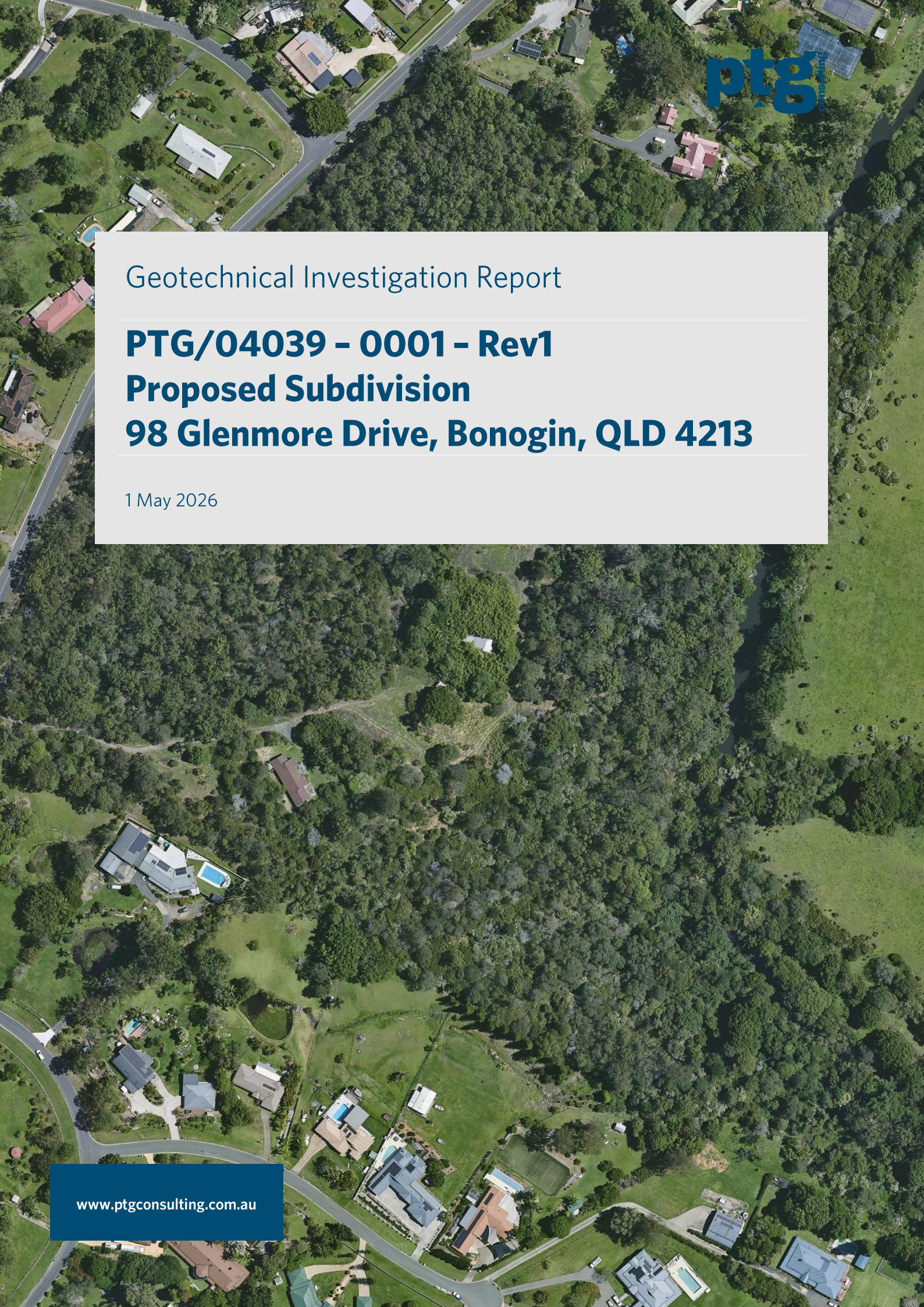
APPENDIX A - LANDSLIDE RISK ASSESSMENT

98 GLENMORE DRIVE, BONOGIN

May 2026

Urban Planning | Urban Design
Project Management | Development Advice



Geotechnical Investigation Report

PTG/04039 – 0001 – Rev1
Proposed Subdivision
98 Glenmore Drive, Bonogin, QLD 4213

1 May 2026

www.ptgconsulting.com.au

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1 EXECUTIVE SUMMARY

This report provides the results of the landslide risk assessment for the proposed residential subdivision at 98 Glenmore Drive, Bonogin.

The subject property is mapped within the City of Gold Coast (CoGC) landslide risk hazard overlay as being in areas identified as having MODERATE risk rating. See Figure 1.

The results of the landslide susceptibility analyses indicate that the proposed lot in its existing state generally has a landslide susceptibility of LOW, which is usually acceptable to regulators. The potential iterations of future development at the property generally returned landslide susceptibility ratings of MODERATE and HIGH, which are usually not automatically acceptable to regulators. A summary of the potential susceptibility results is shown in Table 1 below. Although it is noted that these scenarios can be checked with global stability analysis to determine factors of safety against geotechnical failure, which would be undertaken once detailed development works are known.

Once detailed plans for the residential subdivision are available, it is recommended that they are reviewed against the landslide susceptibility and assumptions outlined in this report and that a detailed landslide risk assessment following the *Australian Geomechanics Society (AGS) 'Landslide Risk Management Guideline 2007'* considering critical elements of the proposed development. Additionally, it is recommended that each proposed retaining wall, cut and fill batters and any other slope support are designed and assessed to be globally stable with factors of safety against global geotechnical failure of 1.5 or greater.

Recommendations have been provided for future development to achieve and/or maintain a risk rating of LOW. These recommendations can be seen below in Table 3.

