAIL BARRIER, CH 0 + 455 TO CH 0 + 493

CLEAN CULVERT INLET, OUTLET AND PIPE. REPLACE GRATE WITH A GRILLE OPENING SIZE OF 100 - 150mm. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

REMOVE DEBRIS WITHIN THE ROAD CORRIDOR TO EXPOSE THE V DRAIN PRIOR TO L-BLOCK INSTALLATION. GEOTECHNICAL REPRESENTATIVE SHOULD BE PRESENT DURING PORTION OF EXCAVATION.

AREA TO BE SCALED/GROOMED

OPTIONAL: INSTALL AND ANCHOR PRECAST CONCRETE L BLOCKS CH 0 +480 TO 0 +540

B CI-00041

B CI-00041

REPAIR/REPLACE G4 -W - BEAM GUARDRAIL BARRIER, CH 0 + 507 TO CH 0 +552

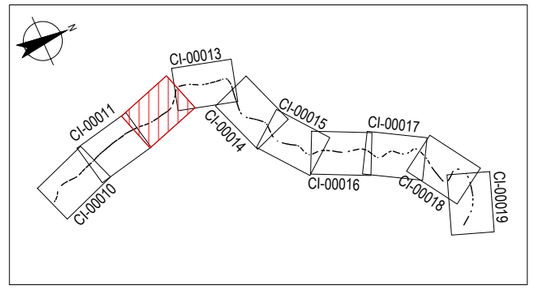
UNDERTAKE EARTHWORKS DETAILED IN CROSS SECTION A-A, DRAWING REFERENCE DRG. No.12670695-00-00-GHD-DRG-CI-00040 (STAGE 1), CH 0 + 530 TO CH 0 + 550

GENERAL ARRANGEMENT PLAN

SCALE 1:500

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.



KEY PLAN

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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 3 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00012

Rev P04

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00012

CH 0+ 590
CH 0+ 610
CH 0+ 630
CH 0+ 650
CH 0+ 670
CH 0+ 690
CH 0+ 740
CH 0+ 760
CH 0+ 780
CH 0 + 790

870
860
850
840

BH203
BH202
BH201

A
CI-00040

A
CI-00040

CLEAN CULVERT INLET, OUTLET AND PIPE. REPLACE GRATE WITH A GRILLE OPENING SIZE OF 100 - 150mm. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

REPAIR/REPLACE G4 W - BEAM GUARDRAIL BARRIER, CH 0 + 635 TO CH 0 + 740

UNDERTAKE EARTHWORKS DETAILED IN CROSS SECTION A-A, DRAWING REFERENCE DRG No. 12670695-GHD-00-00-DRG-CI-00040 (STAGE 1), CH 0 + 650 TO CH 0 + 740

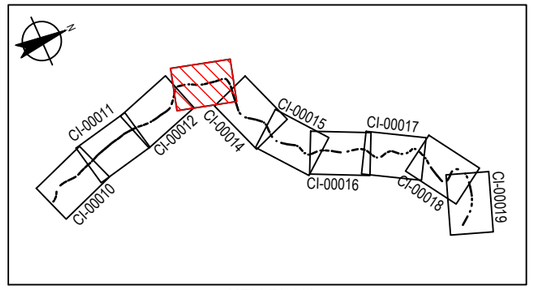
EARTHWORKS - REMOVE DEBRIS FORM ROAD CORRIDOR ENSURING V DRAIN IS CLEAR. BATTER REMAINING SLOPE 27-37 DEGREES. CH 0 + 710 TO CH 0 + 740

CLEAN CULVERT INLET, OUTLET AND PIPE. REPLACE GRATE WITH A GRILLE OPENING SIZE OF 100 - 150mm. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00014

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.



GENERAL ARRANGEMENT PLAN
SCALE 1:500

KEY PLAN
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Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

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SCALE 1:500 AT ORIGINAL SIZE

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Client LITHGOW CITY COUNCIL
Project WOLGAN ROAD RECONSTRUCTION PROJECT
Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT GENERAL ARRANGEMENT PLAN SHEET 4 OF 10
Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00013
Rev P04

Plot Date: 5 March 2026 - 9:04 AM Plotted by: Roberto Balberan
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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00013

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00015

880
870
860
850
840
830
820
810

CH 0 + 790
CH 0 + 810
CH 0 + 830
CH 0+ 850
CH 0+ 870
CH 0+ 900
CH 0+ 920
CH 0+ 940
CH 0+ 960
CH 0 + 970
CH 1 + 000

WAITING AREA TO BE MARKED ON THE ROAD. INSTALLATION PENDING RESULTS OF EXCAVATION BETWEEN CH 0+480 TO CH 0+540

INSTALLATION OF TEMPORARY TRAFFIC LIGHTS CH 460 - 800. ROAD MARKINGS TO DELINEATE MARK WAITING AREA - TRAFFIC LIGHT MUST BE BATTERY OPERATED OR SOLAR. INSTALLATION PENDING RESULTS OF EXCAVATION BETWEEN CH 0+480 TO CH 0+ 540

CLEAN CULVERT INLET, OUTLET AND PIPE. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

REMOVE / SCALE LARGE BOULDER

AREA TO BE SCALED/GROOMED

AREA TO BE SCALED/GROOMED

CLEAN CULVERT INLET, OUTLET AND PIPE. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

GENERAL ARRANGEMENT PLAN

SCALE 1:500

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
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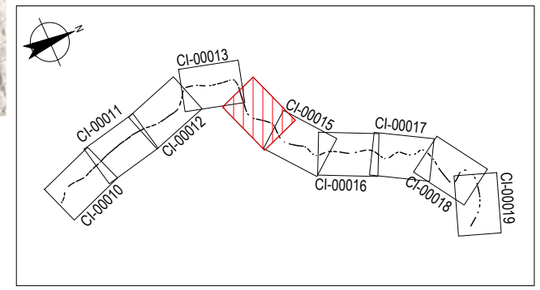

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Designer B. BARBER Design Check D. JONES

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 5 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00014

Rev P04

Plot Date: 5 March 2026 - 9:04 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00010_00019.dwg

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00014

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00016

840

GARDENS OF STONE STATE CONSERVATION AREA BOUNDARY

830

840

CH 0 + 970

CH 1 + 000

820

AREA TO BE SCALED/GROOMED

CH 1 + 100

CH 1 + 200

CH 1 + 180

CH 1 + 140

CH 1 + 160

CH 1 + 030

820

CH 1 + 060

810

CLEAN CULVERT INLET, OUTLET AND PIPE. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

CLEAN CULVERT INLET, OUTLET AND PIPE. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

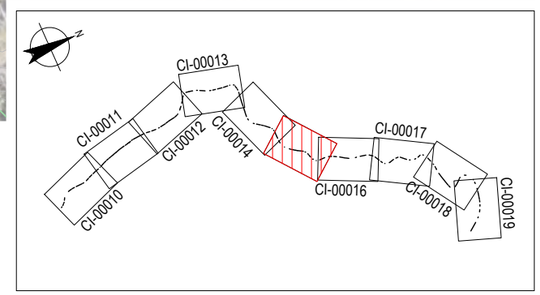
800

GENERAL ARRANGEMENT PLAN

SCALE 1:500

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.



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NTS

Rev	Description	Checked	Approved	Date
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P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

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Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 6 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00015

Rev P04

Plot Date: 5 March 2026 - 9:05 AM Plotted by: Roberto Balberan

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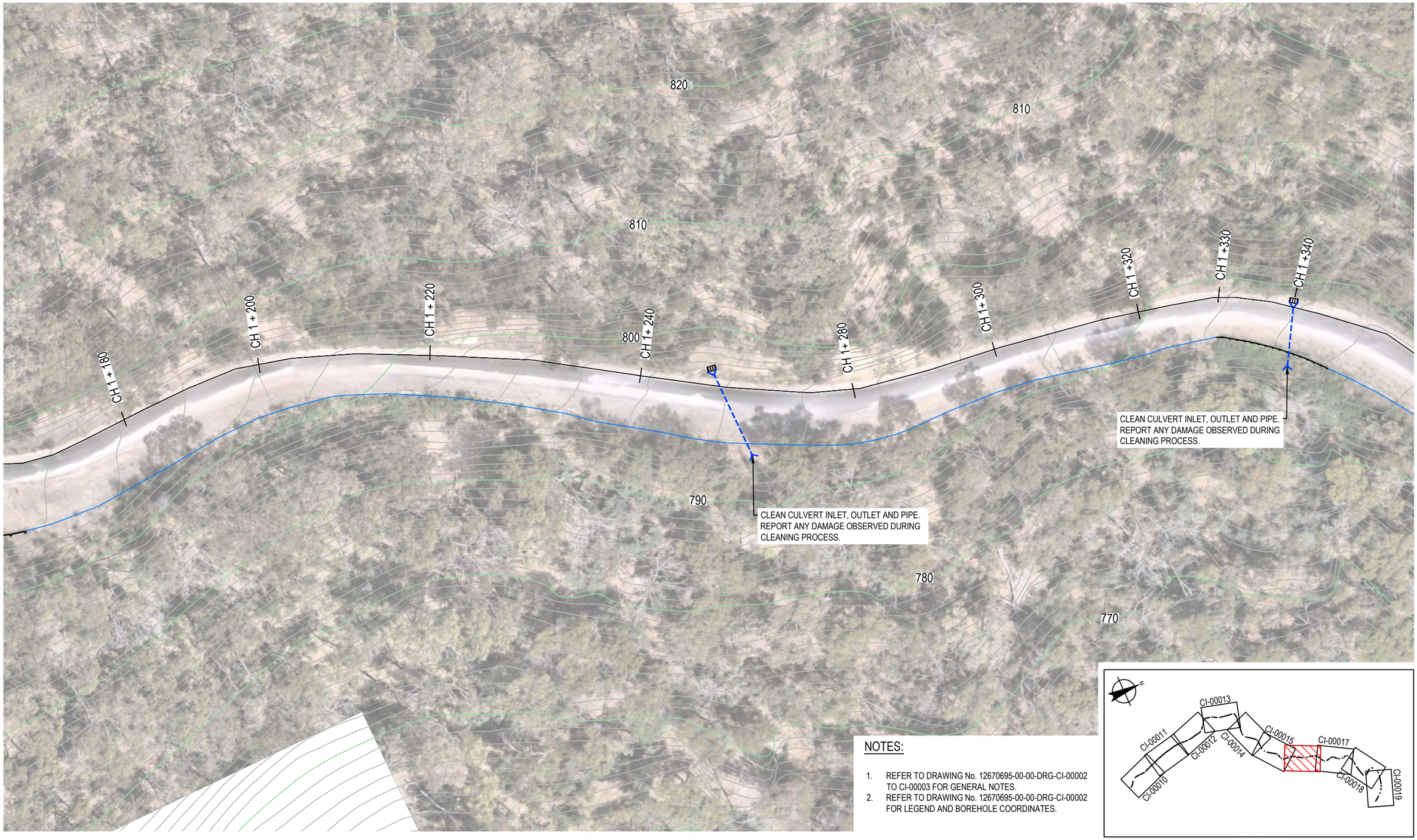

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00017

GENERAL ARRANGEMENT PLAN

SCALE 1:500

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.

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P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 7 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00016

Rev P04

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00016

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00018

CH 1 + 370

CH 1 + 390

CH 1 + 400

CH 1 + 420

CH 1 + 430

CH 1 + 440

CH 1 + 450

CH 1 + 470

CH 1 + 490

CH 1 + 500

CH 1 + 510

CH 1 + 530

CH 1 + 550

810

800

790

780

770

760

750

CLEAN CULVERT INLET, OUTLET AND PIPE. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

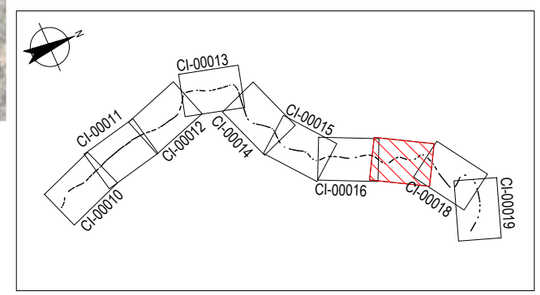
CLEAN CULVERT INLET, OUTLET AND PIPE. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

GENERAL ARRANGEMENT PLAN

SCALE 1:500

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.



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P01	FOR CLIENT REVIEW		BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

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Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 8 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00017

Rev P04

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00017

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00019

790
780
770
760
750
CH 1 + 550
CH 1 + 570
CH 1 + 580
CH 1 + 600
CH 1 + 620
CH 1 + 640
CH 1 + 660
CH 1 + 680
CH 1 + 700
CH 1 + 710
CH 1 + 730
CH 1 + 740
CH 1 + 760
CH 1 + 800

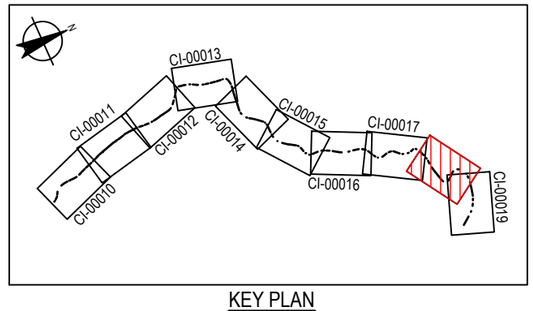
CLEAN CULVERT INLET, OUTLET AND PIPE. REPLACE GRATE WITH A GRILLE OPENING SIZE OF 100 - 150mm. REPORT ANY DAMAGE OBSERVED DURING CLEANING PROCESS.

INSTALL BARRIER TERMINAL COMPATIBLE WITH G4 W - BEAM BARRIER

REMOVE BUND AND PLACE ROAD BASE AT GRADE TO ENABLE 2 CAR TRANSIT AROUND BEND. ENSURE SURFACE IS SEALED POST WORKS TO LIMIT WATER INGRESS. PROVIDE SPRAYED BITUMINOUS SURFACING TO TfNSW R106 WITH TS 00062 COMPLIANT AGGREGATE (STAGE 2).
CH 1 + 600 TO CH 1 + 700

NOTES:

1. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 TO CI-00003 FOR GENERAL NOTES.
2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.



KEY PLAN
NTS

GENERAL ARRANGEMENT PLAN
SCALE 1:500

Rev	Description	Checked	Approved	Date
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P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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Project No. 12670695

Client LITHGOW CITY COUNCIL
Project WOLGAN ROAD RECONSTRUCTION PROJECT
Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
GENERAL ARRANGEMENT PLAN
SHEET 9 OF 10

Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00018
Rev P04

Plot Date: 5 March 2026 - 9:07 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00010_00019.dwg

KEY PLAN

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NOTES:

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2. REFER TO DRAWING No. 12670695-00-00-DRG-CI-00002 FOR LEGEND AND BOREHOLE COORDINATES.

GENERAL ARRANGEMENT PLAN

SCALE 1:500

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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

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GENERAL ARRANGEMENT PLAN
SHEET 10 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00019

Rev P04

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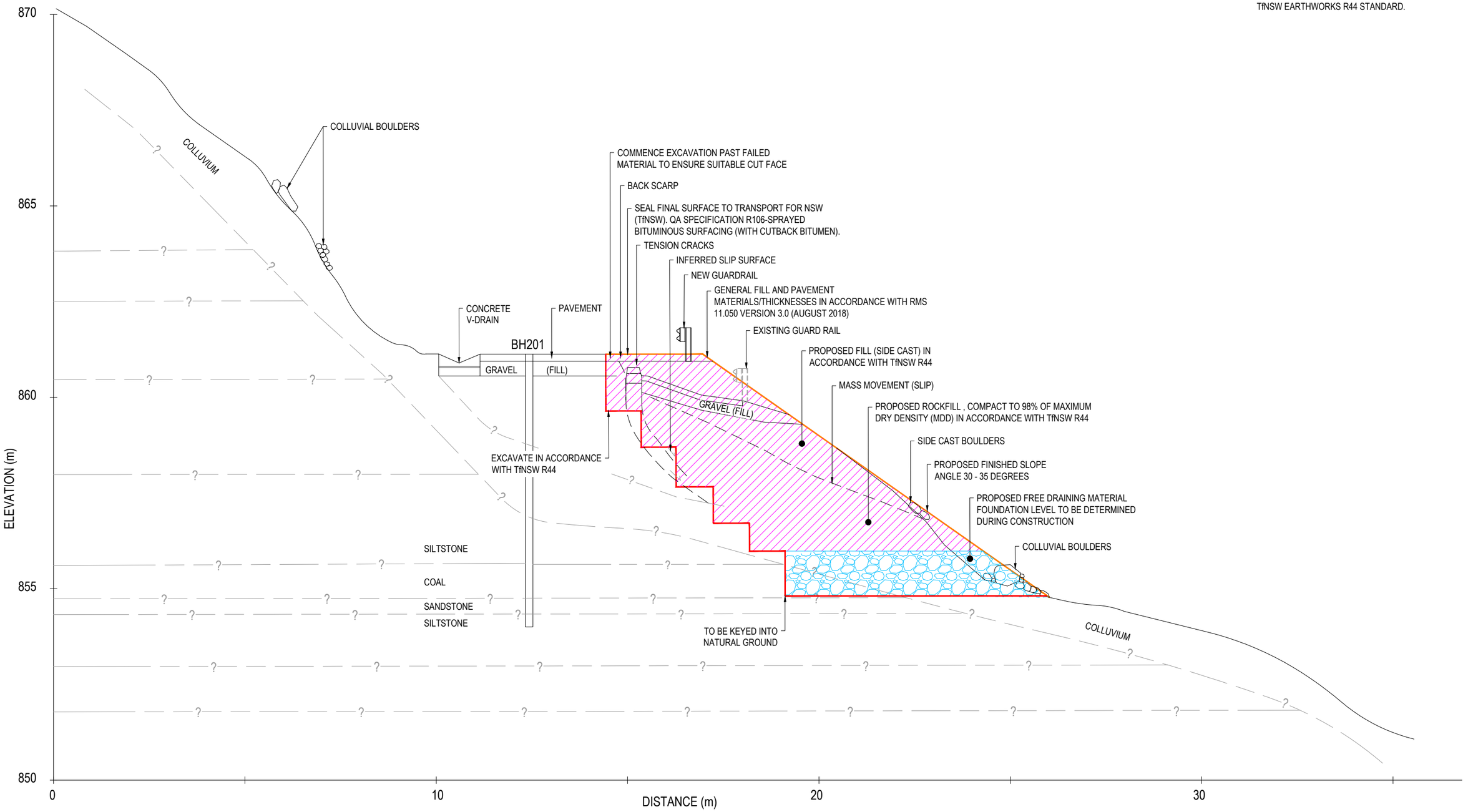
GENERAL NOTE:

1. EARTH WORKS TO BE IN ACCORDANCE WITH TfNSW EARTHWORKS R44 STANDARD.



A CI-00013 SECTION A - A
SCALE 1 : 100

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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

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

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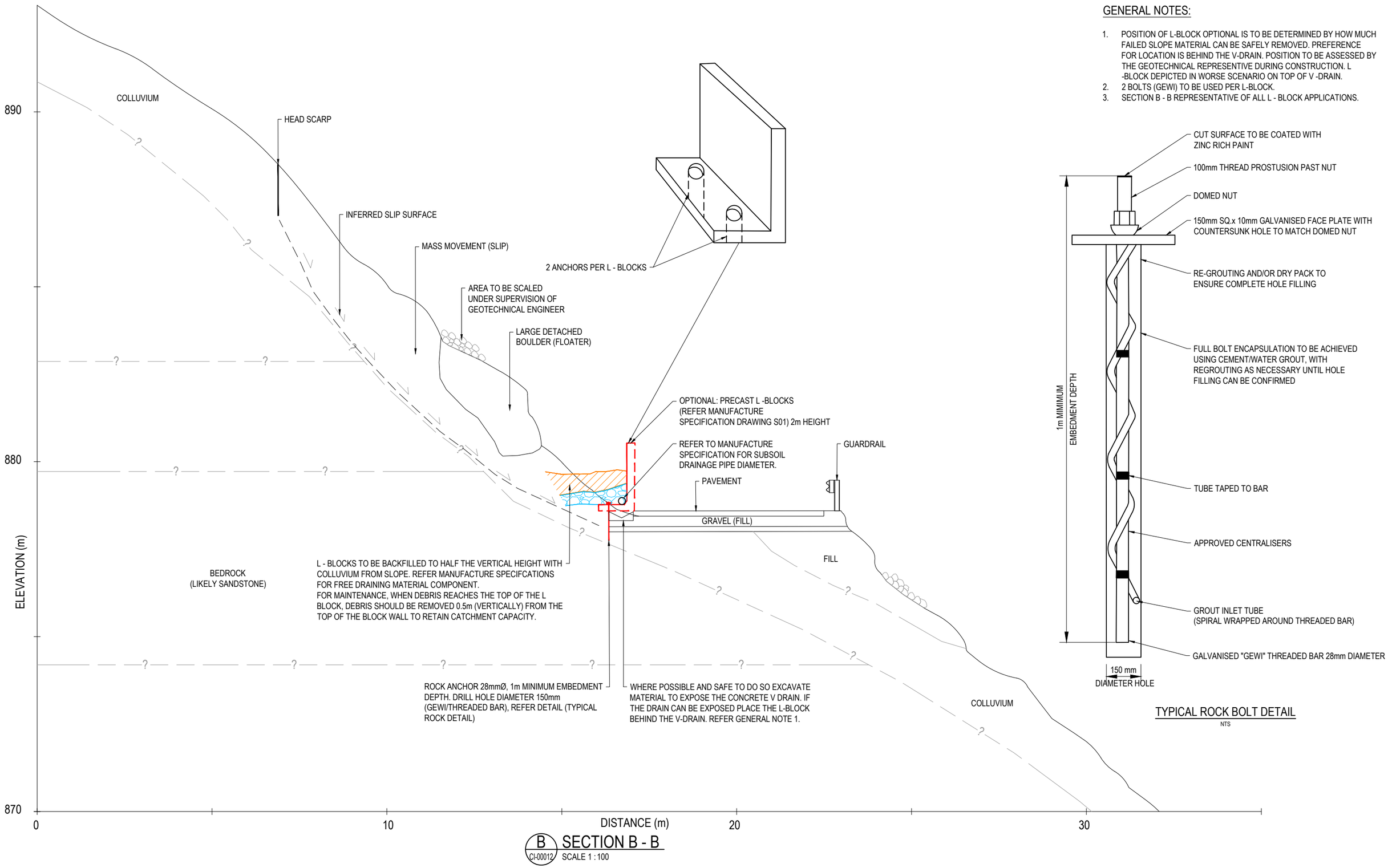
Client LITHGOW CITY COUNCIL
Project WOLGAN ROAD RECONSTRUCTION PROJECT
Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT CROSS SECTION A-A (CH715)
Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00040
Rev P04

Plot Date: 5 March 2026 - 9:34 AM Plotted by: Roberto Balberan
File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-CI-00040-00041.dwg

GENERAL NOTES:

1. POSITION OF L-BLOCK OPTIONAL IS TO BE DETERMINED BY HOW MUCH FAILED SLOPE MATERIAL CAN BE SAFELY REMOVED. PREFERENCE FOR LOCATION IS BEHIND THE V-DRAIN. POSITION TO BE ASSESSED BY THE GEOTECHNICAL REPRESENTIVE DURING CONSTRUCTION. L -BLOCK DEPICTED IN WORSE SCENARIO ON TOP OF V -DRAIN.
2. 2 BOLTS (GEWI) TO BE USED PER L-BLOCK.
3. SECTION B - B REPRESENTATIVE OF ALL L - BLOCK APPLICATIONS.



B CI-00012 SECTION B - B
SCALE 1 : 100

TYPICAL ROCK BOLT DETAIL
NTS

Rev	Description	Checked	Approved	Date
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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER
Designer B. BARBER Design Check D. JONES

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

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Project No. 12670695

Client LITHGOW CITY COUNCIL
Project WOLGAN ROAD RECONSTRUCTION PROJECT
Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
CROSS SECTION B-B (CH508)

Size A3
Drawing No. 12670695-GHD-00-00-DRG-CI-00041
Rev P04

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Appendix F

Trigger Action Response Plan

Wolgan Road Interim Reopening

Trigger Action Response Plan

Lithgow City Council

26 February 2026

→ The Power of Commitment

Project name		Wolgan Road Reconstruction Project					
Document title		Wolgan Road Interim Reopening | Trigger Action Response Plan					
Project number		12657881					
File name		12657881-GHD-00-00-REP-GE-00004-Trigger Action Response Plan					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S3		B. Barber	A. Hunter		D. Jones		19/12/2025
S3		B. Barber	A. Hunter		D. Jones		29/01/2026
S4		B. Barber	A. Hunter		D. Jones		26/02/2026

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Table of Contents

Table index

Figure index

1. Introduction

1.1 General

GHD have been engaged by Lithgow City council (Council) to prepare a Trigger Action Response Plan (TARP) to establish clear protocols for managing geotechnical risks during the interim reopening of Wolgan Road. Wolgan Road serves as a critical access route for the Wolgan Valley community. Reliable passage along this corridor, with appropriate risk management, is essential for maintaining community connectivity and local economic activity. This document is designed to be read in conjunction with GHDs interim reopening geotechnical report titled 12657881-GHD-00-00-REP-GE-00004_Interim Reopening Geotechnical Report, dated 26 February 2026.

1.2 Purpose

The purpose of the Trigger Action Response Plan (TARP) is to provide a structured, risk-based operational framework for managing slope hazards along Wolgan Road during its interim reopening. The TARP defines specific trigger conditions such as, rainfall thresholds, visible ground movement, or changes in slope monitoring data that will initiate predefined actions ranging from increased inspection frequency to full road closure.

By establishing inspection protocols, response actions, and public notification procedures, the TARP aims to proactively manage geotechnical risks for road users. The plan is designed to support Council's goal of restoring limited access to Wolgan Valley while adhering to the "As Low As Reasonably Practicable" (ALARP) principle, recognising that geotechnical risk will remain until a permanent solution is implemented. The TARP is designed to be reviewed and updated as new information becomes available or as site conditions change.

1.3 Limitations

This report: has been prepared by GHD for Lithgow City Council and may only be used and relied on by Lithgow City Council for the purpose agreed between GHD and Lithgow City Council as set out in Section 1.2 of this report. GHD otherwise disclaims responsibility to any person other than Lithgow City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

1.4 Site location

Wolgan Road is located approximately 23 kilometres north of Lithgow, New South Wales (Figure 2). The focus area, known as 'The Gap', is a 1.9- kilometre section of road that descends steeply into Wolgan Valley and provides the main vehicular access to the community and local businesses within the valley. The approximate start and end coordinates are outlined in Table 1. Figure 1 illustrates the Wolgan road (upper corridor) and the alternate lower road corridor, Donkey Steps.

Table 1 Start and end coordinates

Location (site extent)	Longitude	Latitude
Start of Wolgan Road	150.111637	-33.315982
End of Wolgan Road	150.118306	-33.305170

Figure 1 *Wolgan Road proximity to Donkey Steps*

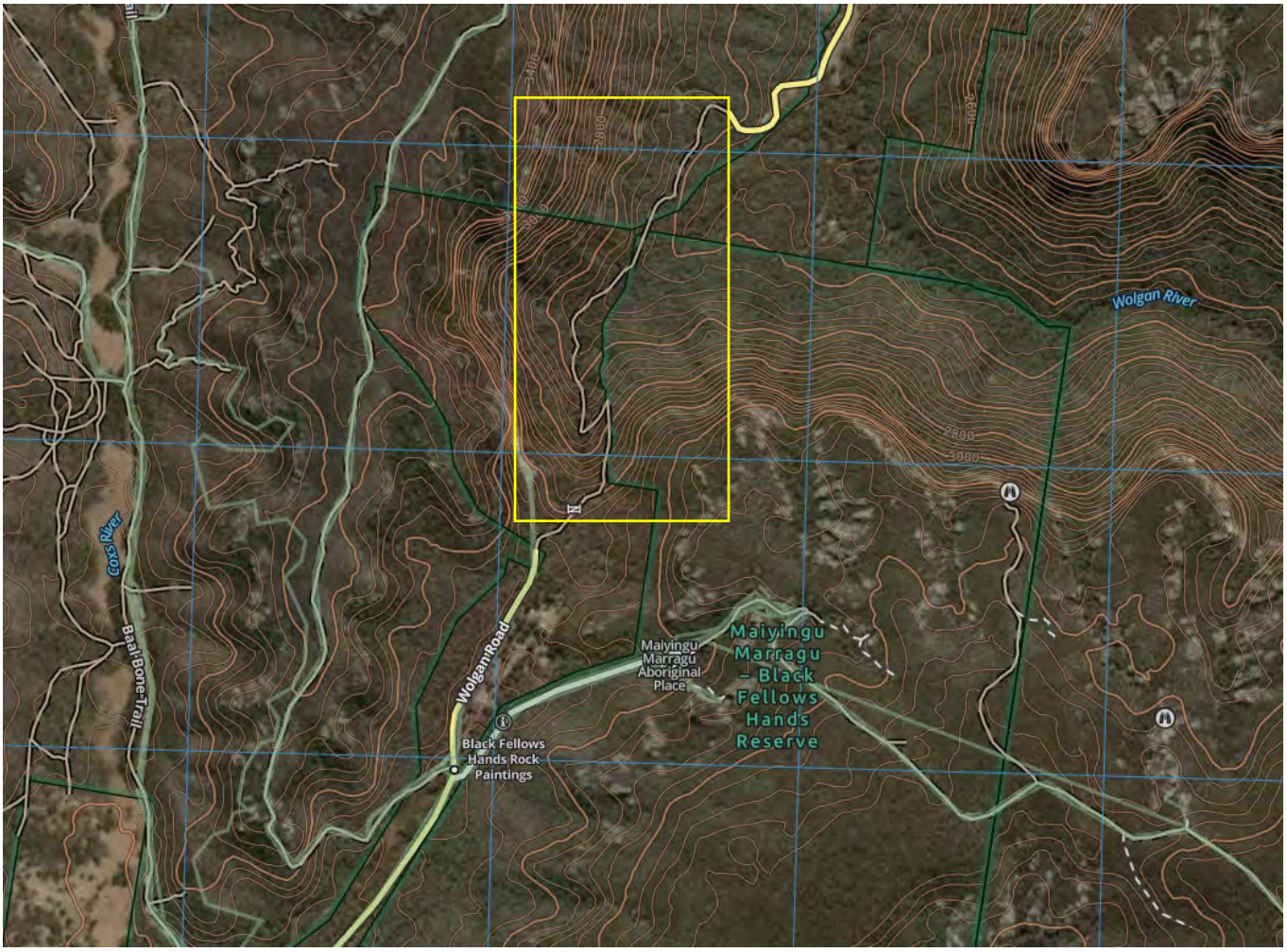


Figure 2 *Extent of Wolgan Road closure outlined (Gaia Maps 2025).*

2. Monitoring methods

2.1 General

The two monitoring methods implemented will be visual monitoring and weather (rainfall and intensity) monitoring. Visual monitoring will be actively carried out by the council or delegated representative. Local community and permitted road users may assist to identify and report any saliant signs of instability. Weather monitoring will track rainfall events that may influence slope stability during the interim reopening period. Automated alerts based on nominated thresholds will be sent to the nominated council representatives.

2.2 Visual Monitoring

Community and permitted road users will provide observations that complement formal monitoring and support trigger-based decision making under the Trigger Action Response Plan (TARP). Observations are especially valuable during periods associated with TARP triggers (e.g., significant rainfall or visible ground movement) and may prompt actions ranging from increased inspections to temporary closures. Community observers should note any of the following:

– Surface distress: New or widening cracks, depressions, bulging, steps or settlement in the road corridor or shoulder.
– Slope/embankment changes: Fresh scarps, soil slippage, rockfalls, or displaced debris.
– Structures & vegetation: Leaning/tilting of trees, fences, signs, guardrails, poles, or culvert headwalls and also fallen trees.
– Water behaviour: New seepage, muddy flows, blocked drains, unusual pooling, or persistent wet patches.
– Additional: Sudden noises (cracking/rumbling) or dust plumes from slopes.

Please note, stopping on Wolgan Road is not advised except in designated areas associated with traffic management.

2.3 Weather monitoring

Rainfall volumes and intensity will be recorded by a site-specific automated weather station configured to record event volume (daily totals and rolling 24-hour, 72-hour and 7-day accumulations) and intensity (mm/hr, including 15-minute and 1-hour peaks) only. Data will stream to the project client portal/alarm manager, where TARP thresholds for volume and intensity are applied so that observed or forecast exceedances generate alerts to prompt heightened inspections or temporary closures. All readings and trigger evaluations are retained in a central inspection/incident log.

Suppliers can provide and maintain the site-specific station, delivering validated rainfall volume and intensity data with portal access and threshold-based alarm management consistent with the project's TARP requirements.

Figure 3 gives an example of the type of weather station that would be required at Wolgan Road. A similar setup was used by GHD in conjunction with Transport for NSW at Jenolan Caves.

Figure 3 Weather station installed by MHL at Jenolan Caves

3. Monitoring Regime

The monitoring regime outlines how visual observations and automated rainfall data is collected, time-stamped, and logged, then reviewed against predefined TARP triggers. It sets the structure for assessment and defines the escalation pathway. When thresholds are met, the appropriate Green/Orange/Red actions can be activated, documented, and communicated, ensuring consistent, timely decisions during the interim reopening of Wolgan Road.

Visual monitoring is to be undertaken by community members and permitted road users while transiting Wolgan Road to note obvious signs of instability outlined in Section 2.2. In parallel, automated weather monitoring operates continuously via the site-specific weather station, capturing rainfall volume (daily and rolling 24-hour/72-hour/7-day totals) and intensity (short-duration peaks). Automated alerts based on nominated thresholds will be sent to the responsible nominated council members. It is important to note it is the councils responsibility to actively notify the community based on these alerts.

3.1 Monitoring frequency

Monitoring will occur at the frequencies defined in Table 2.

Table 2 Monitoring frequency

Monitoring Method	Monitoring Frequency
Visual Monitoring (permitted road users)	At all times while transiting Wolgan Road
Rainfall monitoring	Continuous / Automated (24 hours a day 7 days a week)

3.2 Reporting requirements

Upon identification of a hazard on the road or other pertinent feature listed in Section 2.2, road users should contact Council as soon as practicable. It is recommended that council have a dedicated phone number and email associated with reporting hazards for Wolgan Road.

The information outlined in Table 3 should be collected by council to ensure that visually identified hazards can be added to the Landslide Inventory outlined in Appendix C of GHD report 12670698-GHD-XX-XX-RPT-GT-00001-1_Wolgan Road Slope Risk Assessment, dated 23 September 2025. Photographs of the hazard should accompany each separate entry.