Table 1: Summary of Susceptibility Results

Development Stage	Relative Susceptibility	Susceptibility Rating
Proposed Lot - Existing	0.22	Low
Proposed Lot w/ Cut Earthworks	1.43	Moderate
Proposed Lot w/ Cut and Fill Earthworks (1-3 m)	2.07	High
Proposed Lot w/ Cut and Fill Earthworks (1-3 m Cut; <1 m Fill)	1.75	Moderate

A global stability assessment was undertaken across a number of cross-sections for the future proposed concrete sleeper and block retaining walls at the property. The location and heights of proposed retaining walls including FILL earthworks are outlined in the supplied plans prepared by Legend Consultants; *'Proposed 18 Lot Rural Residential Subdivision 98 Glenmore Drive, Bonogin,' Drawing No. LC25079C200-202 Rev A, and LC25079C320-323 Rev B, dated 25.03.26.*

A total of six (6) sections were considered as part of this assessment looking at long-term stability. A summary of the slope stability analyses are presented in Table 2 below.

In summary, the results of the global stability analyses indicate that suitable global stability factors of safety (FoS) were achieved for the analysed sections for long-term conditions. Although it is noted that some sections required specific minimum structural requirements to achieve suitable factors of safety of greater than 1.5, which are detailed in Section 11 of this report.

Table 2: Summary of Global Stability Analyses

Section	Resultant FoS for Long-term case
Road Chainage 110 m – Three Tier Sleeper Wall	1.82
Road Chainage 90 m – 7m Block Wall	1.55
Lot 7 – Four Tier Sleeper Wall	1.50
Section A – Double Tier Sleeper Wall	1.57
Section B – Three Tier Sleeper Wall	1.61
Section C – Single Tier Sleeper Wall	1.52

It is assumed that each proposed retaining wall has been or will be designed against failure mechanisms normally associated with such structures. Should it be desired to materially alter the proposed development and associated earthworks proposals, this landslide assessment will need to be reviewed with respect to each change.

Table 3: Recommendations to Achieve and Maintain LOW Risk Rating

Applications	Recommendations
Foundations	It is recommended that if part of the future foundations/footings are extended to the underlying rock then the entirety of the foundation be extended into the rock profile to prevent differential settlement. Foundation loads should not influence reticulated stormwater and wastewater services associated trenches. Additionally, foundation loads should not influence any retaining structures or batters unless these have been allowed for through engineering design.
Earthworks	Considering existing site surface gradients, it is recommended that all permanent earthworks that contain buildings or surcharge loads within a distance equal to one batter height from the crest, should undergo detailed stability analysis to determine risk levels. Cut and fill earthworks be assessed for global stability during detailed design phase. Surface and stormwater runover must be directed away from batters and prevented from pooling at the base and crest. At a minimum, spoon drained should be installed at the crest and base of permanent batters.
Retaining Structures	It is recommended that retaining structures be assessed for global stability and designed to achieve a factor of safety (FoS) against global failure of at least 1.5. This is in addition to engineering design against failure mechanisms normally associated with such structures It is imperative that drainage systems within retaining structures are adequately designed and maintained through the life of these systems to prevent erosion, loss of strength of soils due to wetting and additional forces on retaining structures resulting from hydrostatic pressure.
Drainage	Stormwater across the proposed development should be collected and directed in a controlled manner away from the development area and batters.
Erosion	Permanent batters (at a minimum) should be protected from erosion. For soil batters (topsoiling and planting, or erosion matting should be applied to the batters as soon as the permanent batters are shaped appropriately).

2 REPORT SCOPE

This report presents the results of a landslide risk assessment undertaken by PTG Consulting (PTG) for the proposed construction of a new subdivision at 98 Glenmore Drive, Bonogin, QLD 4213. The investigation was commissioned by Shannon Sharp. It is understood that existing dwellings are currently occupied at the site.

The site location is identified on the Gold Coast City Council (GCCC) landslide hazard overlay mapping as generally having a MODERATE risk of landslide hazard (see Figure 1). Therefore, in accordance with GCCC guidelines a landslide risk assessment is required, to be undertaken in accordance with The City of Gold Coast's '*Attachment F: City Planning Policy – Geotechnical Stability Assessment, SC6.10 City Plan Policy – Geotechnical Stability Assessment Guidelines*'.

This report includes a description and results of the fieldwork undertaken and reporting on the following:

- Site description including detailed bore logs, site images and marked site plan with approximate test locations;
- Review of regional geology;
- Subsurface conditions including groundwater (if encountered);
- Desktop study reviewing regional gelogy, site slopes, elevations and historic instability;
- Site preparation and earthwork recommendations
- Broadscale preliminary site classification and predicted ground surface movement (Ys) in accordance with AS 2870-2011
- Allowable bearing pressures for high level footings and estimated settlements;
- Suitable pile types, ultimate base bearing, skin frictions and estimated settlement;
- Temporary and permanent batter slopes;
- Retaining wall design parameters and batter recommendations;
- Landslide susceptibility rating analysis;
- CBR value and modulus of subgrade reaction for pavement design (by others); and
- Any other geotechnical issues identified that will need management (if any).

Following receipt of earthworks proposals and preliminary retaining wall design layouts, a subsequent global stability assessment has been undertaken, with assessment presented in Section 11.

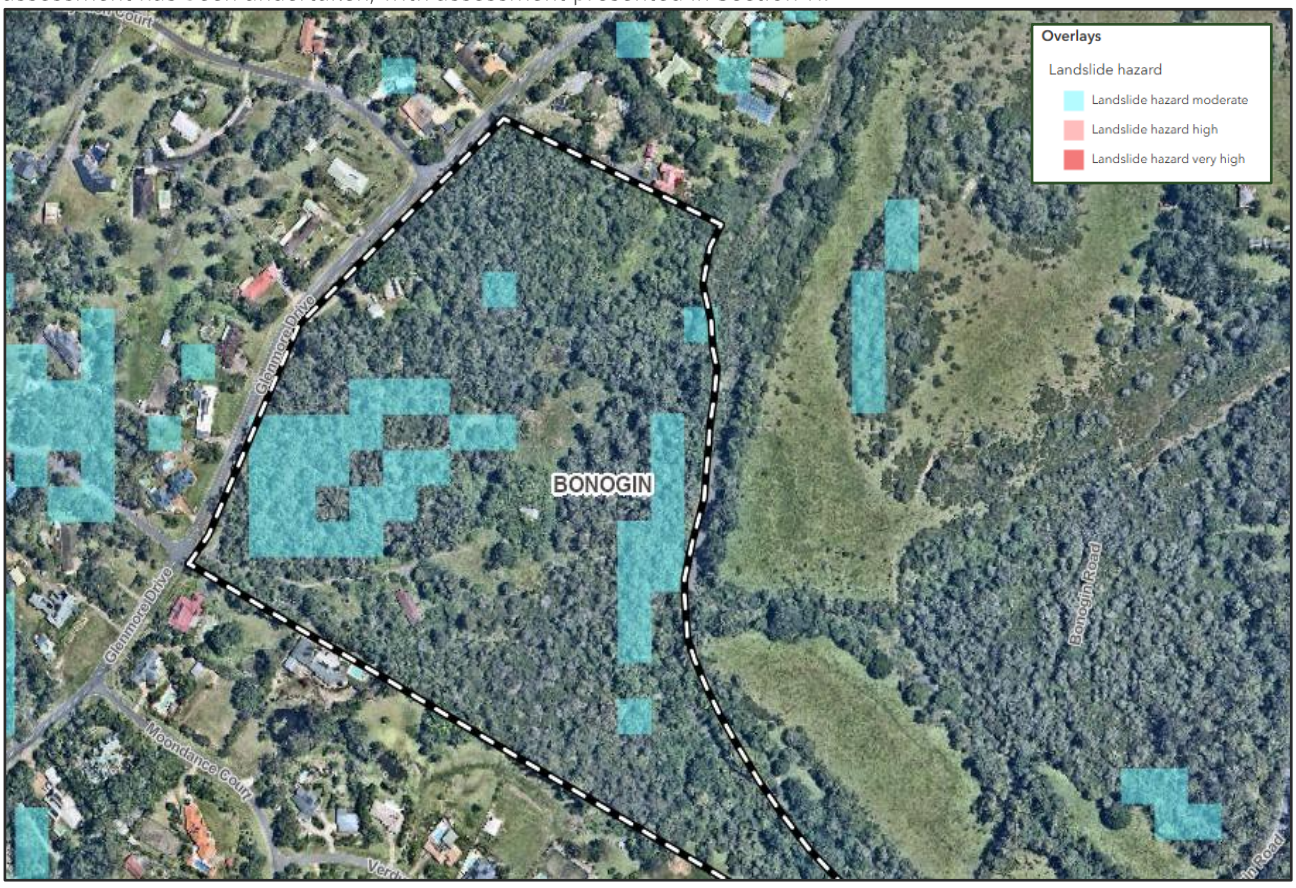


Figure 1: Extract of GCCC Landslide Susceptibility Map Overlay Annotated with Subject Property Boundary

3 PROJECT DESCRIPTION

Based on communication with the client and review of the documentation provided, it is understood that the proposed development comprises the subdivision of the site into eighteen (18) residential lots. It is assumed that the future development will involve reconfiguration of ground levels across the subdivision through cut and fill earthworks, with retaining structures constructed to support cut and fill areas where required. The proposed lot and road layout is shown in Figure 2.

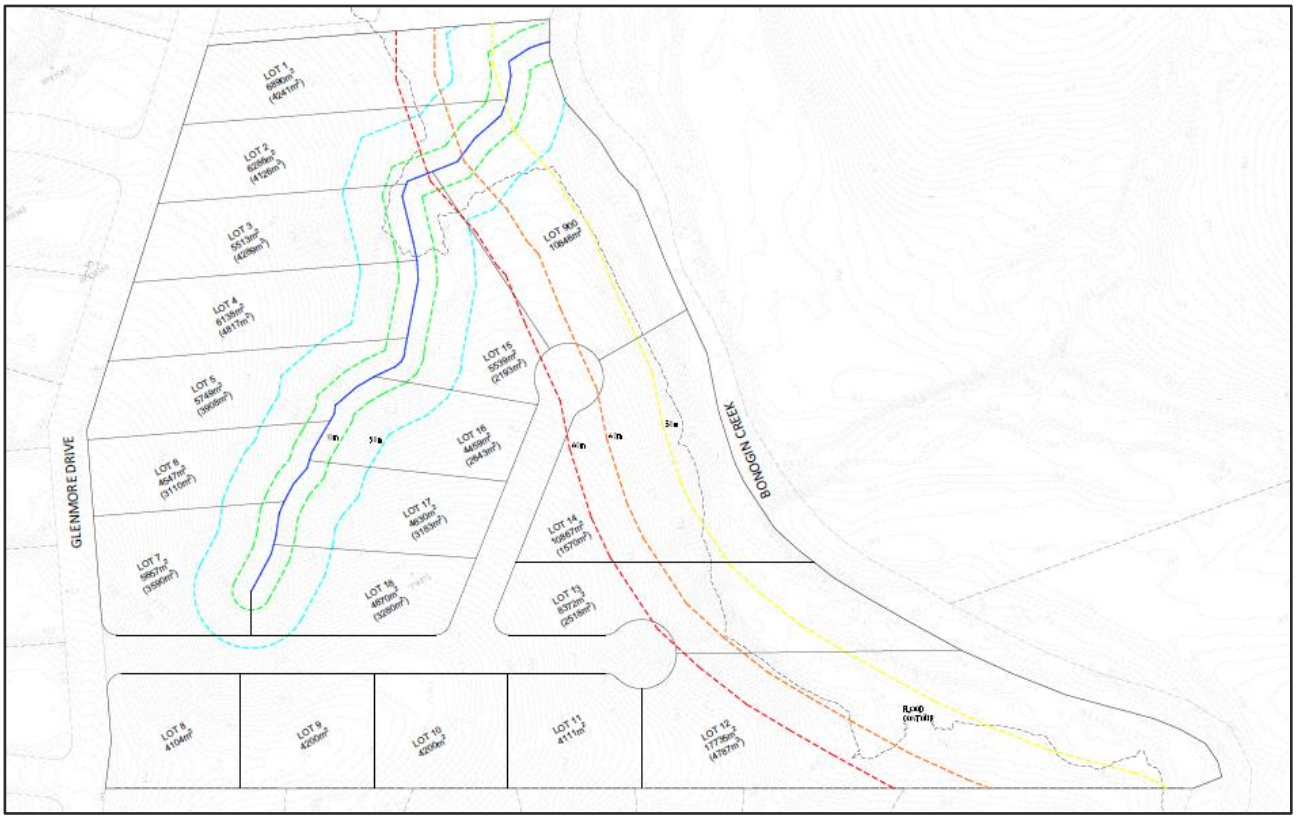


Figure 2: Excerpt of the Contours and Detail Survey, prepared by Steve Cooper & Associates and marked up and provided by the client.