Table 3 Visual hazard reporting fields

Field	Description
Event identification	Unique identifier for the hazard entry determined sequentially by the landslide inventory
Date	Date of occurrence
Locality	Corridor segment, chainage, landmark(s), lane/shoulder. Ideally a GPS location is recorded or road chainage.
Failure mechanism	Best-fit descriptor (e.g., surficial slide, rockfall, embankment scour, drainage-related erosion)
Debris description	Material type/condition (soil/rock/mixed), moisture, notable inclusions (vegetation, infrastructure fragments)
Dimension of largest rock	Longest axis of the largest identifiable block (numeric, metres)
Volume on road	Estimated volume impinging on corridor/shoulder (m^3), or dimensions of failure (length, width, height)
Volume displaced	Estimated total displaced material (including off-road) m^3
Notes	Any additional information provided during the observation, past weather events etc

Automated weather reports triggered by a defined threshold should be tailored to provide outputs that align with the Landslide Inventory Rainfall Data outlined in Appendix C of the GHD report 12670698-GHD-XX-XX-RPT-GT-00001-1_Wolgan Road Slope Risk Assessment, dated 23 September 2025. Council should ensure the required reporting fields outlined in Table 4 are captured.

Table 4 Weather monitoring reporting fields

Field	Description
Event identification	Unique identifier for the hazard entry determined sequentially by the landslide inventory (rainfall)
Qualifier	Basis of the rainfall data (e.g., Observed, Forecast, Estimated)
Date	Date of occurrence
Date confidence	Confidence in the dating of the rainfall event (High, Medium, Low)
Weather station	Wolgan Road weather station
Quality controlled	Whether the rainfall totals have passed quality control
Rainfall hourly	Hourly rainfall (mm)
Rainfall daily	Total rainfall for the 24- hour period (mm)
Rainfall 2-day	Rolling 7-day accumulation (mm)
Rainfall 7-day	Rolling 7-day accumulation (mm)

3.3 Trigger action response

The trigger action response defines how conditions are classified (Green, Orange, Red), who is responsible for decisions, and how actions are executed and communicated. It links slope monitoring (visual observations and event cues) to clear, time-bound responses. Table 5 sets out the alarm thresholds, role-specific responsibilities, and reporting requirements to be followed from first observation through incident management and closure.

Table 5 Trigger Action Response Plan (TARP): Wolgan Road Reconstruction Project

TRIGGER ACTION RESPONSE PLAN (TARP): Wolgan Road Reconstruction Project			
Alarm Thresholds	**Condition: Green**	**Condition: Orange**	**Condition: Red**
Slope Monitoring			
Visual Monitoring	Minor rockfalls (typically <0.2m diameter) or minor pavement distress (i.e. cracks < 5 mm wide, minor depressions).	Any observation of developing instability such as multiple rocks on road (i.e. > 0.2 m diameter), pavement distress (i.e. cracks > 5 mm wide, steps in pavement, depressions), loss of road shoulder.	Any observed hazard impeding traffic.
Event Triggers	N/A	Rainfall > 30mm in 24 hours Local earthquake > M3.0 Confirmed minor visible ground movement/failure Credible community hazard report requiring verification	Rainfall > 50mm in 24 hours Confirmed major visible ground movement/failure Credible community hazard report
Access Response			
Road closure/ Standby	NA	Nominated council members on standby for potential further escalation event triggers	Road closure for 24 h minimum after trigger event.
Required Response			
Geotechnical Engineer or Engineering Geologist	N/A	N/A	Geotechnical engineer / Engineering Geologist to attend site as soon as practicable to carry out visual assessment and reporting of hazard/ road corridor status.
Council member or delegated representative	N/A	Council member or delegate to attend site to confirm reported hazard and or assess road condition.	Council member to attend site as soon as practicable to carry out visual assessment and reporting of hazard/ road corridor status. Landslide mitigation works to be carried out as required (hazard dependant).
Reporting			
Documentation and Communication (Applies to all roles)	Council to update Landslide/ Rainfall Inventory.	Council to update Landslide/ Rainfall Inventory. Notify community via email and text message. Provide timely updates on road status and expected delays.	Council to update Landslide/ Rainfall Inventory. Notify community via email and text message. Provide timely updates on road status and expected reopening timelines.

4. Closure

This document outlines the roles, actions, reporting, and Landslide Inventory compliance required to manage, communicate, and close out reporting of incidents during the interim reopening of Wolgan Road.

If you require further clarification or additional information regarding this document, please contact the report author(s) listed on the title page.

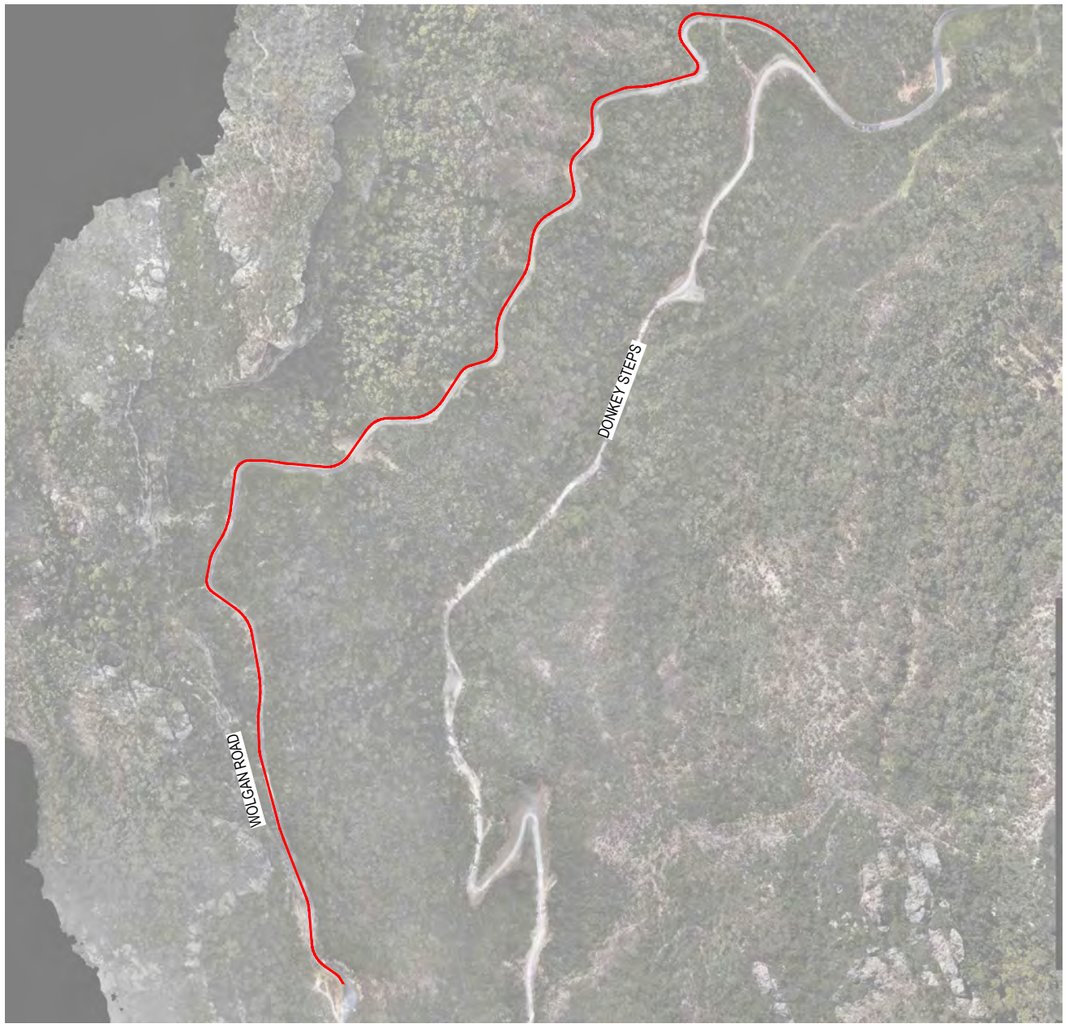
Appendix G

Swept path assessment

LITHGOW CITY COUNCIL

WOLGAN ROAD RECONSTRUCTION PROJECT

SWEPT PATH ANALYSIS



LOCALITY PLAN

NOT TO SCALE

DRAWING INDEX

DRG No.	DRAWING TITLE
12670695-GHD-00-00-DRG-GN-00002	COVER SHEET, LOCALITY PLAN & DRAWING INDEX
12670695-GHD-00-00-DRG-CI-00020	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 1 OF 10
12670695-GHD-00-00-DRG-CI-00021	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 2 OF 10
12670695-GHD-00-00-DRG-CI-00022	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 3 OF 10
12670695-GHD-00-00-DRG-CI-00023	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 4 OF 10
12670695-GHD-00-00-DRG-CI-00024	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 5 OF 10
12670695-GHD-00-00-DRG-CI-00025	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 6 OF 10
12670695-GHD-00-00-DRG-CI-00026	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 7 OF 10
12670695-GHD-00-00-DRG-CI-00027	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 8 OF 10
12670695-GHD-00-00-DRG-CI-00028	SWEPT PATH ANALYSIS - DOWN HILL - SHEET 9 OF 10
12670695-GHD-00-00-DRG-CI-00029	SWEPT PATH ANALYSIS -DOWN HILL - SHEET 10 OF 10
12670695-GHD-00-00-DRG-CI-00030	SWEPT PATH ANALYSIS - UP HILL - SHEET 1 OF 10
12670695-GHD-00-00-DRG-CI-00031	SWEPT PATH ANALYSIS - UP HILL - SHEET 2 OF 10
12670695-GHD-00-00-DRG-CI-00032	SWEPT PATH ANALYSIS - UP HILL - SHEET 3 OF 10
12670695-GHD-00-00-DRG-CI-00033	SWEPT PATH ANALYSIS - UP HILL - SHEET 4 OF 10
12670695-GHD-00-00-DRG-CI-00034	SWEPT PATH ANALYSIS - UP HILL - SHEET 5 OF 10
12670695-GHD-00-00-DRG-CI-00035	SWEPT PATH ANALYSIS - UP HILL - SHEET 6 OF 10
12670695-GHD-00-00-DRG-CI-00036	SWEPT PATH ANALYSIS - UP HILL - SHEET 7 OF 10
12670695-GHD-00-00-DRG-CI-00037	SWEPT PATH ANALYSIS - UP HILL - SHEET 8 OF 10
12670695-GHD-00-00-DRG-CI-00038	SWEPT PATH ANALYSIS - UP HILL - SHEET 9 OF 10
12670695-GHD-00-00-DRG-CI-00039	SWEPT PATH ANALYSIS -UP HILL - SHEET 10 OF 10

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
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P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

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Project No. 12670695

Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT COVER SHEET, LOCALITY PLAN AND DRAWING INDEX

Size A3

Drawing No. 12670695-GHD-00-00-DRG-GN-00002

Rev P04

Plot Date: 5 March 2026 - 9:22 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-GN-00001-SWEPT PATH.dwg

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

NTS

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
P03	FOR CLIENT REVIEW	BB	DJ	26.02.26
P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN **Drafting Check** A. HUNTER

Designer B. BARBER **Design Check** D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

N

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Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 1 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00020

Rev P04

Plot Date: 5 March 2026 - 9:15 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

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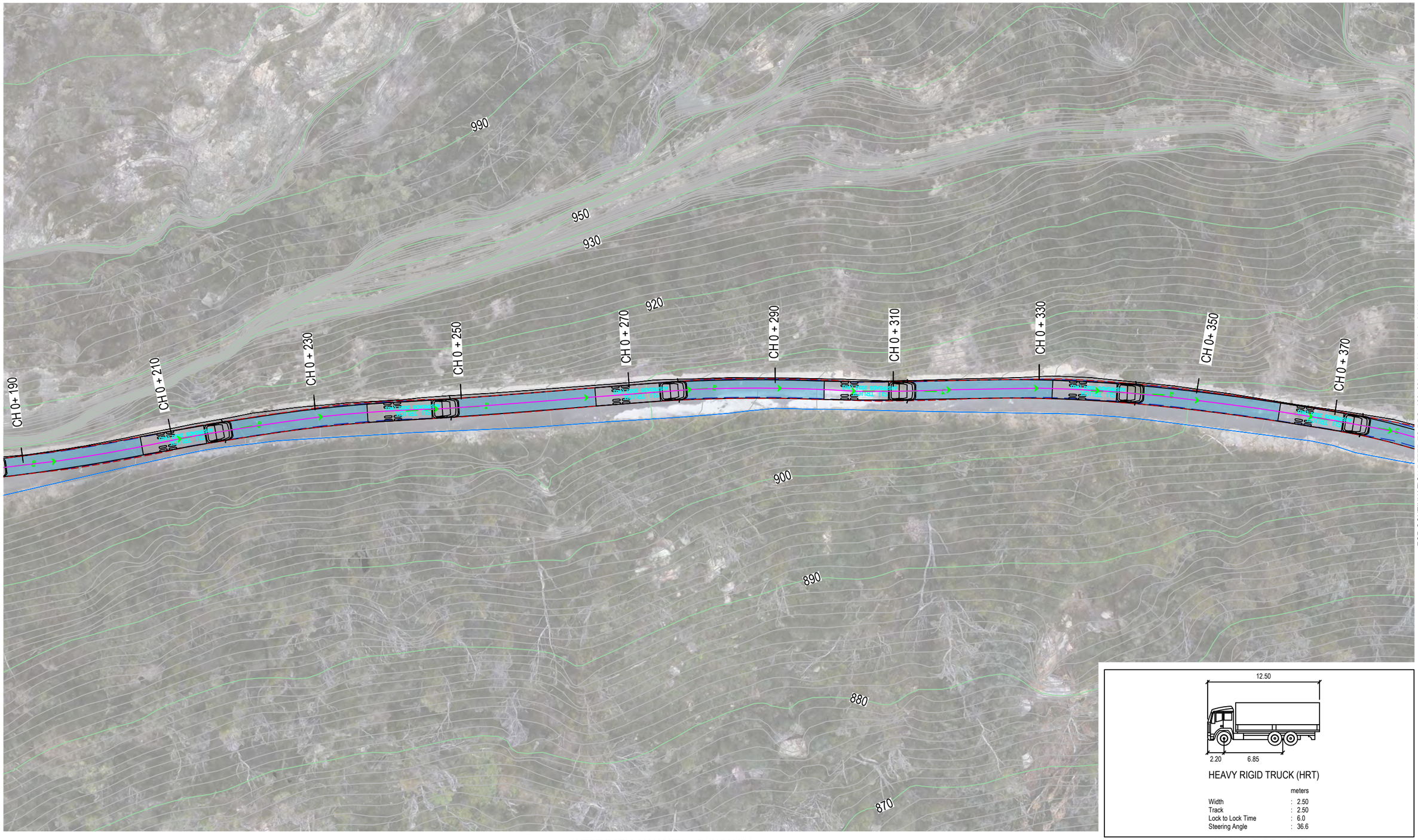

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00022

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

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P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project No. 12670695

Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 2 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00021

Rev P04

Plot Date: 5 March 2026 - 9:16 AM Plotted by: Roberto Balberan

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00021

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00023

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

VEHICLE PROFILE

NTS

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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN **Drafting Check** A. HUNTER

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 3 OF 10

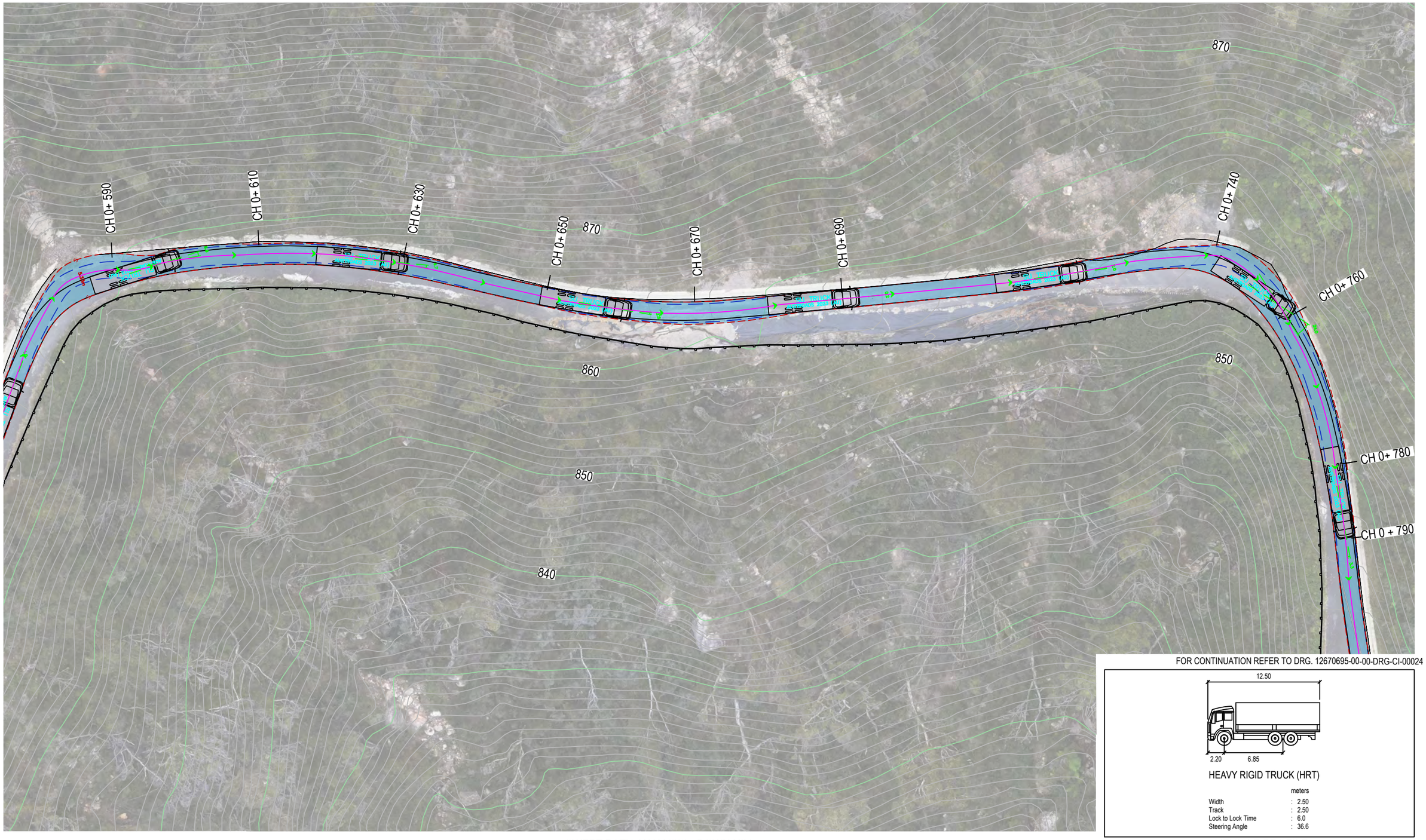
Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00022