4 SITE DESCRIPTION

The site is bounded by Bonogin Creek to the east, Glenmore Drive to the west, and existing residential dwellings to the north and south. The site is currently highly vegetated, comprising medium to tall grass and established medium to tall trees across the allotment. An existing access track traverses the site.

It is assumed that a combination of cut and fill earthworks were undertaken to form level development areas. Figure 3 below shows the site contours based on Queensland Lidar Data (2014, 1 m intervals).

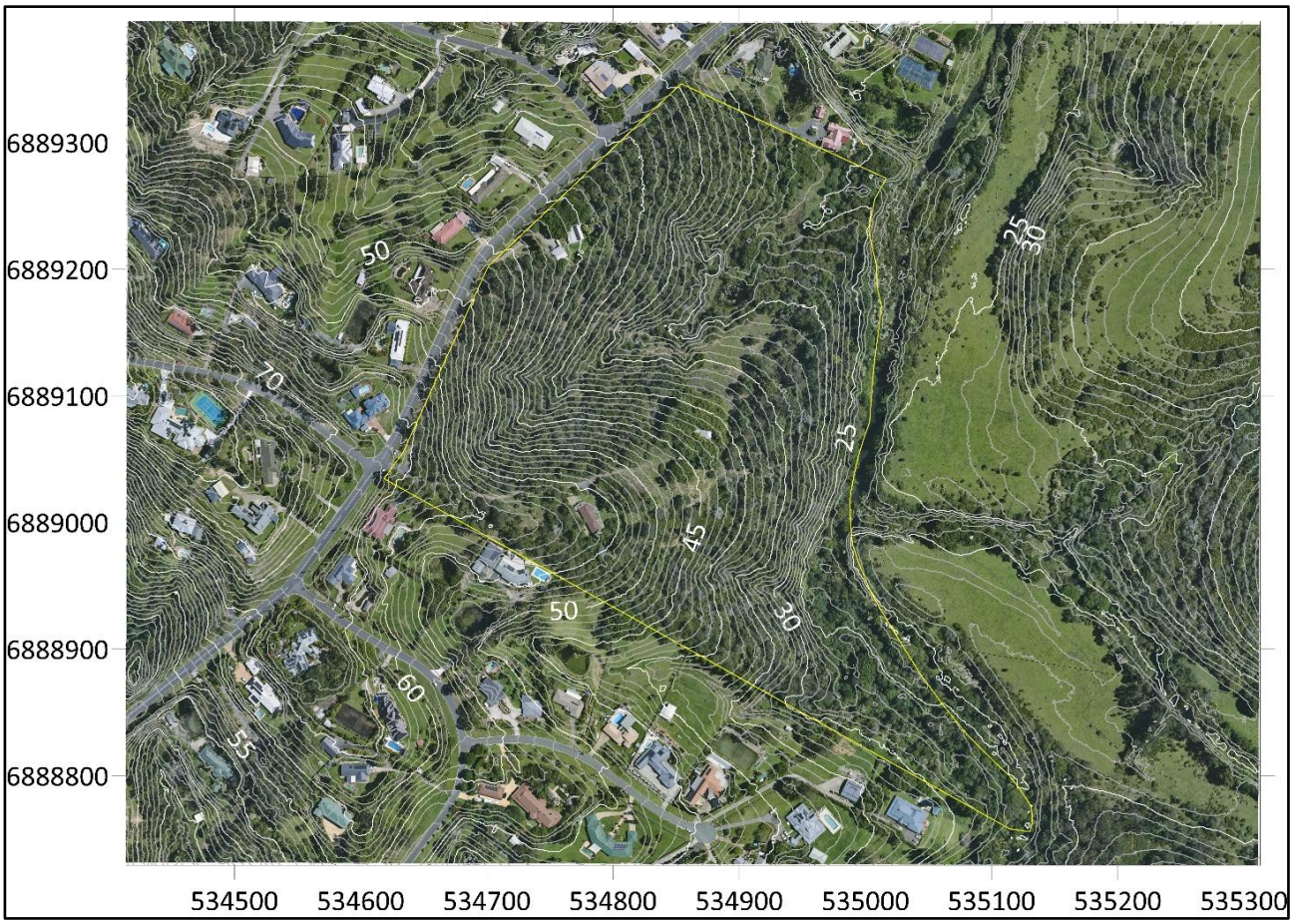


Figure 3: Aerial Image from MetroMaps showing subject property and surrounds, annotated with external site boundaries as well as contours based on Queensland LiDAR Data (2014, 1 m intervals).

Figures 4 to 7 are images that were taken at the time of the investigation and show the general site conditions.



Figure 4: General site conditions



Figure 5: General site conditions



Figure 6: General site conditions



Figure 7: General site conditions

5 REGIONAL GEOLOGY

Reference to the Queensland Government's 1:100,000 geology series available on the QGD.org.au platform indicates that the site is generally underlain by Devonian - Carboniferous Aged Neranleigh-Fernvale beds (DCf); which generally comprises mudstone, shale, arenite, chert, jasper, basic metavolcanics, pillow lava and conglomerate. See Figure 8 below.



Figure 8: Regional geology extracted from Queensland Geotechnical Database

6 FIELD INVESTIGATION

The fieldwork included five (5) auger boreholes to a targeted depth of 6.0 m below current ground level (m bcgl). However, due to shallow weathered rock, all boreholes refused in highly weathered sandstone at a maximum depth of 4.0 m. The machine auger boreholes were progressed using a 4WD utility mounted drilling rig fitted with 100 mm diameter solid flight augers. The drilling was undertaken by an experienced geo-technician who logged the boreholes.