Rev P04

Plot Date: 5 March 2026 - 9:17 AM Plotted by: Roberto Balberan

File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg



SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

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Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 4 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00023

Rev P04

Plot Date: 5 March 2026 - 9:17 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00023

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

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Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 5 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00024

Rev P04

Plot Date: 5 March 2026 - 9:18 AM Plotted by: Roberto Balberan

File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00024

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00026

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

NTS

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P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

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0 5 10 15m

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Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 6 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00025

Rev P04

Plot Date: 5 March 2026 - 9:19 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

VEHICLE PROFILE

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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

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0 5 10 15m

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 7 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00026

Rev P04

Plot Date: 5 March 2026 - 9:19 AM Plotted by: Roberto Balberan

File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00026

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00028

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

VEHICLE PROFILE

NTS

Rev	Description	Checked	Approved	Date
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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

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0 5 10 15m

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 8 OF 10

Drawing No. 12670695-GHD-00-00-DRG-CI-00027

Size A3

Rev P04

Plot Date: 5 March 2026 - 9:19 AM Plotted by: Roberto Balberan

File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00027

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00029

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

VEHICLE PROFILE

NTS

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
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Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

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Project No. 12670695

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

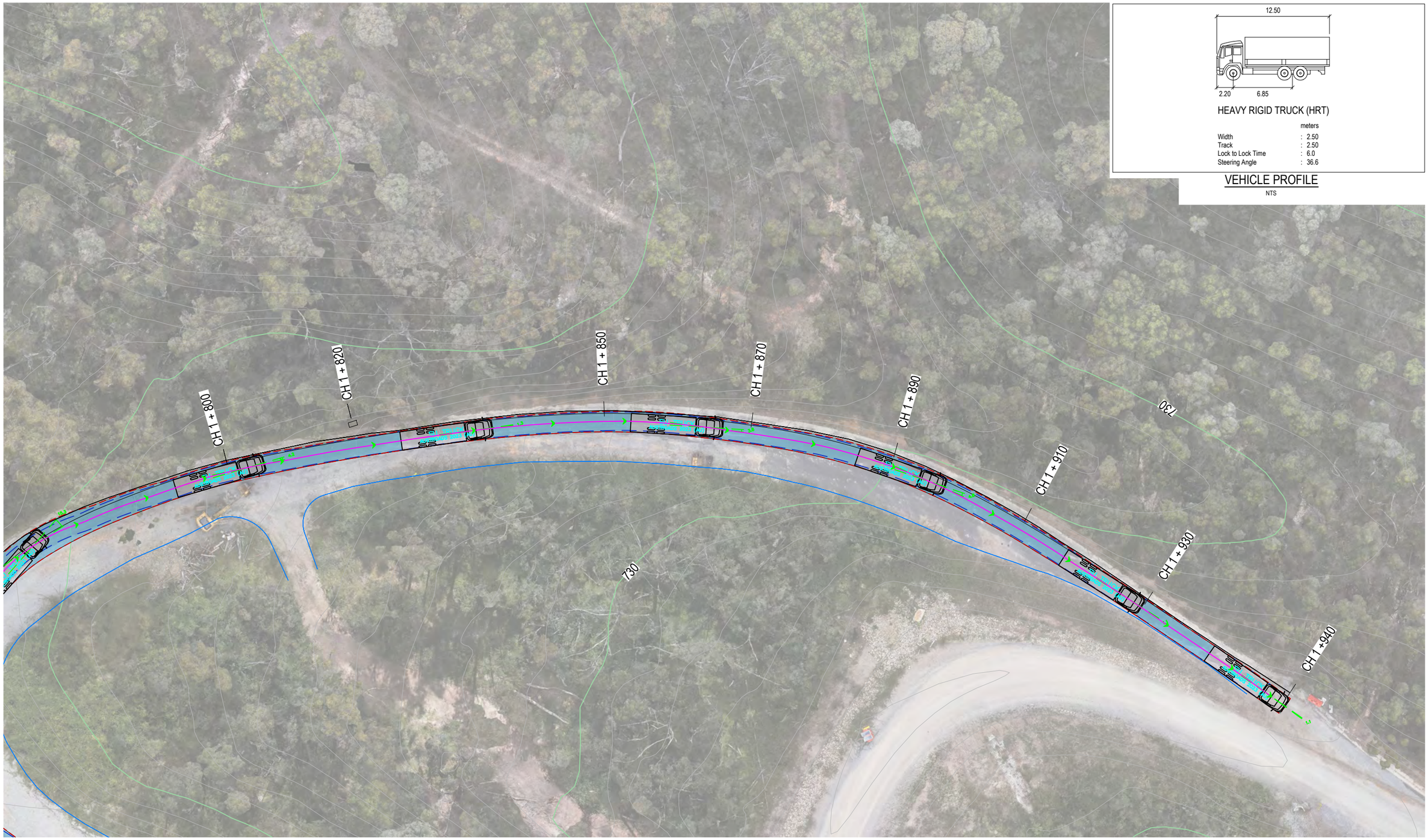
Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 9 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00028

Rev P04

Plot Date: 5 March 2026 - 9:20 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg



12.50

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

NTS

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00028

SWEPT PATH ANALYSIS - DOWN HILL

SCALE 1:500

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
P03	FOR CLIENT REVIEW	BB	DJ	26.02.26
P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project No. 12670695

Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - DOWN HILL
SHEET 10 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00029

Rev P04

Plot Date: 5 March 2026 - 9:21 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00020_00029 _TURNPATH.dwg

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

NTS

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
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P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - UP HILL
SHEET 1 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00030

Rev P04

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SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

NTS

Rev	Description	Checked	Approved	Date
P04	FOR CLIENT REVIEW	SR	DJ	05.03.26
P03	FOR CLIENT REVIEW	BB	DJ	26.02.26
P02	FOR CLIENT REVIEW	BB	DJ	29.01.26
P01	FOR CLIENT REVIEW	BB	DJ	23.12.25

Author R. BALBERAN Drafting Check A. HUNTER

Designer B. BARBER Design Check D. JONES

0 5 10 15m

SCALE 1:500 AT ORIGINAL SIZE

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Project No. 12670695

Client LITHGOW CITY COUNCIL

Project WOLGAN ROAD RECONSTRUCTION PROJECT

Status PRELIMINARY

Drawing Title WOLGAN ROAD RECONSTRUCTION PROJECT
SWEPT PATH ANALYSIS - UP HILL
SHEET 2 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00031

Rev P04

Plot Date: 5 March 2026 - 9:27 AM Plotted by: Roberto Balberan

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00033

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

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0 5 10 15m

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SWEPT PATH ANALYSIS - UP HILL
SHEET 3 OF 10

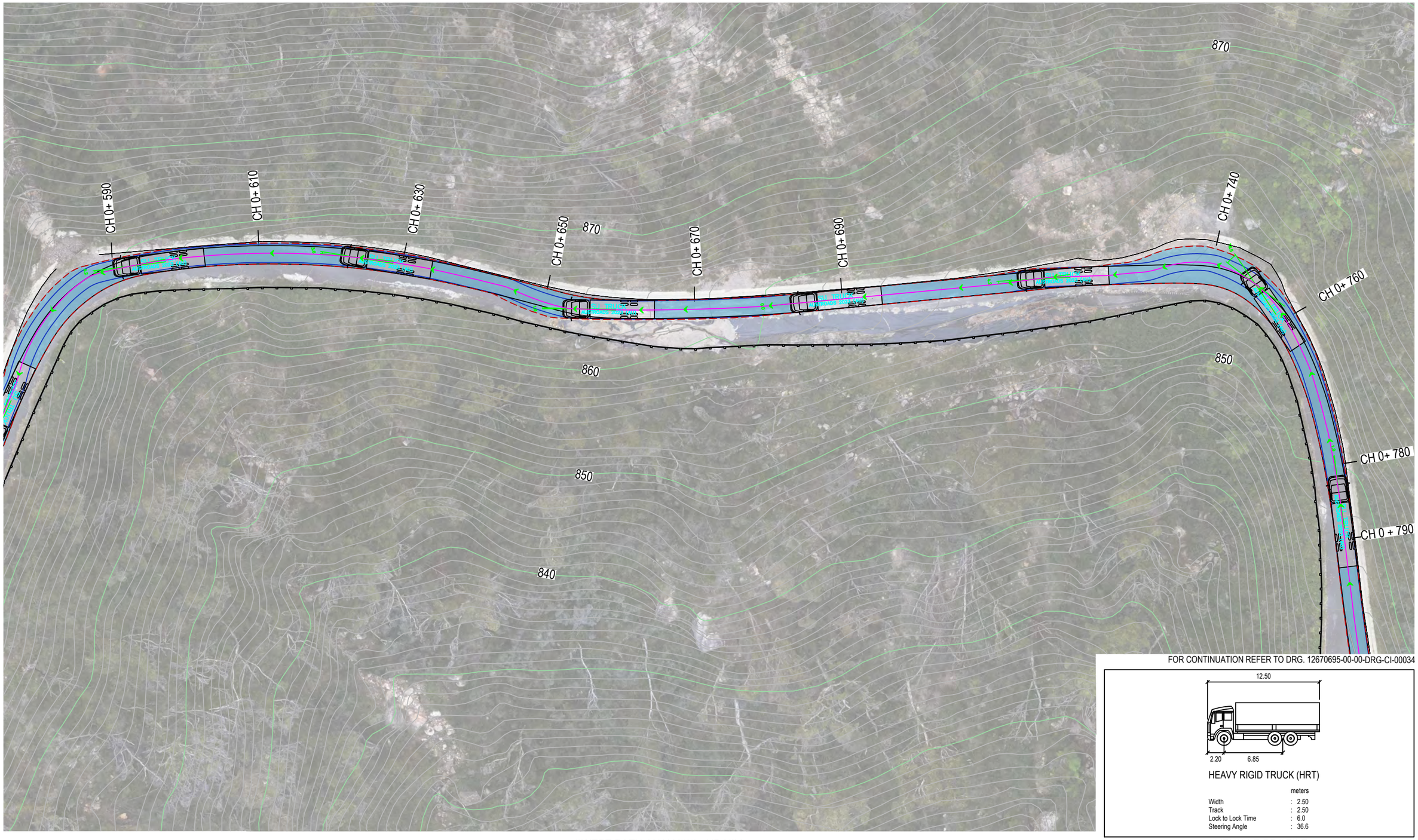
Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00032

Rev P04

Plot Date: 5 March 2026 - 9:28 AM Plotted by: Roberto Balberan

File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00030_00039 _TURNPATH.dwg



SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
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SWEPT PATH ANALYSIS - UP HILL
SHEET 4 OF 10

Size A3

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00035

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
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SWEPT PATH ANALYSIS - UP HILL
SHEET 5 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00034

Rev P04

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00036

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

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SWEPT PATH ANALYSIS - UP HILL
SHEET 6 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00035

Rev P04

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00037

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 36.6

VEHICLE PROFILE

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SWEPT PATH ANALYSIS - UP HILL
SHEET 7 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00036

Rev P04

Plot Date: 5 March 2026 - 9:30 AM Plotted by: Roberto Balberan File Name: C:\12d\SW\data\P-00-12D-001\22-12657881 - Wolgan Road Reconstruction_3618\CADD\Drawings\12670695-GHD-00-00-DRG-00030_00039 _TURNPATH.dwg

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FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00038

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
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SWEPT PATH ANALYSIS - UP HILL
SHEET 8 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00037

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SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

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	meters
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SWEPT PATH ANALYSIS - UP HILL
SHEET 9 OF 10

Size A3

Drawing No. 12670695-GHD-00-00-DRG-CI-00038

Rev P04

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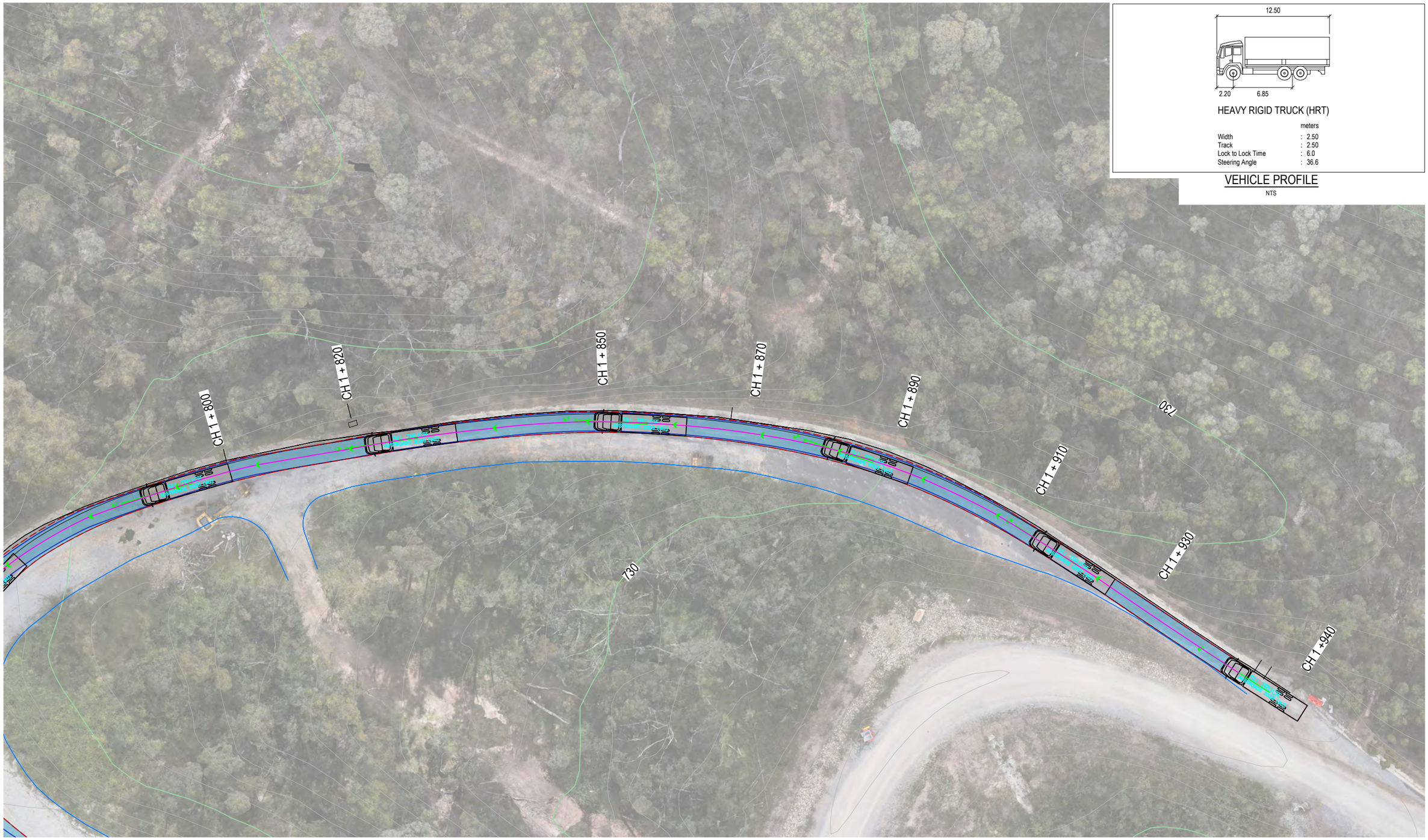

HEAVY RIGID TRUCK (HRT)

		meters
Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

VEHICLE PROFILE

NTS

FOR CONTINUATION REFER TO DRG. 12670695-00-00-DRG-CI-00038

SWEPT PATH ANALYSIS - UP HILL

SCALE 1:500

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SWEPT PATH ANALYSIS - UP HILL
SHEET 10 OF 10

Size A3

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Appendix H

Constructability Assessment

Trodon Pty Ltd

Construction Engineering

ABN 61624073892

Jerrabomberra, NSW

Wolgan Road Reconstruction Project – Constructability Assessment

Author: Asher Trounce

Revision: 3

Date: 5th of March 2026

Contents

1. Executive Summary

This report has been developed as a constructability review for the repairs associated with currently damaged Wolgan Road to facilitate an interim reopening of the alignment.

The project consists of a number of work scopes, including stormwater upgrades, edge barrier installations, formation improvements and pavement reconstruction activities.

With the work being located within a 20min drive from Wallerawang, general access to the site for workers and materials is considered reasonable for standard construction operations.

The terrain and existing condition of the alignment create onsite risks to the delivery of the work, which therefore requires a planned and sequenced approach to delivery. This will include pre-establishment planning and procurement, the establishment of site facilities and storage areas, to the management of onsite plant operations and travel arrangements to efficiently and safely delivery the works.

2. Background

Wolgan Road, located in the Lithgow council region of NSW, services residents and industry located in the Wolgan Valley.

The road is currently closed to all traffic, due to significant damage to the existing road infrastructure including sections of the formation, stormwater network, pavement and safety barrier system.

To rectify the damage and reopen the road, a two-stage damage repair is proposed to initially provide access along the road for Wolgan valley residents, and then a following stage for limited access or further permanent solution.

The purpose of the proposed repairs is not to fully restore the road to is former condition, as a new section of infrastructure, rather to provide safe and reliable access to Wolgan Valley users.

3. About the Author

Asher Trounce is an experienced civil construction engineer with 20 years of experience in heavy civil infrastructure and road construction. His experience includes road formation and pavements, large scale dams, structures, significant excavations, traffic management, utility relocations, large diameter pipework, geotechnical stabilisations, foundation improvements, greenfield developments, contaminated land restoration and material processing.

4. Construction scope

The scope of repair proposed can be initially summarised as reasonably straightforward although due to the location, terrain and restricted working conditions the work must be carefully considered and planned to avoid creating additional risks during delivery or further impacting on the integrity of the existing road assets.

The scope of work is generally planned to be broken into the following stages and scope

4.1.1 Stage 1

- Drainage network improvements.
- Formation reconstruction including upslope and downslope reconstruction and stabilisation.
- Safety barriers installations.

4.1.2 Stage 2

- Pavement repairs
- Completion of safety barrier repairs
- Removal of existing access controls and installation of permanent traffic controls. Noting that traffic signals may still be required at the completion of this stage.
- The following information provides details on each of the repair treatments nominated.

4.2 Drainage network improvements

The drainage improvements will involve the cleaning and inspection of existing stormwater culverts. It is foreseen that this work will be done by means of adjustable-pressure truck mounted Jetter to both clear the culvert and complete optional CCTV inspection to assess any defects in the existing installations.

The cleaning and inspection work will be a relatively fast operation, with the works foreseen to progress as its own operation progressively along the alignment.

It should be noted that experienced operators should be engaged for this work, and medium to low pressures be used to facilitate the jet cleaning to avoid damaging any open joints or defects that are in the existing pipe.

Given the condition of the road and location, there is potential for some of the existing culverts to be damaged and requiring repair of replacement either in part or entirely. If this is the case, it is strongly suggested that any such repair be targeted as soon as practical to ensure the sites stormwater management is fully operational as to not direct flows to other areas of the alignment and therefore create further issues and defects.

During the cleaning works, it is suggested that the existing pit inlets could be improved to better improve flow and debris management. It is suggested that this could be a combination of installing alternate pit grates with larger inlet aperture and potentially a castled kerb constructed uphill of the pit inlet to help capture larger debris and prevent them from blocking the pit inlet grates. Although given the variation in geometry and location, such improvement would be a location-by-location approach, therefore such work would be best performed in stage 2 to avoid delaying the opening of stage 1 and allow time onsite to develop a suitable option for each location.

As with all pit grate replacements, the size and shape can create availability issues and require custom fabricated components to facilitate a simple onsite swap out. It is suggested that detailed measurements be made early to facilitate early procurement of alternate lids to avoid onsite delivery delays.

To facilitate the installation of the alternate pit grates and debris management, a small crew of experience tradesmen would be required to carry out the works including any concrete adjustment work. It is noted that from some investigations into the road alignment during its operation before the current defects, debris blockage of the stormwater pits was an ongoing issue as is representative in the following image.

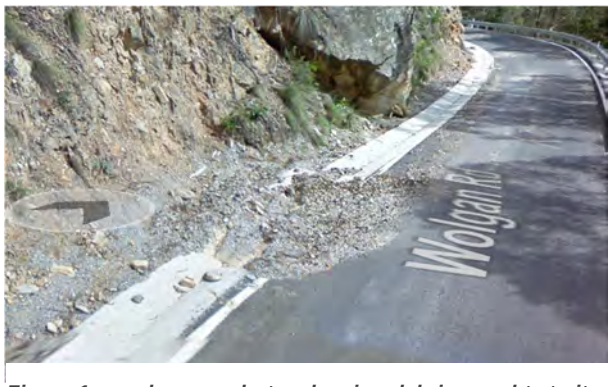


Figure 1. pre damage photo, showing debris caught at pit grate

This debris management presents a long-term maintenance requirement on this road, unless significant and permanent stabilisation of the surfaces above the road is completed. Noting that it is assumed to be cost prohibitive due to access and scale of area that would need to be treated.

If pipe culverts are required to be replaced, it is foreseen that construction equipment and personnel to be assigned to the formation reconstruction work would be suitably purposed to complete this work.

4.3 Formation Reconstruction – Catch Barriers

For sections along the alignment, it is proposed that precast retaining wall units will provide a simple and suitable solution to catch debris and stabilised the existing upslope failures.

This is a simple and fast method of construction that will allow construction crews simple and relatively methods for retaining and debris capture.

The construction process for this work would include.

- Verification of extent of treatment.
- Procurement of precast wall units, including any custom features to accommodate curved installation.
- Once units are available from precasting operations, carry out:
  - Excavation and foundation preparation, which would include a base gravel foundation construction.
  - Carry out vertical rock anchor installation into the foundation to provide vertical and lateral restraint
  - Installation of the proposed L block units.
  - Installation of subsoil drainage and drainage medium behind the wall, progressively with backfill material where specified.

Figure 2 Proposed L precast catch barrier wall units

The following image shows the L block retaining/ catch barrier system proposed, noting that onsite cutting of the legs is anticipated to facilitate radial installation to follow the road alignment geometry

To facilitate this work, a small construction crew including a medium sized excavator, onsite delivery trucks and construction labour will be required. It is suggested that an excavator mounted rock drill be used to carryout the rock anchor drilling operation.

The stability of the excavation during this work needs to be carefully managed, as to not expose it for too long once the excavation work is completed and before the wall is constructed or exposing it to inclement weather events as both could result in further instability and slumping of the slope.

Once installed, maintenance behind the installed blocks would be required if backfill has not be suitable placed to support the uphill slope. Maintenance would be seen to be carried out by means of small excavator that would reach over the wall from the roadside and remove debris as it builds up over a period. A small truck can then be used to transport debris away from site.

4.4 Formation Reconstruction – Embankment Reconstruction

Other sections of the alignment that have eroded require the reconstruction of the existing earth embankment.

This work will involve the excavation and removal of insitu spoil to expose a suitable foundation, and then the engineered placement of rock fill and a drainage mattress. This will require careful management of the works and progressive construction including keying of the new fill into the existing pavement.

Due to the available working room, this process will be slow and detailed requiring the management of material removal, import and placement.

Drainage of the existing area both in the fill placement/ below the pavement and final surface will need to be installed during this work to ensure long term integrity of the repair.

Concerning working widths, this will need to be managed with suitable mobile plant and equipment on a case by case, with particular attention needed at Chainage 650 to 740.

As the existing width is narrow and depending on onsite keying in advise it is suggested that small to medium size excavators with small foot track foot prints and minimal slew radius be used for the works Such an approach will achieve access into areas around 2.5-3m in width to carry out the works.

4.5 Safety Barriers – Temporary

Temporary safety barriers will need to be installed during the stage 1 works to suitably protect the existing edges.

It is suggested that the most efficient approach for this be

- Installation of semi-permanent concrete barriers at CH 50
- Reinstall the permanent guardrail barriers at all other high-risk locations

This is proposed over water field barriers due to.

- Duration of time the barriers will be established, before any follow-on permanent improvement work.
- The level of edge protection offered.
- The issues with maintain waterfilled barrier and leaking units.
- The issue of waterfilled barriers blocking surface waterflows and channel flows to areas of risk.

The installation of the concrete barriers will provide a robust barrier, that will protect against the significant drop off at this location. It is suggested that three-metre-long barrier units be used at this location to minimise the size of construction equipment that is needed to lift and position the units. These barriers should be bolted together to aid in the protection offered, with potentially custom connection required to facilitate curved installation to reduce the overall length of install.

When installing these barriers, care will need to be taken to ensure the barriers are not located over the existing over hanging pavement, this extends to the position of lifting equipment and delivery truck.

4.6 Safety Barriers – Permanent

The reinstallation of the permanent guardrail barriers is proposed, as the cost and time of reinstallation would be similar to that of the Waterfilled barriers when looking at the duration the barriers would be on with week hire costs. The location of the works could present rock foundation risks that will increase the installation time and cost, but as the barriers needs reinstallation this cost would be required in the long run at any point.

During the stage 1 works the barriers could either be installed as a temporary installation, or semi-permanent with suggested only minor approach terminal treatments as the reopening speed will be very low and negate the need for high-speed compliant approach installations.

During stage 2, the full length of remaining barriers would be reinstalled on the design alignment, if the decision was not made during the stage 1 works. Noting consideration should be given to working room restrictions for plant and equipment carrying out pavement reconstruction and if the presences of the barriers would impact such operations.

The existing posts would need to be assessed for integrity before being reused, which would need to be completed by both inspection and deflection testing.

The installation of the terminals would be by a specialised subcontractor with suitable post driving and drilling equipment.

4.7 Pavement Repairs

The existing pavement has a number of existing defects that will contribute to short- and long-term failures. These failures appear to be from a number of contributing factors including

Cracking of previous mass concrete repairs

- Deformation of the surface from poor underlying pavement strength conditions
- Potholing of the wearing surface from general use
- Grader damage from grading the existing sealed surface

To treat these defects the following is proposed

4.7.1 Stage 1

- Bitumen crack sealing of the existing surface cracks in the existing concrete and bitumen sealed surface.
- Temporary pothole repair including minor asphalt patching.

4.7.2 Stage 2

- Removal of section of the existing bitumen seal.
- Existing gravel preparation by means of rip and re-compaction.
- Treatment of unsuitable material if encountered.
- Construction of new pavement base layers.
- Resurfacing via bitumen seal or asphalt.

The application of crack sealant would be completed by a specialised contractor to place rubber emulsion in the existing cracks. This process is relatively straightforward with the correct equipment and would be completed within 1-3 days.

The pothole repair would be completed by a small crew removing existing debris and unsuitable material. Then depending on the depth of repair, would involve the placement of full depth asphalt, or base gravel such as DGB20 and then surfacing the patch with a nominal 50mm of asphalt. It is suggested that full depth asphalt would be the optimum repair process as it would be overall faster than a two-material treatment option. Depending on condition at the time of treatment, it is expected that this pothole treatment duration would be in the order of 3-5 days.

The pothole treatment could also extend to some surface level repairs between the pavement surface and existing concrete V drain. This will improve the capture and management of surface waterflows.

As some of the existing bitumen seals sections are in poor condition, the entire removal of the existing material is required to ensure a homogeneous road surface profile can be reconstructed. This treatment should be carried out for the full width of the pavement to ensure smooth final surface for waterflow, surface ride quality and also differential movement prevention in the completed surface.

This pavement treatment would need to be carried out by experienced road construction crews with good knowledge of foundation, gravel pavements and tying surfaces into existing structures.

Given the slope of the road alignment, it is suggested that an asphalt surface be considered in place of bitumen seal to improve overall surface life and robustness to defects.

4.8 Traffic Controls

During the delivery of works, traffic management is critical to the efficient and safe construction operation. To facilitate each stage, it is proposed that following is implemented.

- We assume that the alignment can be closed to all public access and divert all traffic via the Donkey Steps
- Construction traffic to access and exist the works from the southern approach and complete the works, working north i.e. downhill.
- Temporary construction traffic controls should be installed to facilitate reversing of delivery trucks down the hill where possible to avoid additional works to facilitate construction traffic though the alignment to turn around.

The detouring of traffic via Donkey Steps is required to minimise construction durations and remove the risks associated with construction in a restricted area around live traffic, it is foreseen that at some points during construction, traffic flows could coexist with construction operations, but this is foreseen to be a sporadic arrangement.

During the delivery of the works, it will be important to maintain the Donkey Steps detour in the form of grading to ensure it remains a viable alternative for local traffic.

Upon completion of stage 1 & the stage 2 works, it is planned that the traffic will be controlled between CH 460 & CH 800 as the repairs will only establish enough room for a single travel lane. It is intended that the traffic will be controlled by traffic signals by means of semi-permanent installation, with the prioritisation for uphill travel. The following considerations need to be taking into consideration when establishing this system.

- Power supply, and exposure to sunlight to suitably charge the system from solar panels given the location will be shaded during times of the day due to vegetation and terrain. This could require the need to backup supply from a system established in an improved exposure position and running power supply to the signal units. Noting no existing power supply is known to be onsite.
- Sensor control to allow the lower installed signal to be the primary controller and be triggered by the presence of a car. This sensor could either be microwave or detector loop established in the pavement. Alternate logic could be installed to ensure the uphill travel is always a green signal.

4.9 Overhead Hazards

The site is surrounded by two overhead hazards group that could present a WHS risk to workers during delivery and traffic post-delivery. This includes trees and rock formations.

To manage these two hazards, preconstruction and pre-opening inspections and required treatments are to be completed. With the tree hazards to be completed by an experienced arborist and the rock formations by an experienced geotechnical engineer or geologist.

The treatment of these hazards are expected to involve.

- Pruning or removal of trees or limbs that present risks.
- Rock removal and or spot bolting.

If tree or limb removal is required, an assessment would be made if this was something that could be completed progressively onsite by the civil contractor, or pre works by an experience an arborist.

If rock removal or bolting is required, a specialised anchoring and scaling subcontractor would be required to carry out the required specialised height and drilling activities.

4.10 Site Resources

To complete the works onsite, if foreseen the following resources will be required

4.10.1 Human

- Project Manager
- Site Supervisor
- Skill Construction Labour

4.10.2 Plant & Equipment

- Medium sized excavator, preferably zero swing (15-20t)
- Small sized excavator, preferably zero swing (5-8t)
- Small compaction rollers
- Rigid Tipper Road Truck – onsite delivery of quarry materials and spoil disposal
- Rigid flat top truck – Delivery or materials
- Small grader for road resurfacing and upgrade works.
- Site dumper – Onsite material movements
- Skid Steer loader – general material handling.
- Road Grader – pavement reconstruction

4.10.3 Stockpile areas

- An area above the works will be required to facilitate the bulk delivery of materials to the project, this is suggested to avoid multiple trips with smaller equipment to the site.
- An area above and below the works to facilitate the stockpiling of spoil by the onsite resources, that can then be removed offsite via more efficient transport means i.e. truck & dog etc.

4.10.4 Materials

- Precast Debris Catch wall components
- Precast concrete barriers
- Precast stormwater pipes, in the case of culvert replacement
- Pit inlet grates
- Steel guardrail system
- Rockfill
- Rock aggregate for drainage medium
- Geofabric Bidum
- Subsoil drainage pipe
- Base gravel i.e. DGB20
- Bitumen Seal
- Asphalt

5. Program

5.1 Proposed Program

A delivery program has been developed for this work which has been sequenced with the works starting from the top of the alignment, working downhill

Some of the activities will be completed progressively along the alignment, and other will need to be complete before other works further along the alignment can be completed.

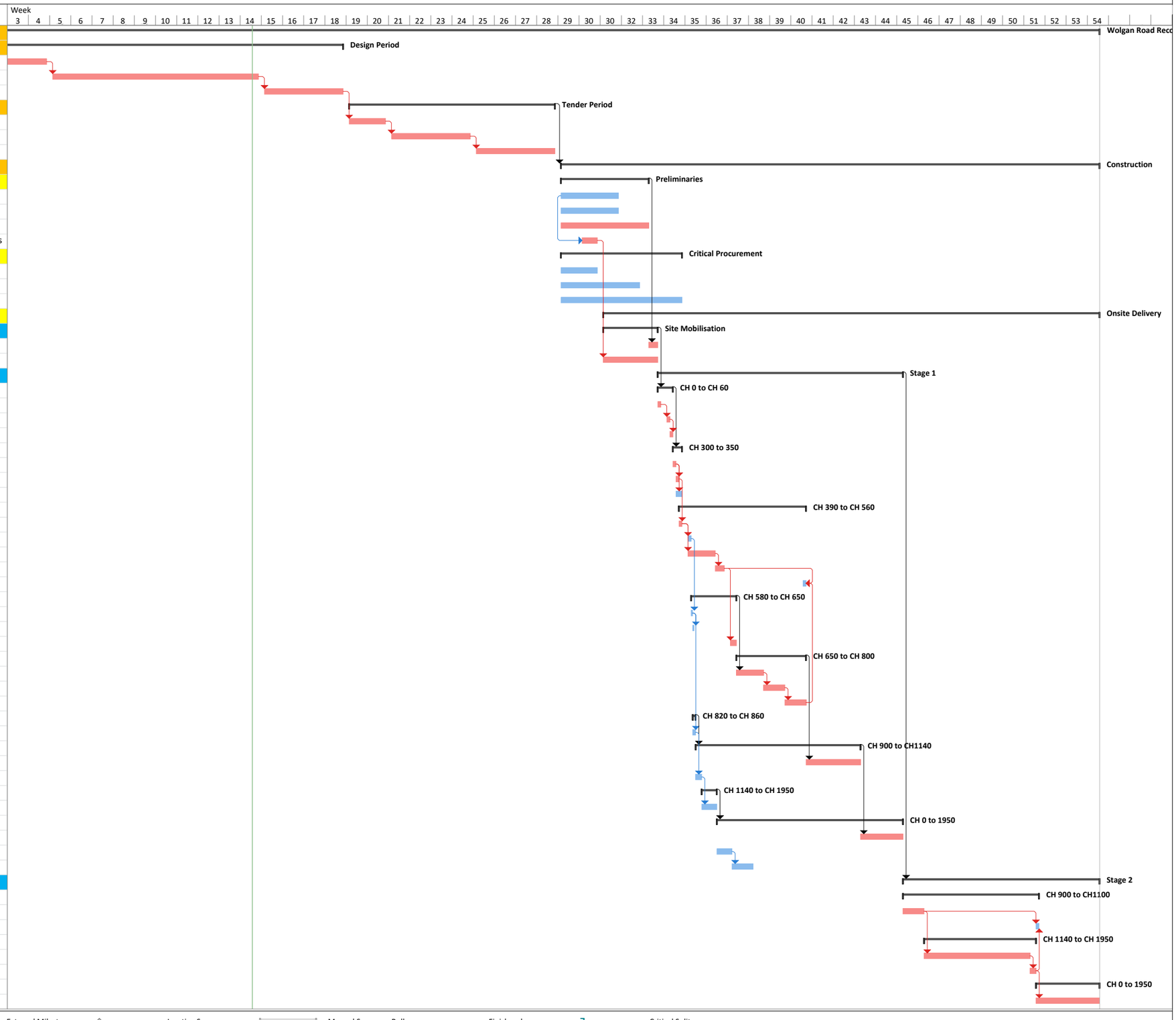
The following pages presents the proposed delivery program, with the following notes and assumptions.