DCP testing was undertaken adjacent to the boreholes from the surface, with the number of blows to achieve 100 mm depth penetration recorded in accordance with AS1289.6.3.2. Soil consistency and relative density described on the borehole logs were inferred from the DCP results, tactile assessment, and published correlations.

The approximate borehole locations and numbers are shown on the test location plan attached in Appendix 1. The borehole log report sheets are attached in Appendix 2.

7 LABORATORY TESTING AND RESULTS

NATA accredited laboratory testing was undertaken on selected representative soil samples recovered from the boreholes in accordance with 'AS1289-Methods of Testing for Engineering Purposes'. The purpose of the laboratory testing was to determine typical soil behaviour characteristics for engineering assessment.

Laboratory testing comprised three (3) Atterberg Limits test, four (4) Particle Size Distribution (PSD) and one (1) California Bearing Ratio (CBR). The laboratory test results are summarised in Table 4 – 6 and the lab reports are presented in Appendix 3.

Table 4: Summary of Atterberg Limits Testing

Borehole No.	Depth (m)	Material	W_L (%)	W_P (%)	I_P (%)	LS (%)
1	0.6 – 0.9	Silty Clay with Sand	69	25	44	16.5
1	1.5 – 1.9	Sandy Clay	30	16	14	8
3	0.4 – 0.7	Silty Clay	38	16	22	10.5

Note: W_L = Liquid limit; W_P = Plastic limit; I_P = Plasticity index; LS = Linear shrinkage

Table 5: Summary of PSD Testing

Borehole No.	Depth (m)	Material	Gravel (%)	Sand (%)	Fines (%)
1	0.6 – 0.9	Silty Clay with Sand	0	21	79
2	1.5 – 1.9	Sandy Clay	0	35	65
3	0.4 – 0.7	Sandy Clay	0	29	71
4	0.2 – 0.4	Sandy Clay	0	47	53

Table 6: Summary of CBR Testing

Borehole No.	Depth (m)	Material	FMC (%)	OMC (%)	MDD (t/m^3)	Swell (%)	CBR (%)
3	0.4 – 0.7	Silty Clay with Sand	10	17.2	1.69	2.0	4.0

Notes: FMC – field moisture content; MDD – Maximum dry density; OMC – optimum moisture content

8 GEOTECHNICAL MODEL

Table 7 summarises the subsurface conditions encountered within the boreholes. The soil profile generally comprised a silty sand topsoil extending to a depth of 0.2 m, underlain by sandy clay to depths ranging between 1.0 m and 3.6 m.

The sandy clay was underlain by extremely weathered sandstone and transitioned into highly weathered sandstone. The highly weathered sandstone was encountered in all boreholes from depths of approximately 1.0 m below ground level and resulted in drilling refusal.

Table 7: Summary of Materials Encountered in Boreholes

Borehole No.	Silty SAND (Topsoil) (m)	Sandy CLAY (m)	Sandy GRAVEL (Extremely Weathered Sandstone) (m)	Weathered Sandstone (m)
1	0.0 – 0.2	0.2 – 3.0	3.0 – 3.3	3.3 – 3.4^{R}
2	0.0 – 0.1	0.1 – 3.6	3.6 – 3.9	3.9 – 4.0^{R}
3	0.0 – 0.2	0.2 – 1.0	-	1.0 – 1.1^{R}
4	0.0 – 0.2	0.2 – 1.5	-	1.5 – 1.6^{R}
5	0.0 – 0.1	0.1 – 0.4	0.4 – 1.1	1.1 – 1.2^{R}

Notes: ^{R} Refusal on material

Groundwater was not encountered during the drilling of the boreholes. It should be noted that groundwater levels can be perched and fluctuate seasonally and during and after heavy rainfall events. Given this natural variability, it is prudent to assume that water levels can fluctuate.

9 GEOTECHNICAL COMMENTS

The geotechnical comments in this report are based on factual information collected during the fieldwork, common practice, local experience and published literature however are fundamentally opinion.

9.1 EARTHWORKS ADVICE

9.1.1 SUBGRADE PREPARATION

To achieve a uniformly well compacted subgrade to support slabs and pavements, the subgrade should be uniformly compacted to a minimum 95% standard compaction. To prepare the subgrade, the upper 0.3 m depth (particularly in cut areas) may need to be scarified, moisture-conditioned and recompacted to a minimum 95% minimum dry density ratio (DDR) with a moisture variation not exceeding ±2% of the optimum moisture content (OMC) followed by a test roll and sealing as soon as practical.

9.1.2 FILLING

All structural fill should be placed and compacted under Level 1 inspection and testing in accordance with site specific design drawings and specifications. Minimum earthwork requirements should be in accordance with 'AS3798–2007 Guidelines on Earthworks for Commercial and Residential Developments'. In summary, AS3798 guidelines recommend the following:

- Strip vegetation and uncontrolled fill (if any);
- Test rolling using the following plant and load conditions:
  - a static smooth steel wheeled roller with a mass not less than 12 tonne and a load intensity under a wheel load not less than 6 tonnes;
  - a pneumatic tyred plant with a mass not less than 20 tonnes and a ground pressure not less than 450 kPa per tyre; or
  - a highway truck with rear axle loaded not less than 8 tonnes with tyres inflated to 550 kPa;
- Subject to site specific conditions, any soft areas identified might need to be removed and replaced with select material; and
- Structural fill should be in near horizontal layers, commonly termed 'lifts', and generally not to exceed 300 mm thick (uncompacted) and compacted to a 95% minimum dry density ratio (DDR) for general fill and 95% minimum DDR in the upper 0.5 m depth beneath slabs and pavements with a moisture variation not exceeding ±2% of the optimum moisture content (OMC). The maximum particle size should be limited to two-thirds of the compacted layer thickness. Where structural fill abuts slopes generally steeper than 8H:1V (if any), benches equal to the height of the fill layer should be cut into the slope before filling.

Other earthwork considerations include:

- Over-compacted clay soils can significantly increase site reactivity and be prone to future softening, and should be avoided;
- The most suitable plant for compaction is a pad-foot roller for cohesive soils with varying amounts of silt and clay and a smooth drum roller for granular (i.e. clean sand and crushed road base gravel) soils; and
- Any wet soils would need to be dried out before reuse or continuation of earthworks. Drying of insitu wet soils are accelerated by tyning the upper 0.1 m to 0.3 m depth and baking-out (to within ±2% of the OMC) during sunny weather.