- Designs will be approved and formalised before works starts onsite.
- A site design representative will be resourced to the project for verification and design alteration purposes to avoid delays with delivery. With an assume site presence of 50-100% during the stage 1 works and 25-50% during the stage 2 works.
- The road would be closed to traffic during the onsite works.
- No allowances for inclement weather or latent conditions.
- It is assumed the works would be delivered by a civil contractor as a principal contractor that would engage all required specialised subcontractors and suppliers.

It is noted that the sequencing in the program shows stage 2 being completed immediately following stage 1 works. This sequence can be altered, as the road could be reopened following the stage 1 work, and the stage 2 works completed at a future point in time.

Wolgan Road Reconstruction Project

ID	Task Name	Duration	Predecessors
1	**Wolgan Road Reconstruction Project**	**53.6 wks**	
2	**Design Period**	**18 wks**	
3	Initial Design Assessment	4 wks	
4	Client Review & Approval	10 wks	3
5	Final Design Development	4 wks	4
6	**Tender Period**	**10 wks**	
7	Development of Tender Documents	2 wks	5
8	Tender Period	4 wks	7
9	Assessment & Award	4 wks	8
10	**Construction**	**25.6 wks**	**6**
11	**Preliminaries**	**4.2 wks**	
12	Submission of Contract Docs	15 days	
13	Management Plan (WHS, QA, EM, etc)	15 days	
14	Traffic Management Plans, including council approval	21 days	
15	Preconstruction Hazard Assessment	5 days	12SS+5 edays
16	**Critical Procurement**	**6 wks**	
17	Barriers	2 wks	
18	Stormwater pit components	4 wks	
19	Retaining wall blocks	6 wks	
20	**Onsite Delivery**	**23.6 wks**	
21	**Site Mobilisation**	**2.8 wks**	
22	General Site Establishment - Initial traffic controls, site amenities etc	3 days	11
23	Allowance for overhead hazard treatment	14 days	15
24	**Stage 1**	**11.4 wks**	
25	**CH 0 to CH 60**	**0.6 wks**	**21**
26	Vegetation clearing	1 day	
27	Installation of concrete barriers	1 day	26
28	Installation of signage	1 day	27
29	**CH 300 to 350**	**0.6 wks**	**25**
30	Clean existing culverts	1 day	
31	Replace inlet grate	1 day	30
32	Repair Existing V drain	2 days	30
33	**CH 390 to CH 560**	**6 wks**	
34	Clean existing culverts	1 day	31
35	Replace inlet grates	1 day	34
36	Retaining Wall - L Blocks	7 days	34
37	Repair of Guardrail Installation	3 days	36
38	Establish Traffic Signals	1 day	37FF,46FF
39	**CH 580 to CH 650**	**2.2 wks**	
40	Clean existing culverts	0.5 days	35
41	Replace inlet grate	0.5 days	40
42	Repair of Guardrail Installation	2 days	37
43	**CH 650 to CH 800**	**3.4 wks**	
44	Bulk Earthworks & Disposal of spoil	7 days	39
45	Construction of drainage blanket and reconstruction of formation	5 days	44
46	Pavement reconstruction	5 days	45
47	**CH 820 to CH 860**	**0.2 wks**	
48	Clean existing culverts	1 day	40
49	**CH 900 to CH1140**	**7.7 wks**	**47**
50	Retaining Wall - L Blocks	12 days	43
51	Clean existing culverts	2 days	48
52	**CH 1140 to CH 1950**	**0.6 wks**	
53	Clean existing culverts	3 days	51
54	**CH 0 to 1950**	**8.7 wks**	**52**
55	Allowance for Culvert Replacement - Risk allowance	10 days	49
56	V Drain Clean	3 days	
57	Crack Sealing and & Pothole repair	5 days	56
58	**Stage 2**	**9.4 wks**	**24**
59	**CH 900 to CH1100**	**6.6 wks**	
60	Pavement Reconstruction	5 days	
61	Asphalt Surfacing	1 day	60,64
62	**CH 1140 to CH 1950**	**5.4 wks**	
63	Pavement Reconstruction	25 days	60
64	Asphalt Surfacing	2 days	63
65	**CH 0 to 1950**	**3 wks**	
66	Final Guardrail Restoration & Repairs	15 days	64



Project: msproj11
Date: Thu 5/03/26

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Critical | Critical Split | Progress | Manual Progress

5.2 Acceleration Opportunities

Several acceleration opportunities are available to speed up the reopening of the road, and are presented below

Option	Description	Forecast Time Saving
1. Establish secondary construction access at the base of the alignment via Donkey steps	By establishing a secondary access point at the base of the alignment, construction schedule for later in the stage can be actioned earlier and therefore reduce overall stage delivery. This approach will also reduce duration risk if unknown works are discovered during the stage delivery. This would require construction access via Donkey Steps and therefore sharing the access with limited access.	6 weeks
2. Council complete preliminary approvals and critical procurement activities	This approach would see council completing a majority of the preliminary plan develop and approvals such as the traffic control inclusive of an S138. This would also involve council procuring critical lead time materials such as concrete debris catch wall components. This would remove this lead time duration post tender award and reduce the preliminary duration from a nominated four weeks to one week.	2 weeks
3. Council complete stormwater line cleaning and assessment works	This approach would see council completing the stormwater cleaning works in advance of the other works so the presences of jetting trucks etc does not impact access to other work areas. This would need to be completed by carryout out a careful risk assessment for access, as this approach would require access before some of the edge protection controls are in place.	1 week
4. Combination of 1, 2 and 3	A combination of all the above, noting each option is mutually exclusive.	9 weeks

The time savings nominated are savings off the program developed for section 5.1, and if selected, would reduce the time from tender award to the completion of stage 1 from a currently nominated 15 weeks to 6 weeks. Therefore, a complete of the 16th of June compared to the 11th of August 2026.

6. Commercial Considerations

The delivery of this work presents controllable and uncontrollable commercial risks associated with extents of work that can be currently managed and designed, and unknowns that will present at the time of delivery.

The commercial framework that is implemented for delivery should be considered to provide good value for money for the council operations but also fairness the flexibility to the contractor engaged to ensure speedy response can be implemented as site conditions and scope variations and adjustment occur.

Based on this it is suggests a works contract with lump sums for site operations and management, along with schedule of rates for individual works be used to manage the delivery of this project. Additionally provisional sums should be considered to allow the project team comprising of the council and contractor to rapidly respond and manage changes and varying scope. Such provisional sums that could be considered would be

- Management of Overhead Hazards.
- Upgrade of Donkey Steps Road.
- Removal and replacement of stormwater culverts.
- Unsuitable material treatment (remove and replace)
- Unexpected Works.

Alternatively, a cost-plus contract arrangement could be established with a competent contactor, that could work with council to facilitate a speedy delivery.

A lump sum style commercial approach would not be suitable for such work.

7. Site Specific Risks

The following table provides detailed risk assessment for the construction works and should be considered when completing any design and or works delivery scope such as a tender or works order.

Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
Traffic Management	Management of road users	**Low**	- Available detour available. - Detour would be greatly improved with temporary surfacing of steep section of alignment.	**Low** - Duration of the works extending requiring ongoing maintenance to the detour.	**Low** - Inclement weather risks. - Speed of travel
	Construction Access	**Medium**	- Works to treat hazards progressively from the top to the bottom to accommodate safe construction access. - Suitable sized equipment needs to be selected to prevent unneeded congestion of the work area - Stockpiling and material storage area to be established at the top of the alignment to allow for smaller site trucks to facilitate movements from stockpile areas to the worksite. - Reversing into the worksite to be considered to remove the need to turning around of onsite delivery trucks	**Low** - Traffic management, storage areas and onsite management of transport to be factored into site operations.	**Medium** - Management of reversing equipment. - Management of exposed edges - Storage of materials on sloping ground
	Post Completion	**Low – Medium**	- Operation of the proposed traffic signals will need a robust power supplier. - Routine inspection and maintenance will be required i.e. weekly during operation.	**Low** - Once operational - Signal system needs robust power supply	**Low**
Stormwater Network	Cleaning of Culverts	**Low**	- Simple process for cleaning and inspection	**Low** - Risk of additional costs if damage existing pipes are found.	**Low** - Management of plant of sloping ground. - Snakes & Spiders Interaction

Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
	Pit Grate Replacement	**Low**	- Relatively simple process to remove and replacement scope.	**Low**	**Low** - Snakes & Spiders Interaction
	Replacement of damaged Culverts	**Medium**	- Will require excavation, removal and reinstallation of pipe work. - The work would require access to the remaining section of the alignment to be closed until the new pipe is installed.	**Medium** - Unknow scope, could extend from one culvert to all 16. So, cost risk of $15,000 to 240,000	**Low** - Excavation - Working on slope - Material management on slope - Mobile plant and personnel interactions.
Formation Reconstruction	Debris Catch Barrier wall construction	**Medium**	- Work requires the removal of existing spoil, including disposal offsite. - Work requires construction adjacent to failed existing slopes, and over excavation will be required to facilitate alignment of debris catch wall components. - Relatively small sections in terms of length and height, so duration of works will not be major. - Rock anchoring will be required to hold the units in place, added to the construction process. - Onsite cutting of the base leg will be required to facilitate side by side unit installation around curves to meet road geometry requirements.	**Medium** - Costs risk, as scope is reasonably known at this time. - Additional cost risks could be encountered from temporary support. Would estimate this could be in the order of 50-200k	**Medium** - Excavation support - Constriction of Catch barriers - Working on sloping ground - Inclement weather impacts on excavation. - Mobile plant and personnel interactions.
Formation Reconstruction – Embankment Reconstruction	Embankment construction	**Medium**	- Work requires the removal of existing spoil, including disposal offsite. - Foundation and hill stability needs to be assessed, but currently appears to be low risk - Keying into the existing formation is required - Drainage needs to be incorporated into the construction.	**Medium** - Cost risk, as foundation exposure needs to occur before risk is removed. Estimate risk could be in the order 50-200k - Additional cost risk could be encountered if additional foundation improvements are required, although the	**Medium** - Excavation support - Working on sloping ground - Inclement weather impacts on excavation. - Mobile plant and personnel interactions.

Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
				utilisation of rock fill could minimise cost risk.	
Safety Barrier Installation	Temporary installations – Concrete barriers	**Medium**	- Need to establish on solid foundation to ensure structural suitable if impact occurs. - Relatively simple installation including delivery. Would suggest adopting 3m units in place of 6m to make handling and installation simpler.	**Low** - Project should purchase these assets, as it is foreseen the duration of use would warrant owning in place of hire.	**High** - Lifting of precast units - Working on sloping ground - Working around exposed edge - Mobile plant and personnel interactions.
	Permanent Barrier Installation	**Medium**	- Removal and reinstatement of existing required as majority of existing appear damaged - May encounter rock foundations in some of the alignment requiring time and costs. - Specialist contractor required to complete the installation - Would suggest compliant approach terminals would not be required given the speed conditions of the road.	**Low** - The presence of rock will increase cost, but unknown. An allowance should be included in the project cost schedule for approx. 50% of post at $150/post	**Medium** - Working on sloping ground. - Mobile plant and personnel interactions.
Pavement Construction	Crack sealing	**Low**	- Simple process that would require delivery from a specialist contractor. - Short duration works, with no special access requirements.	**Low** - In terms of application costs per m. - Costs will increase if additional defects are discovered during the works. - The project should consider a complete release of areas not being treated by the pavement reconstruction scope to improve the pavement condition and minimise the crack sealing scope.	**Low** - Working sloping ground - Working with high temperature materials.

Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
	Pothole repairs	**Low**	- Simple process that can be carried out at any stage of the works.	**Low**	**Medium** - Working sloping ground - Working with high temperature materials. - Mobile plant and personnel interactions.
	Pavement Reconstruction General	**Medium**	- Relative tight working areas confined by uphill and downhill terrain. - Existing road conditions present signs of some minor pavement structural failures that would require treatment. - Small equipment required to complete the works	**Low** - Low-cost risk based on exposure to unknown issues, given pavement failures are more attributed to surface damage than foundation structural issues. - Inclement weather impacts will create duration issues, as the area will not provide good drying conditions of placed gravel materials.	**Medium** - Working sloping ground - Mobile plant and personnel interactions. - Management of material delivery and disposal via revering trucks.
	Pavement Reconstruction Wearing Surface	**Medium**	- Know process with many suitable contractors available - The slope of the alignment is boarder line for effective bitumen seal performance. Suggest looking at asphalt surface alternative to provide longer term durability. - Existing surface defects need to be removed before application of wearing surface material.	**Low** - Bitumen seal offers lower upfront cost but would need additional ongoing maintenance compared to asphalt surfacing.	**Medium** - Working sloping ground - Working with high temperature materials. - Mobile plant and personnel interactions. - Management of material delivery and disposal via revering trucks.
Site General	Management of Overhead Hazards	**High**	- Preconstruction assessment to be completed and then any treatment to occur ahead of the works before repair works to occur below the identified hazard. - Inspection & management plan to be established in the event of inclement	**Medium** - Unknown, as scope is unknown at time of report. This could range from $10,000 to $200,000 depending on assessment.	**High** - Working at heights - Inclement weather impacts on stability conditions.

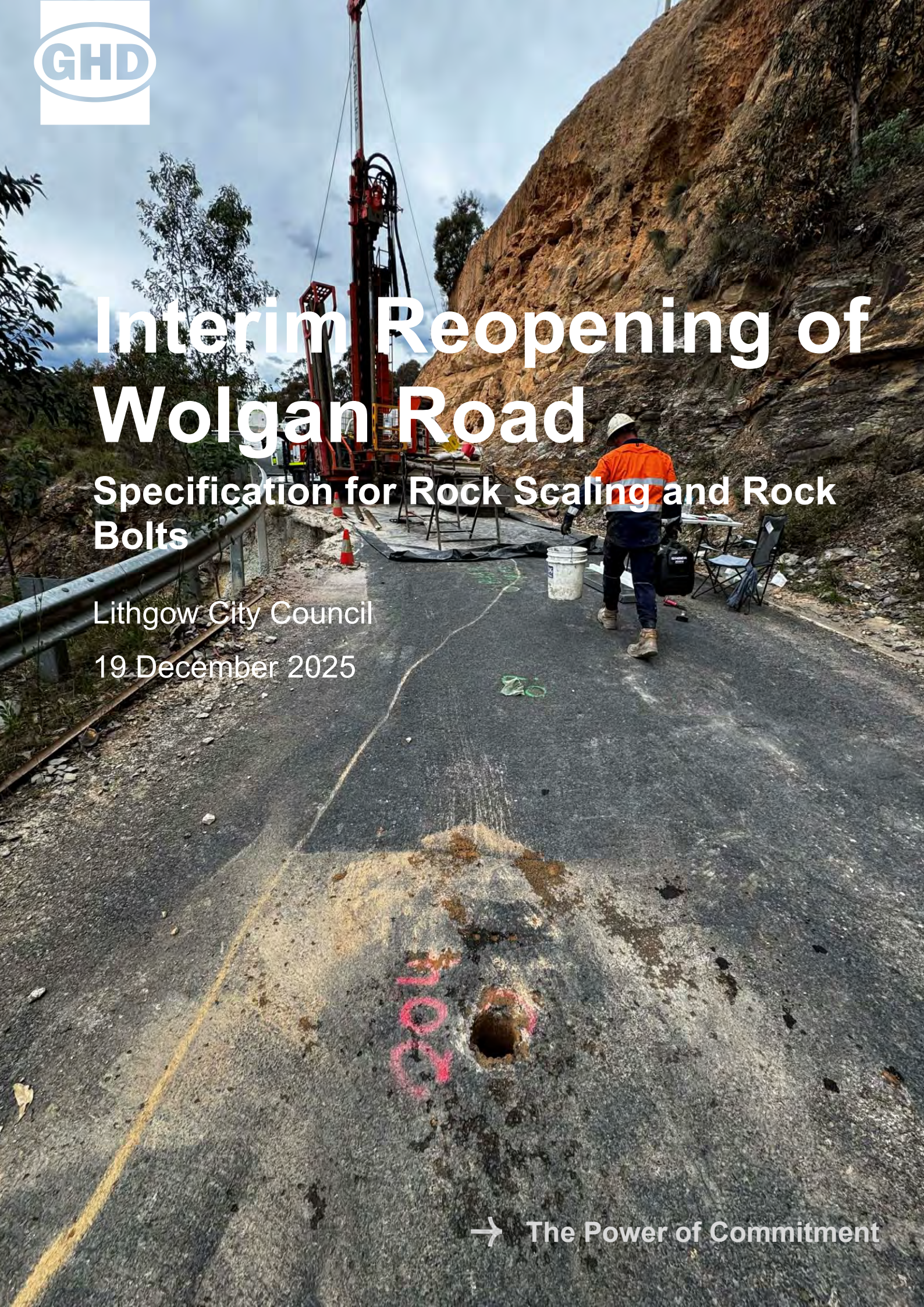
Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
			weather in consultation with site geotechnical advice.	- Initial indications are not immediate rock bolting is required.	
	Site Facilities & amenities	**Low**	- A suitable location is available at the top of the alignment that would facilitate temporary site facilities, parking and material storage. - The location will need to be managed to ensure safe access to deliveries and construction equipment using the storage area for the movement of materials on and off the site. - Disposal of spoil to be regularly carried out to minimise risk of congesting this location with materials.	**Low**	**Medium** - Congestion of storage and site access - Working on sloping ground - Mobile plant and personnel interactions.
Delivery Program	Staging of the works	**Low**	The works are currently intended to be staged, which will provide a reduce duration from starting the works to reopening the road. Some efficiencies are lost with this approach particularly in stage 2, as once the road is reopened at the completion of stage 1, construction activities will need to manage the additional interface of road users. Public perception could be negative with the two-stage approach as they will want it reopened with out restrictions, but this can be easily managed with concise public messaging	**None**	**Low** - Increase risk due to works being competed under traffic control.
	Acceleration Options	**Medium**	Stage 1 works could be accelerated serval ways including 1. Option 1: Starting works at both the top and bottom of the alignment and utilising the Donkey steps detour to provide access to construction personnel to complete the works at the base of the alignment, whilst the	**Low to Medium** Option 1: Initial assessment would be an increase of 10-15%. This could be expected to remove up to 6 weeks from the duration.	**Low** - None of these acceleration options are expected to increase WHS above what is already present.

Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
			works top of the alignment is unimpacted by their need for access. 2. Option 2: Council carry out some of the preliminary works for the contractor to remove lead item issues at the start of the works and allow works to start faster upon award. This would include completing the required traffic control plans and approvals, procurement of lead time items such as barriers, catch barrier wall blocks etc. 3. Option 3: Council undertakes stormwater debris removal and cleaning works in advance of waiting for a contractor thus removing the interface and program dependencies	Option 2: Initial assessment would be an increase of 0-5%. Although it would be expected to remove up to 2 weeks in program duration. Option 3: No expected increase in cost. Although it would be expected to remove up to 1 weeks in program duration.	
	Early opening option use of temporary barriers	**Low**	Considered as a reasonable approach, although based on the speed in which permanent barriers can be reinstalled and be compliant, temporary barriers are very much a band aid, that will then need to be replaced by more permanent barriers which will required restrictive traffic controls to be established to allow permanent barriers to be installed i.e. temporary detour via Donkey Steps. This option will reduce duration of stage 1, but overall cost more and present the need to future detours via donkey steps.	Extra 5-10%	**Low** No increase, other than doing work that need to then be replaced in the near future.
	Early opening option minimisation of earthworks and complete earthworks during stage 2	**Medium**	Considered a less desirable approach, as the treatment of areas would require later works that would require the project to impose restrictive traffic controls i.e. detours via Donkey Steps. Leaving the earthworks current nominated on stage 1 is considered a suitable approach to minimise future impacts. But can be done if required.	Extra 0-5%	**Low** - Increase risk due to works being competed under traffic control.

Scope of Work	Sub Component	Construction Complexity	Constructability Comments	Cost Risk	WHS Risk
	Council by bypass external contractor involvement or at least the tender process and get going on repairs ASAP via internal managers and workforce and by existing panel contract arrangements	**Low**	Consider council internal teams, and or coupled with already engaged contractors to complete the works as soon as sufficient design information is present. This would remove both the tender period and a majority of the preliminary period from the proposed delivery program, which would save up to 12 weeks (2.7 months).	None, possibly some efficiencies with an unplanned approach.	**Low** No increase.

Appendix I

Rock anchor specification



Interim Reopening of Wolgan Road

Specification for Rock Scaling and Rock Bolts

Lithgow City Council

19 December 2025

→ The Power of Commitment

Project name		Interim Reopening of Wolgan Road					
Document title		Interim Reopening of Wolgan Road | Specification for Rock Scaling and Rock Bolts					
Project number		12657881					
File name		12657881-GHD-00-00-SPC-GE-00003_Rockbolt Specification					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4		B. Barber	D. Jones		D. Jones		19/12/25
[Status code]							
[Status code]							
[Status code]							
[Status code]							

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Contents

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1. Introduction

GHD has prepared these technical specifications for rock scaling and removal works vegetation removal and the installation of cement grouted anchors. Requirements for minimum testing frequencies of various materials are given in Annexure 1.The schedule of 'Hold Points' applicable to the installation of cutting treatments are contained in Annexure 2. Please note that this specification is not project specific and therefore may require revision to conform to individual site requirements. Any deviation from this specification should be confirmed and approved by the Geotechnical Representative listed within Section 2.

2. Project Roles

The Principal

Lithgow City Council

The Contractor

To be confirmed

The Geotechnical Representative

The geotechnical consultant (GHD Pty Ltd) who designed the remedial works. The Geotechnical Representative shall advise the Principal on an as needed basis with site queries specific to the design. The Geotechnical Representative will provide geotechnical advice and direction to The Contractor during construction and will be responsible for the release of Hold Points.

3. Rock scaling and vegetation removal

3.1 General

Prior to any treatment works being executed, preparatory rock face works are to be carried out on all cuttings. The rock faces shall be suitably prepared for rock bolting / meshing via a combination of scaling, grooming and tree lopping as specified below. The work is to include the disposal of removed rock, soil and vegetation, material off cuts and excess grout to an approved disposal site. Although no specific hold points have been defined, please note that the preparatory rock face works require review and approval from the Principal's Geotechnical Representative as works proceed and prior to the commencement of the specific treatments specified below.

3.2 Vegetation Removal/Lopping

This activity applies to the removal of all vegetation (including trees and shrubs but not grass) growing on the rock cuttings and within 3 m slope distance of the cutting crest in the vicinity of the work designated.

Unless otherwise directed by The Geotechnical Representative, trees and saplings in areas requiring slope preparation shall not be uprooted or grubbed out, but shall be cut off to a stump close to ground surface and the stumps immediately poisoned to prevent regrowth (within 20 seconds) or as a separate campaign via cuts or drilled holes into the stump.

3.3 Scaling

3.3.1 General

Scaling and grooming involves excavation, removal and/or reshaping of materials present at the rock face, crest and works area in order to reduce or remove the hazard presented by that material, or to prepare it for specialist treatment (e.g. mesh installation, rock bolting, etc.).

The following simplified definitions apply to this section:

– Scaling is the removal of potentially unstable rock blocks from the excavation zone;
– Grooming is the removal of leaf litter, small rock fragments and soil accumulations from ledges; and

Areas requiring scaling and grooming are shown in photomosaic figures presented in the covering report or will be as identified in the field by the Geotechnical Representative. Additional areas requiring scaling/ grooming may be identified during the devegetation of the rock face and crest, and these additional areas shall be scaled/ groomed as required.

Scaling and grooming shall be undertaken as a top-down sequence of work in order to minimise the risk of potentially unstable features becoming dislodged directly onto and/or impacting personnel and/or plant.

Materials that may be encountered include:

– Vegetation debris or remnant trees and stumps;
– Soil profiles (e.g. Topsoil, Residual, Colluvium);
– Rock Fragments (Detached Blocks, fractured and/or weathered zones, protrusions).

Scaling and grooming is typically undertaken by hand scaling, machine scaling, specialised methods or any combination of the above.

Spoil shall be removed from the faces or crest in a controlled and safe manner, and then safely transported to an approved stockpile area.

Scaling works shall not commence in any area without approval from The Principal as to the proposed equipment and method of scaling.

Any damage or disruption incurred to existing structures as a result of scaling shall be repaired/ reinstated to the same condition as prior to the commencement of works at the site.

3.3.2 Machine Scaling

This activity includes specific scaling and/or removal of identified unstable rock blocks or rock masses by plant, as delineated on the photomosaic figures of the covering report, or as directed by the Principal's Geotechnical Representative. Machine scaling shall not be undertaken without prior approval of the Geotechnical Representative as to the suitability of the proposed plant to the scaling requirements of the area being considered. Plant suitable for scaling may include the following:

– Excavator - a variety of excavator capacity may be considered ranging from 2 tonne to 30 tonne, including long reach excavators. Bucket and tine size may also vary according to the requirements of the area to be scaled. Hammers shall not be used without approval of the Geotechnical Representative
– Back Hoe
– Bobcat

Additional hand scaling is typically required at the completion of machine scaling, to remove accumulations of soil and small rock fragments that cannot be removed using large plant.

3.3.3 Hand Scaling

This activity includes specific scaling and/or removal of identified unstable rock blocks or rock masses, as delineated on the photomosaic figures of the covering report, or as directed by the Principal's Geotechnical

Representative. The works are generally assumed to be to undertaken by specialist contractors accessing the rock faces by methods such as boom lift or using twin rope access techniques to conduct the scaling / grooming work.

The works are assumed to be undertaken by a combination of hand scaling (e.g. large pinch bars, crow bars, 'pelican picks' and rakes etc.). The works shall involve the systematic removal of all loose rock material / blocks that are loose enough to be potentially dislodged with hand tools. If particular blocks are deemed to require removal after failed attempts by hand tools, the Principal's Geotechnical Representative shall determine if other measures such as jack hammers, rock splitting, air-bag removal or rock bolting may be applied.

4. Cement Grouted Passive Rock Bolts

4.1 General

This part of the Specification sets out the requirement for the supply, installation and grouting of rock bolts. The Specification also includes the drilling of the holes to receive the rock bolts.

The Contractor shall furnish, install and grout rock bolts where directed or approved by the Geotechnical Representative.

The rock bolts and methods of installation of the rock bolts, including the details of the equipment necessary to drill the hole, effectively seat and tighten the anchorage in the hole, tighten the bolt and grout the rock bolt after installation shall be subject to the approval of the Geotechnical Representative.

4.2 Standards

Standards are referred to in abbreviated form eg AS 1234. For convenience, the full titles of relevant standards are given below:

Australian Standards

AS 1012	Methods of Testing Concrete
AS 1214B	Hot-Dipped Galvanised Coatings on Threaded Fasteners
AS 1275	Metric Screw Threads for Fasteners
AS/NZS 1252	High-strength Steel Fastener Assemblies for Structural Engineering - Bolts, Nuts and Washers
AS/NZS 4671	Steel for the reinforcement of concrete
AS 3972	Portland and blended cements
AS 3678	Structural Steel
AS/NZS 4680	Hot dipped galvanised (zinc) coatings on fabricated ferrous articles

Unless otherwise stated, the applicable issue of any referenced standard shall be the issue current at the date one week before the closing date for tenders.

4.3 Alternative Rock Bolt Systems

Any tender based on alternative types or capacities of rock bolts will be deemed to be non-conforming unless the tenderer also submits a tender based on the type and capacity of rock bolt required in this Specification.

Such alternative types or capacities of rock bolts will only be considered if the tenderer submits with his tender, all relevant details together with working drawings.

4.4 Lengths and Location of Bolts

The lengths and locations of the rock bolts shall be as shown on the drawings or as directed or approved by the Geotechnical Representative.

4.5 Skilled Workmen

The Contractor, or his proposed sub-contractor, shall produce evidence that his workmen are skilled and have previously been engaged on the installation of rock bolts and that the equipment proposed is suitable for the intended use.

4.6 Rock Bolts

The rock bolts shall consist of grade 500 steel reinforcing bars conforming to the requirements of AS 4671. Rock bolts shall be 28 mm diameter with a nominal lengths of 1 m (*embedment depth*) or as specified by the Geotechnical Representative. Rock bolts shall be galvanised (GEWI® or equivalent) threaded bars supplied complete with all fixtures and accessories, galvanised to match. The threaded bar shall have a minimum tensile capacity of 308 kN. Face plates for crest/top rock bolts shall comprise Geobrugg TECCO P33 spike plates or an approved equivalent.

The bars shall be fitted with suitable centralising devices, at a maximum spacing along the bar of 0.3 m, to ensure that bars are located clear of the walls of the drill holes and to ensure compliance with minimum cover requirements. Centralisers shall be firmly fixed to the bar and shall be of a form which will not impair free flow of the grout. Centralisers shall be manufactured from material which is not corrodible and will not have deleterious effects on the bolt bar and the grout. Centralising devices shall be fitted equidistant from the ends of the rock bolts and from each other. Regardless of the minimum spacing specified above, all rock bolts shall be fitted with at least two such devices and rock bolts 4 m or greater in length (if specified by the Geotechnical Representative) shall be fitted with at least three.

Bearing plates for bottom mesh anchors shall be steel Grade 250 to AS 3678. Unless otherwise specified the bearing plates shall be domed, a minimum of 10 mm thick and have a minimum bearing surface area of 150 mm x 150 mm. Each plate shall have a hemispherical washer fitted so that the nut will bear evenly on the washer surface even though the bolt is not normal to the plane of the plate. Bearing plates shall have provision for the injection and bleeding of grout.

Mid slope rock bolts (i.e. installed on the rock face to protrude through mesh) shall be grouted 28mm diameter galvanised GEWI® threaded bars or approved equivalent as outlined above with a nominal lengths of 1 m (embedment depth) or as specified by the Geotechnical Representative. The face plates for the mid slope rock bolts shall comprise Geobrugg TECCO P33 spike plates or an approved equivalent and shall be installed following mesh installation to assist with tensioning the mesh. Each installed anchor shall include a ground clearance of maximum 100mm for a rope arrangement beneath P33 spike plates.

Nuts shall comply with the requirements of AS 1252. The nut and thread shall be capable of holding a tensioning force of at least 308 kN.

Threads on rock bolts and nuts shall be clean and free of scale and rust.

All rock bolts shall have the bar, nuts, washers and bearing plates hot-dip galvanised in conformance to the requirements of AS 1214 and AS/NZS 4680. Any rock bolt that is cut on site compromising the galvanised finish will require a suitable product applied to seal the surface and prevent corrosion. The contractor is to provide specification of a suitable product for approval by the Geotechnical representative.

The number and length of rock bolts may vary depending on the effectiveness of the preceding scaling programme. The Geotechnical Representative will confirm rock bolt locations, lengths and orientations after scaling and devegetation are complete, via spray paint mark-up of the rock faces.

4.7 Drilling for Rock Bolts

Drilling for rock bolts should only be undertaken by an experienced drilling contractor. Holes may be advanced by either pneumatic hammer drills or rotary drills as approved by the Geotechnical Representative. Holes shall be slightly rough, clean, true to size and not deviate from the initial line of the bore by more than 25 mm per each 2 m depth of hole.

Drill hole diameter should be a minimum of 150 mm, dependent upon the drilling equipment employed at the site and the grouting procedures to be adopted. Unless otherwise directed by the Geotechnical Representative, holes for the rock bolts shall be drilled to a diameter sufficient to provide a minimum grout cover of 60 mm over the bars.

The holes shall be started at the locations as directed by the Geotechnical Representative. Maximum offsets to the marked location that may be permitted at the Geotechnical Representative's discretion are 100 mm vertically and horizontally.

The bearing of the hole shall be oriented generally perpendicular to the surface or as directed by the Geotechnical Representative. Any hole whose bearing is more than 5° from the required bearing shall not be acceptable and will need to be redrilled unless the Geotechnical Representative, at his sole discretion, accepts the hole.

The vertical direction of each hole shall be declined at 20 degrees below horizontal (unless otherwise specified). Any hole whose initial direction (i.e. that of the first 0.5 m of the hole) lies more than $\pm$ 2 degrees outside of the range shall not be accepted.

The depth of each hole, from the finished surface of the rock face at the collar to the bottom of the hole, shall be determined by the Geotechnical Representative. An extra length of 250 mm shall be provided below the end of the bar to leave space for the deposition of cuttings that cannot be flushed out of the drill hole.

The Contractor shall include in his procedures proposed measures to check that the specified alignment and deviation from straight are being maintained.

In the case of drill holes penetrating through material likely to collapse, the Contractor shall give full details of proposed procedures for supporting this material during drilling, installation and grouting.

Drill holes shall be cleared of all deleterious material on completion of drilling and the opening sealed to prevent the entry of foreign matter. Cleaning shall be carried out by flushing with water or water and air, to ensure removal of all drill cuttings from the walls and bottom of the drill holes. The Contractor shall submit details of its cleaning methods and equipment to suit variations in sub-surface conditions.

Where the loss of drilling water or air occurs during the drilling of a rock bolt hole, the hole shall be fully grouted and then redrilled. This cycle of drilling and re-grouting shall continue until there is no loss of drilling medium.

The Contractor shall submit conformance records for the drill holes prior to installing the rock bolts in the holes.

The submission of conformance records for drill holes shall constitute a **HOLD POINT.**

4.8 Installation of Rock Bolts

a. General

Unless otherwise approved by the Geotechnical Representative, installation of rock bolts shall commence within 3 days of completion of drill holes.

The Contractor shall give at least one working day's notice of his intention to commence installation.

b. Installation Procedure

Each drill hole shall be kept sealed until the rock bolt is ready to be installed.

Immediately, prior to installing the bolt, the walls of the drill hole into which it is to be installed shall be cleaned of all deleterious materials or accumulations which would impair the effectiveness of the rock bolt. This shall be accomplished in accordance with Clause 5.6. Following cleaning the hole shall be gauged to confirm that it is unobstructed for the full depth and to the full diameter.

The rock bolt with centralisers shall be assembled and positioned in the hole in accordance with the manufacturer’s instructions and the requirements of this document.

4.9 Grouting

a. General

Rock bolts shall be grouted in place as soon as practicable after installation, but in any event within 3 days of completion of drill holes, except as otherwise directed or approved by the Geotechnical Representative. Grouting shall be carried out in such a manner as to ensure that all bolts are fully encapsulated by grout, to the collar of the drill hole.

The Contractor shall give the Geotechnical Representative at least one working day's notice of his intention to commence grouting.