PTG can provide Level 1 supervision and testing following site specific design drawings and specifications and AS 3798–2007 if required.

9.1.3 EXCAVATION CONDITIONS

Excavation of the encountered fill, natural soils and extremely weathered rock could be achieved using excavators of any size. Where suitable production rates are required, a 20 tonne excavator (minimum) would likely be required.

Actual excavation rates in rock are dependent on many factors including strength, fracture/joint spacing, fracture/joint orientation, plant age and operator experience.

9.1.4 SUITABILITY OF SITE WON MATERIAL

Provided that there are no limitations on fill (ie shrink-swell, CBR, WPI), site materials could be considered suitable for reuse as structural fill.

9.2 PRELIMINARY SITE CLASSIFICATION AND SITE MOVEMENTS

For information purposes, the empirical method described in 'AS2870-2011 Residential slabs and footings' was used to calculate the characteristic surface movement (ys) (i.e. site reactivity) due to variation in normal seasonal moisture conditions and climatic effects, and subsequent site classification.

To predict the characteristic ground surface movement in normal soil moisture conditions, the results of the Atterberg Limits and linear shrinkage tests were used to infer shrink-swell index (Iss) values. Based on the inferred shrink-swell values and the empirical methods described in Section 2.3 of AS2870, the characteristic ground surface movement was estimated to be between 40 mm and 60 mm, or up to 60 mm, consistent with a site class 'H1'.

Where any cutting or filling is carried out, the crack depth should be reconsidered based on the future proposed earth works and reactivity of the exposed material when calculating ground surface movement (ys).

This classification is relevant to sites subject to normal moisture conditions. Abnormal moisture conditions such as from the removal or planting of trees (including on adjacent sites), poor site drainage, and development of gardens adjacent to footings, may cause higher movements to occur, probably results in damage, which may or may not be within acceptable limits.

Abnormal soil moisture conditions currently exist in parts of the site due to the presence of numerous trees. Examples of abnormal soil moisture conditions are described in Section 1.3.3 of AS2870-2011. Even if the trees are removed, the effects must be considered unless a significant amount of time is allowed to pass between tree clearing and construction. On this basis, ground movements will likely be affected by the expected abnormal soil moisture conditions.

The design of new building footings must take account of the calculated characteristic ground surface movement, ys, and the potential surface movement resulting from tree induced suction changes, yt, (considering both present and recently removed trees) calculated as described in Appendix H of AS2870-2011.

Potential ground surface movements due to the effects of trees (yt) can be assessed using the parameters in Table 8.

Table 8: Ground Surface Movements Due to Effects on Trees

Design Suction Change Depth Hs (m)	Single Tree		Tree Group	
	Maximum Extra Suction Change (pF)	Maximum Design Drying Depth Ht (m)	Maximum Extra Suction Change (pF)	Maximum Design Drying Depth (Ht)
1.5	0.3	2.5	0.38	3.0

From preliminary assessments, ytmax calculated in accordance with Appendix H of AS2870-2011 ranges approximately as follows:

- Single Tree – 20mm to 25mm
- Group of Trees – 30mm to 35mm

The potential ground surface movements due to the effects of trees (yt) is calculated using ytmax and considers the height and proximity of the tree(s) to a potential building slab. AS2870-2011 Appendix H states that the footing can be designed for a tree induced differential centre heave mound height, ym of equal to (0.7.ys + yt).

The characteristic ground surface movements will change where:

- Earthworks are carried out, particularly if any cutting is carried out, soils or weathered rock of lower reactivity are exposed, or if any reactive clay soils are placed as fill;
- Abnormal soil moisture conditions are allowed to develop;
- Tree planting is carried out on site or adjacent to the Site.

All footings and slab systems for structures founding at grade should be designed to accommodate the expected ground surface movements for the conditions existing after completion of any further earthworks, including the additional suction effects of trees.

9.3 FOUNDATIONS

Based on an interpretation of subsurface conditions encountered during the investigation, it is anticipated that high level foundations would be considered suitable for the development.

Based on the information available at the time of writing this report, general design parameters and recommendations have been provided in the subsections below which can be used for design of the foundation systems of future structures. The design of the structure must consider the structural loads against serviceability

All footing excavations should be inspected by PTG to confirm that bearing pressures have been achieved, and footings are clean and free from loose and/or water softened materials.

9.3.1 HIGH LEVEL FOUNDATIONS

Preliminary design of high-level pad footings up to 3 m wide or strip footings with a minimum 0.5 m depth can be designed using the allowable bearing pressures in Table 9. Elastic settlements of properly designed and constructed high level footings are usually in the order of 10 mm for 0.5 m wide strip footings to 25 mm for large square pad footings up to 3 m wide.

It is anticipated that the ground conditions at foundation level will be variable across the site and comprise a mix of natural clay, and potentially weathered sandstone.

Differential settlement will occur between parts of the structure supported on undisturbed sandstone and parts of the structure supported on a nominal layer of sand/clay soil (both natural and controlled fill). PTG can undertake detailed analysis to provided differential settlement predications if required (footing and slab size and loads would need to be provided).

Table 9: Allowable Bearing Pressures for High Level Footings

Material Type	Allowable Bearing Pressure (kPa)
Controlled Fill	100
Stiff silty/sandy clay	100
Very stiff silty/sandy clay	200
Hard silty/sandy clay	400
Dense sandy gravel	400
Very low strength ROCK Or stronger	500

9.4 SAFE TEMPORARY AND PERMANENT BATTER SLOPES

Excavations up to 2.5 m depth could generally be designed with a safe 1H:1V temporary batter slope or 2H:1V for permanent batter slopes. This assumes that soils are not wet/saturated and groundwater is not present, and is subject to the below recommendations:

- All temporary batters should not have construction loads (i.e. plant, equipment or soil stockpiles) or people at the crest of the batters at a distance equal to the height of the slope;
- Permanent batters (at a minimum) should be protected from erosion. Topsoiling and planting, or erosion matting should be applied to the batter as soon as possible;
- Suitable drainage and stormwater provisions must be installed for the batters. Surface and stormwater runover must be directed away from batters and prevented from pooling at the base and crest. At a minimum, spoon drained should be installed at the crest and base of permanent batters;
- Temporary batters should not remain open for extended periods of time. Vertical excavations of up to 1.2 m are usually formed near vertical for short periods of time to allow for the installation of services and construction of footings. Any batters or excavations exceeding this should be inspected by a suitably qualified geotechnical engineer to assess to the temporary stability of the batter; and
- Batters exceeding the heights or slopes stated above, or batters that contain buildings or surcharge loads within a distance equal to one batter height from the crest, should undergo detailed stability analysis to determine risk levels.