All grouting operations shall be carried out under the personal direction of a skilled supervisor experienced in this type of work.

The grouting supervisor shall also inspect the rock bolt assemblies prior to installation and verify that grouting tubes have been correctly installed.

b. Grout Materials and Mix Design

Grout for rock anchors shall be in accordance with the Transport for New South Wales (TfNSW) QA Specification R64.

Grout fluidity bleed and compressive strength testing to be in accordance with TfNSW R64 Clause 3.4.3.

Ensure suitable provisions are in place to minimise grout loss in holes such as grout socks, thickened mix/additives etc.

c. Testing of Grout

i. Properties of Hardened Grout

Representative test specimens shall be 100 mm cubes stored under standard curing conditions of 23 degrees Celsius and 100% relative humidity.

During production, pairs of cubes shall be taken at the following frequencies, with additional cubes if testing is required at other than seven days:

Grout Batches	**Test Frequency**
Each batch/day	1 sample i.e. 2 cubes

A typical batch size would be up to 200 litres.

Testing shall be carried out in accordance with AS 1012.

ii. Mix Characteristics

The specific gravity and the bleed characteristics of the trial mix shall also be established, so that these values may be used to monitor the production process.

d. Grout Mixing

Batching into mixers shall be carried out by measuring the water by volume and using whole bags of cement. Any additives shall be premeasured into individual doses per batch.

The grout shall be mixed in a high speed mixer (minimum 1000 rpm) capable of imparting a high shear to the grout components so that a colloidal grout of uniform consistency is produced in a mixing time of less than five minutes.

The grout mixing process shall utilise a recirculating system where the grout is continuously discharged and recharged into the mixing unit during the mixing period.

After the mixing the grout shall be kept continuously agitated.

The grout shall be passed through a nominal 1.2 mm sieve prior to injection. The grout shall be used as soon as possible after mixing and in any case within 30 minutes of adding cement.

e. Grout Pumping Equipment

Grout pumps shall be efficient and capable of running continuously for the duration of grouting of each rock bolt. They shall be capable of pumping the grout specified at a rate appropriate to the required rate of rise of grout in the holes.

Grouting shall be carried out by use of supply lines directly connecting the pumps to the down-hole tubes.

Grout fittings shall be appropriately located to control the injection of grout to the down-hole tubes. Fittings at the tops of holes shall include a valve discharging to waste and a pressure gauge. Pressure gauges shall be maintained in calibration.

f. Grouting Procedure Requirements

Prior to commencement of grouting, the Contractor shall determine the volume of the hole less the rock bolt over the full length of the drill hole as a basis for control of volumes and rates of grout injected.

Prior to grouting, the grout tubes shall be checked individually by pumping water through them to ensure that they have not been compressed or blocked.

Sufficient water shall be circulated through the grout tubes to ensure that all air has been displaced from the hole and water circulation shall continue until the emerging water is clear. The grout tubes shall be full of water at the commencement of grout injection.

Grouting shall proceed by injection through the feeder tubes to the bottom of the hole. Grouting shall be continuous until all the water is displaced from the collar and the emerging grout is the same consistency as the grout entering the feeder tubes.

Once the emerging grout has reached the specified consistency, observation shall be continued by an experienced operator, and the grout discharge shall be allowed to continue until there is no reasonable doubt that all zones of low quality grout have been displaced.

The grout which has over flowed from the hole shall be discarded to waste and disposed of to the satisfaction of the Geotechnical Representative. This shall include the cleaning off of any grout that has spilled onto the rock face. All rock faces must be left clean and with a natural rock appearance.

After the grout has hardened, the level of grout in each hole shall be checked and any fall in level made good by placement of additional grout so as to completely fill the rock bolt hole. This process should be repeated if necessary until final filling has been confirmed.

Contract must supply grout logs for each drill hole with exact volumes used.

g. Pull Out Testing and Conformance Records

The Contractor shall submit conformance records for grouting of rock bolts within three working days of completion of grouting operations.

The Geotechnical Representative may direct the Contractor to expose the fully grouted rock bolts for inspection and/or to conduct pull-out tests on 2% of bolts installed (locations to be confirmed with the geotechnical representative), except that where failures occur, the Geotechnical Representative may direct additional tests. When tested, the anchor shall be capable of withstanding, with a movement of not more than 0.2 % of the bolt length, a pull-out test load equal to 75 % of the nominated average yield strength of the threaded section of the bolt shank.

Testing shall be carried out with a calibrated hydraulic jacking system capable of exerting an axial load up to 90 % of average yield strength of the bolt. The pull out testing should be carried out under the direction of Geotechnical Representative or the Principal.

The pull out testing is designed to establish the adequacy of the bond strength between the grouted length of rock bolt and the surrounding rock mass. The following test methodology is proposed:

- Ensure injected grout has had time to cure such that a minimum compressive strength of 32 MPa is attained before testing.
- Determine the yield strength (YS) of the rock bolts installed for pull out testing. For a 28 mm diameter GEWI® Threadbar, a YS of 339 kN may be adopted, as per product information available on the DSI website (DSI Australia, 2018).
- Subject the sacrificial rock bolts to incremental load cycles, based on percentage of YS, as per Table 2. It is critical that the maximum test load does not exceed 75% of the rock bolt YS. Dial gauges shall be used to accurately measure the elongation for each load cycle.

Table 1 Test loads for pull out testing with minimum periods of observation.

Test loads iterations as a % of YS	Period of observation (minutes)*
25%, 50% & 75%	5

**Note: The observation period (given in minutes) is the minimum period of observation at the peak test load for each iteration.*

Rock bolt pull test results are acceptable if the following criteria are satisfied:

- The permanent rock bolt develops and holds applied load for not less than 10 minutes.
- Axial movement is less than 10 mm for rock bolts or the elastic movement under the test load exceeds 80% of the theoretical elastic elongation of the free stressing length and is less than the theoretical elastic elongation of the free stressing length plus 50% of the bonded bar length.
- Continued movement under sustained load does not occur.

The results of all pull testing shall be retained as in a manner acceptable to the Superintendent not more than 24 hours after the completion of the test or test stage. Test results and data shall include the following:

a. date of testing.

b. names of persons carrying out the testing and making the record.

c. method of installation including the equipment used to drill the holes, to clean out the drilled holes, to grout the rock bolt in the holes and to tension the rock bolt to the specified load.

d. reference number and location.

e. date and time of rock bolt installation.

f. type of rock bolt and length.

g. drill hole diameter and depth.

h. pre-tensioning load.

i. details of bolt grouting.

j. grout materials.

k. results of grout tests.

l. water flows (if any), rate and testing (if any).

m. load/displacement results in graphical form.

n. problems during installation and other pertinent details.

o. testing procedure (by reference to standard documents).

p. departures from standard test procedure and reasons.

q. note of any spalling or other movement of the surrounding rock during testing such as embedment of the jack.

r. note of any problems encountered or unusual occurrences during testing.

s. any other significant feature of the test.

4.10 Finishing

a. Dry-Packing

On completion of grouting, rock bolts holes shall be prepared so that the shrinkage of the grout column at the top of the hole is to be completely filled with dry pack grout and the area behind the rock bolt bearing plate shall be prepared so that the plate will bear uniformly on the rock surface.

b. Surface Plates and Washers

The surface plates for rock bolts shall be a minimum of 10 mm thick and have a minimum bearing surface area of 0.0225 m^2. Each plate shall have a hemispherical washer fitted so that the nut will bear evenly on the washer surface, even though the bolt is not normal to the plane of the plate.

The face plates for the mid slope rock bolts shall comprise Geobrugg TECCO P33 spike plates or an approved equivalent. Each installed anchor shall include a ground clearance of maximum 100mm for a rope arrangement beneath P33 spike plates.

c. Nuts

Nuts shall comply with the requirements of AS 1275. The nut and thread shall be capable of holding a tensioning force at least equal to twice the Design Working Load.

The thread of the nut shall be clean and free of scale or rust.

d. Protective Treatment

All rock bolts shall have the bar, nuts, washers and bearing plates hot-dip galvanised in conformance with the requirements of AS 1214B and AS/NZS 4680.

Submission of conformance records for the installation of rock bolts shall constitute a **HOLD POINT**.

Annexure 1 - Minimum Frequency of Testing

Table 2 Minimum Frequency of Testing

Clause	Characteristic Analysed	Test Method	Min Frequency of Testing
4.9 (c)	Properties of Hardened Grout	AS 1012	1 batch/day -1 sample ie 2 cubes 2 batch/day - 2 samples ie 4 cubes
4.9 (g)	Pull-out Testing	As defined above	3 Rock bolts

Annexure 2 - Schedule of Hold Points

Table 3 Schedule of Hold Points

Specification Reference	Description
4.7	Submission of conformance records for drill holes.
4.10	Submission of conformance records for installation of rock bolts including grout logs.

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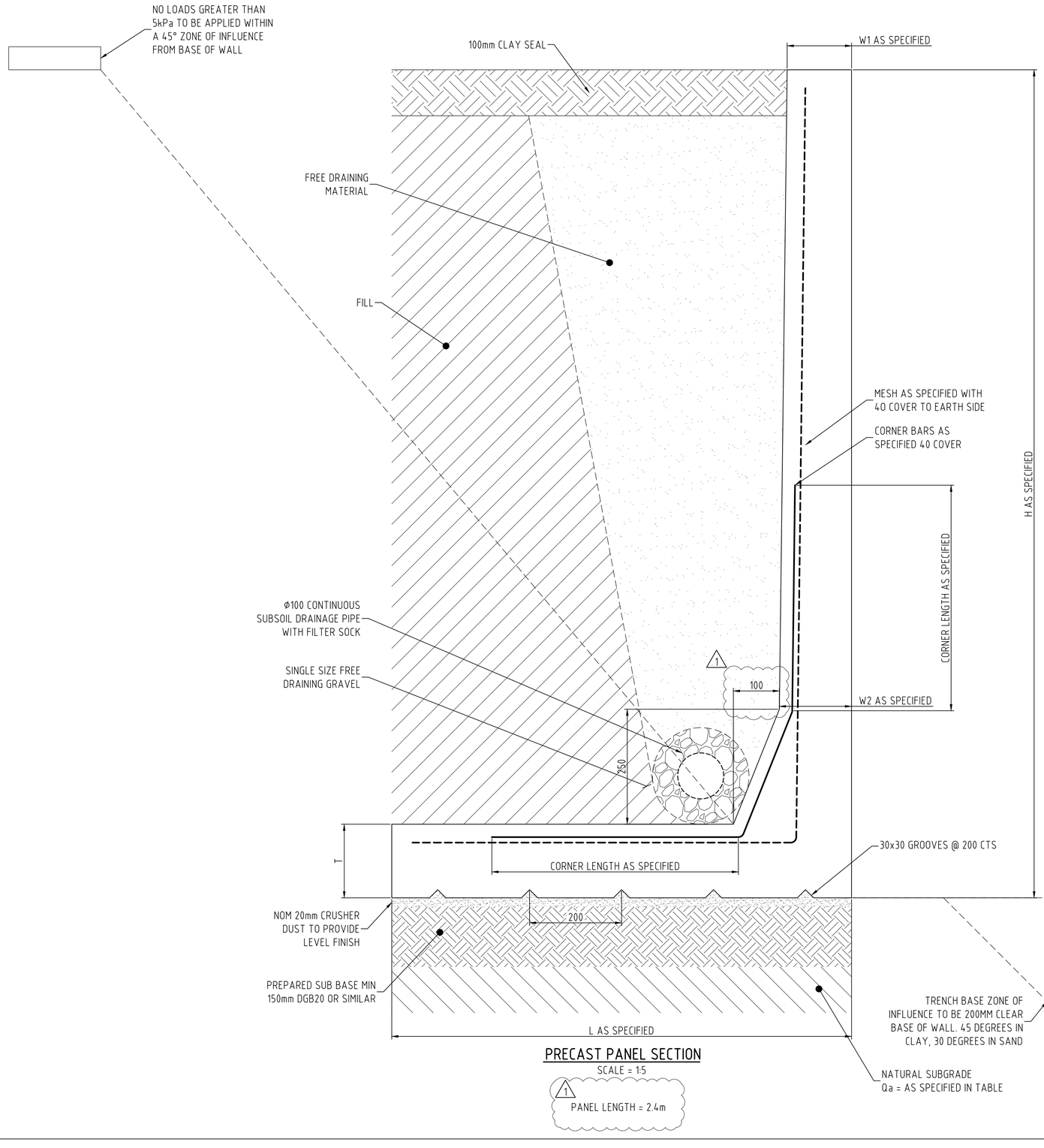
Appendix J

Precast L-Block specification



PRECAST PANEL SECTION

SCALE = 1:5

1 PANEL LENGTH = 2.4m

GEOTECHNICAL NOTES

1. THESE CONCRETE PANELS HAVE BEEN DESIGNED FOR AN ASSUMED CLASS "M" OR "H1" SITE AND BELOW PARAMETERS.
2. SITE SPECIFIC GEOTECHNICAL PARAMETERS TO BE VERIFIED BY A GEOTECHNICAL ENGINEER. IF PARAMETERS DIFFER FROM THOSE LISTED ON DRAWING, REFER STRUCTURAL ENGINEER FOR DESIGN ADVISE.
3. FRICTION COEFFICIENT OF CORRUGATED BASE & GRAVEL SUB-BASE = 0.7.
4. ALLOWABLE BEARING CAPACITY Qa - REFER TABLE

LOADING NOTES

1. ALL LOADS ARE ACCORDING TO AS1170
2. DEAD LOADS:
   A) SELF WEIGHT OF CONCRETE STRUCTURE
3. LIVE LOADS:
   A) 5 kPa CLASS B RETAINING WALL TO AS4678-2002
4. EARTH LOADS:
   A) Ka = 0.35
   B) DENSITY = 20 kN/m^3
5. CONFIRM LOADS TO SUIT PROJECT & GEOTECHNICAL INFORMATION PRIOR TO CONSTRUCTION.

CONCRETE PANEL NOTES

1. CONCRETE EXPOSURE CLASSIFICATION = B1 TO AS3600-2018
2. CONCRETE IS TO BE GRADE N40 (40 MPa STRENGTH AT 28 DAYS AGE)
3. PANEL DEPTH AND WIDTH PER RELATIVE DETAILS.
4. PANEL REINFORCEMENT PER RELATIVE DETAILS WITH 40mm COVER.
5. CLASS 3 FINISH TO VISUAL SURFACES.

NOTES

1. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE PROJECT SPECIFIC DRAWINGS AND SPECIFICATIONS FOR THE INTENDED RETAINING WALL APPLICATION.
2. ALL SETOUT DIMENSIONS ARE TO BE CONFIRMED BY TRUCAST PRIOR TO CASTING UNITS.
3. ANY INCONSISTENCIES IN MEASUREMENTS ARE TO BE NOTIFIED TO BARNSON PTY LTD PRIOR TO FABRICATION
4. COVER TO REINFORCEMENT 40mm
5. CONCRETE TO BE APPROVED MIX, f'c = 40 MPa MAXIMUM AGGREGATE SIZE 20mm
6. ALLOWABLE TOLERANCES FOR DIMENSIONS:

SPAN HEIGHT	±10mm
THICKNESS	+8mm, -5mm
LENGTH	±15mm
COVER	+10mm, -0mm

7. CULVERTS TO BE MANUFACTURED IN ACCORDANCE WITH; AS3850.1-2015, (PREFABRICATED CONCRETE ELEMENTS)
8. RIGID FORMWORK AND INTENSE COMPACTION IN ACCORDANCE WITH CL 4.14.3.3 AS5100.5-2017 TO BE USED
9. ALL REINFORCING MESH AND BAR TO BE GRADE 500 STEEL
10. INSTALLATION OF UNITS SHALL BE IN ACCORDANCE WITH; SECTION 6 AS1597.2-2013
11. LIFTING POINT LOCATIONS TO BE NOMINATED ON MANUFACTURER'S SHOP DRAWINGS. MINIMUM CONCRETE STRENGTH AT LIFTING 21MPa.

WALL DIMENSIONS					
H (mm)	L (mm)	W1 (mm)	W2 (mm)	T (mm)	Qa (kPa)
1200	800	90	100	120	125
2000	1000	110	140	160	150
2500	1300	110	156	160	175
3000	1600	137	200	200	200

REINFORCEMENT			
HEIGHT (mm)	WALL REINFORCEMENT	CORNER BARS	CORNER BAR LENGTH (mm)
1200	SL82 MESH	N12 @ 300 CTS	1000
2000	SL81 MESH	N12 @ 300 CTS	1000
2500	SL81 MESH	N16 @ 300 CTS	1000
3000	SL81 MESH	N16 @ 250 CTS	1400

ISSUED FOR CONSTRUCTION

barnson. DESIGN . PLAN . MANAGE

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Rev	Date	Description
A	07-08-2023	PRELIMINARY DRAWING
B	23-08-2023	REINFORCEMENT DETAILS ADDED
C	31-08-2023	ADDITIONAL SIZED RETAINING WALLS ADDED
D	05-09-2023	REINFORCEMENT UPDATED
E	07-09-2023	UPDATES BASED ON CLIENT FEEDBACK
F	07-09-2023	UPDATES BASED ON CLIENT FEEDBACK
0	11-09-2023	ISSUED FOR CONSTRUCTION
1	02-11-2023	PANEL SIZES UPDATED

Project
PRECAST 'L' PANEL STRUCTURAL DESIGN
Site Address

Client
TRUCAST

Drawing Title
PRECAST PANEL & NOTES

Design MK
Drawn MK
Check RN

Original Sheet Size A1
Revision 1

Certification
6/11/2023
Richard Noonan BE(Hons) ME FIEAust NER 472690

Project No 42150
Drawing No S01

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