9.5 RETAINING WALL PARAMETERS

It is understood that retaining walls will be required for the development. It is understood that retaining wall types have not yet been finalised at the time of writing this report, although correspondence from the client indicates that cantilever type walls are being considered.

Any retaining structures at the site should be designed in accordance with AS4678-2002 'Earth Retaining Structures'. Retaining wall design should consider the below:

- The distance from the crest and magnitude of any surcharge loads (ie buildings, roads);
- Whether the selected wall type is suitable for the proposed loading conditions;
- Wall geometry and the presence of any slopes at the crest or toe of the wall; and
- Type of backfill to be used behind the wall, and whether compaction will exert additional forces onto the wall.

Based on the results of the fieldwork, the unfactored drained retaining wall parameters in Table 10 were inferred from Tables D1, D3 and D4 of Appendix D of AS4678-2002.

Table 10: Geotechnical Parameters for Retaining Wall Design

Material Type	Bulk Unit Weight (kN/m^3)	Drained Cohesion (c' kPa)	Effective Friction Angle (ϕ' °)
Stiff silty/sandy clay	18	3	25
Very stiff silty/sandy clay	19	4	25
Hard silty/sandy clay	20	5	25
Dense sandy gravel	20	0	35
Very low strength ROCK Or stronger	21	8	32

9.6 PRELIMINARY CBR VALUES

Based on the results of the fieldwork and provided information, the exposed subgrade at the site prior to construction is anticipated to comprise a mixture of natural clay and weathered rock. The laboratory testing returned soaked CBR value of 4%.

The CBR values and modulus of subgrade reaction in Table 11 may be adopted for preliminary pavement design. These values assume that the materials are compacted to a minimum of 100 % MDD.

Table 11: Preliminary Pavement Design Parameters

Soil Type	CBR Value (%)	Swell (%)	Modulus of Subgrade Reaction (kPa/mm)
Natural silty/sandy clay	3	2	25
Undisturbed ROCK	10	-	50

Where/if CBR values have returned lower than the assumed design CBR value, either subgrade replacement or an increase in pavement design thickness will be required. Subgrade testing should be undertaken in accordance with local council guidelines once pavement areas have been boxed out.

Site management (ie drainage and surface water run-off) and construction timing must be considered during pavement construction. Once subgrade areas have been stripped or boxed out, the exposed subgrade will deteriorate if exposed to wet weather or water ponding, and will require over excavation or subgrade remediation.

9.7 EARTHQUAKE SUB-SOIL SITE CLASSIFIFCATION

In accordance with AS1170.4-2007 'Structural Design Actions Part:4 earthquake actions in Australia' Section 4.2, the site has an earthquake class definition of Class Ce – shallow soil site.

10 LANDSLIDE TISK ASSESSMENT

10.1 LANDSLIDE SUSCEPTIBILITY ANALYSIS

The Landslide Susceptibility Analysis identifies the constraints associated with the proposed development and has been carried out in accordance with SC6.10 City Plan policy - Geotechnical Stability Assessment Guidelines. It provides an overall slope stability risk rating for the Site, based on the assessment of several site factors related to slope stability, including but not limited to natural slope angle, site geology, cut and fill heights, and stormwater disposal.

The site location is identified on the Gold Coast City Council (GCCC) landslide hazard overlay mapping as generally having a MODERATE risk of landslide hazard (see Figure 1). It should be noted that the mapping is a broadscale indication of landslide susceptibility only. The hazard rating is superseded by this site-specific assessment.

The identified features including the subsurface conditions and the surface site features such as the ground slope angles were used to assess the pre and post development risk level for this site as assessed under the Landslide Susceptibility Analysis. It is noted that no future development proposals are available at this early stage of the subdivision process. For the purpose of undertaking the Landslide Susceptibility Analysis a number of iterations of potential development outcomes have been considered as outline below.

Based on the subject property and proposed development a landslide susceptibility assessment has been undertaken as follows: -

- Proposed Lot – Existing
- Proposed Lot with Cut Earthworks (between 1-3 m)
- Proposed Lot with Cut and Fill Earthworks (between 1-3m)
- Proposed Lot with Cut and Fill Earthworks (between 1-3m Cut, < 1m Fill)

Recurring assumptions made through the initial susceptibility analysis are as follows: -

- Stormwater discharge to site,
- Future soil retention systems to comprise concrete walls, and
- Wastewater via onsite disposal – soak pit/trenches.

Landslide Susceptibility Analysis was based on the following parameters obtained from the site conditions observed during the walkover survey, the subsurface profiles encountered, and assumptions made for probable future development at the property. Where the below factors are changed, a reassessment will be required.

10.1.1 PROPOSED LOT – EXISTING

Where the below factors are changed, a reassessment will be required.

Natural Ground Slope Angle – Between 5° and 15°
Slope Shape - Planar
Site Geology – Low-grade Metamorphic
Residual Soil – Between 1-3 m
Fill Depths – None
Evidence of groundwater - None
Cut height – None
Surface Water Concentration – Crest
Stormwater Disposal – Discharge On-Site

10.1.2 PROPOSED LOT WITH CUT EARHTWORKS (1-3m)

Where the below factors are changed, a reassessment will be required.

Natural Ground Slope Angle – Between 5° and 15°
Slope Shape - Planar
Site Geology – Low-grade Metamorphic
Residual Soil – Between 1-3 m
Cut height – Between 1-3 m
Material in Cutting – Soil
Slope of cut face – More than 60°
Cut Slope Support – Concrete Wall
Evidence of groundwater - None
Surface Water Concentration – Crest
Stormwater Disposal – Discharge On-Site
Wastewater Disposal – Onsite; Soak Pit/Trenches

10.1.3 PROPOSED LOT WITH CUT AND FILL EARHTWORKS (1-3m)

Where the below factors are changed, a reassessment will be required.

Natural Ground Slope Angle – – Between 5° and 15°
Slope Shape - Planar
Site Geology – Low-grade Metamorphic
Residual Soil – Between 1-3 m
Proposed Fill - Between 1-3 m
Cut height – Between 1-3 m
Material in Cutting – Soil
Slope of cut face – More than 60°
Cut Slope Support – Concrete Wall
Evidence of groundwater - None
Surface Water Concentration – Crest
Stormwater Disposal – Discharge On-Site
Wastewater Disposal – Onsite; Soak Pit/Trenches

10.1.4 PROPOSED LOT WITH CUT AND FILL EARHTWORKS (1-3m CUT; <1m FILL)

Where the below factors are changed, a reassessment will be required.

Natural Ground Slope Angle – Between 5° and 15°
Slope Shape - Planar
Site Geology – Low-grade Metamorphic
Residual Soil – Between 1-3 m
Proposed Fill – Less than 1 m
Cut height – Between 1-3 m
Material in Cutting – Soil
Slope of cut face – More than 60°
Cut Slope Support – Concrete Wall
Evidence of groundwater - None
Surface Water Concentration – Crest
Stormwater Disposal – Discharge On-Site
Wastewater Disposal – Onsite; Soak Pit/Trenches

10.2 SUMMARY OF LANDSLIDE SUSCEPTIBILITY RESULTS

These scenarios have been assessed in accordance with the Gold Coast City Council stability assessment guidelines. Susceptibility ratings are summarised in Table 12 below and the detailed analyses are provided in Tables 15 to 18 in Appendix 4 with the stated implications based on Table 20 found in Appendix 5.

Table 12: Summary of landslide susceptibility assessment

Development Stage	Relative Susceptibility	Susceptibility Rating
Proposed Lot - Existing	0.22	Low
Proposed Lot w/ Cut Earthworks	1.43	Moderate
Proposed Lot w/ Cut and Fill Earthworks (1-3 m)	2.07	High
Proposed Lot w/ Cut and Fill Earthworks (1-3 m Cut; <1 m Fill)	1.75	Moderate

The results of the landslide susceptibility analyses indicate that the proposed lot in its existing state generally has a landslide susceptibility of LOW, which is usually acceptable to regulators. The potential iterations of future development at the property generally returned landslide susceptibility ratings of MODERATE and HIGH, which are usually not automatically acceptable to regulators. Although it is noted that these scenarios can be checked with global stability analysis to determine factors of safety against geotechnical failure, which would be undertaken once development proposals are known.

Due to the landslide susceptibility rating of the assumed potential future earthworks and associated retaining at the property being MODERATE and HIGH, following the Gold Coast City Council stability assessment guidelines, it is a requirement that a detailed landslide risk assessment following the *Australian Geomechanics Society (AGS) 'Landslide Risk Management Guideline 2007'* should be carried out in order to determine whether the risk to life and property is acceptable. In this regard a LOW or VERY LOW risk to property and life is acceptable to Council.

It is assumed that all future retaining wall structures at the site are each globally stable, with factors of safety against global failure of 1.5 or greater and will be designed against failure mechanisms normally associated with such structures.

Once proposals for the future development have been determined, it is recommended that they are reviewed against the landslide susceptibility and assumptions outlined in this report and that a detailed landslide risk assessment following the *AGS 'Landslide Risk Management Guideline 2007'* considering critical elements of the proposed development. Additionally, it is recommended that each proposed retaining wall, cut and fill batters and any other slope support are designed and assessed to be globally stable with factors of safety against global geotechnical failure of 1.5 or greater.

Recommendations have been provided for future development to achieve and/or maintain a risk rating of LOW. These recommendations can be seen below in Table 13.

Table 13: Recommendations to Achieve and Maintain LOW Risk Rating

Applications	Recommendations
Foundations	It is recommended that if part of the future foundations/footings are extended to the underlying rock then the entirety of the foundation be extended into the rock profile to prevent differential settlement. Foundation loads should not influence reticulated stormwater and wastewater services associated trenches. Additionally, foundation loads should not influence any retaining structures or batters unless these have been allowed for through engineering design.
Earthworks	Considering existing site surface gradients, it is recommended that all permanent earthworks that contain buildings or surcharge loads within a distance equal to one batter height from the crest, should undergo detailed stability analysis to determine risk levels. Cut and fill earthworks be assessed for global stability during detailed design phase. Surface and stormwater runover must be directed away from batters and prevented from pooling at the base and crest. At a minimum, spoon drained should be installed at the crest and base of permanent batters.
Retaining Structures	It is recommended that retaining structures be assessed for global stability and designed to achieve a factor of safety (FoS) against global failure of at least 1.5. This is in addition to engineering design against failure mechanisms normally associated with such structures It is imperative that drainage systems within retaining structures are adequately designed and maintained through the life of these systems to prevent erosion, loss of strength of soils due to wetting and additional forces on retaining structures resulting from hydrostatic pressure.

Applications	Recommendations
Drainage	Stormwater across the proposed development should be collected and directed in a controlled manner away from the development area and batters.
Erosion	Permanent batters (at a minimum) should be protected from erosion. For soil batters (topsoiling and planting, or erosion matting should be applied to the batters as soon as the permanent batters are shaped appropriately).

11 GLOBAL STABILITY ANALYSIS

Global stability analysis has been based on critical cross-sections through the proposed site as detailed in the supplied plans prepared by Legend Consultants; *'Proposed 18 Lot Rural Residential Subdivision 98 Glenmore Drive, Bonogin,' Drawing No. LC25079C200-202 Rev A, and LC25079C320-323 Rev B, dated 25.03.26.* The locations of the assessed cross sections are outlined on Figure 9 below.

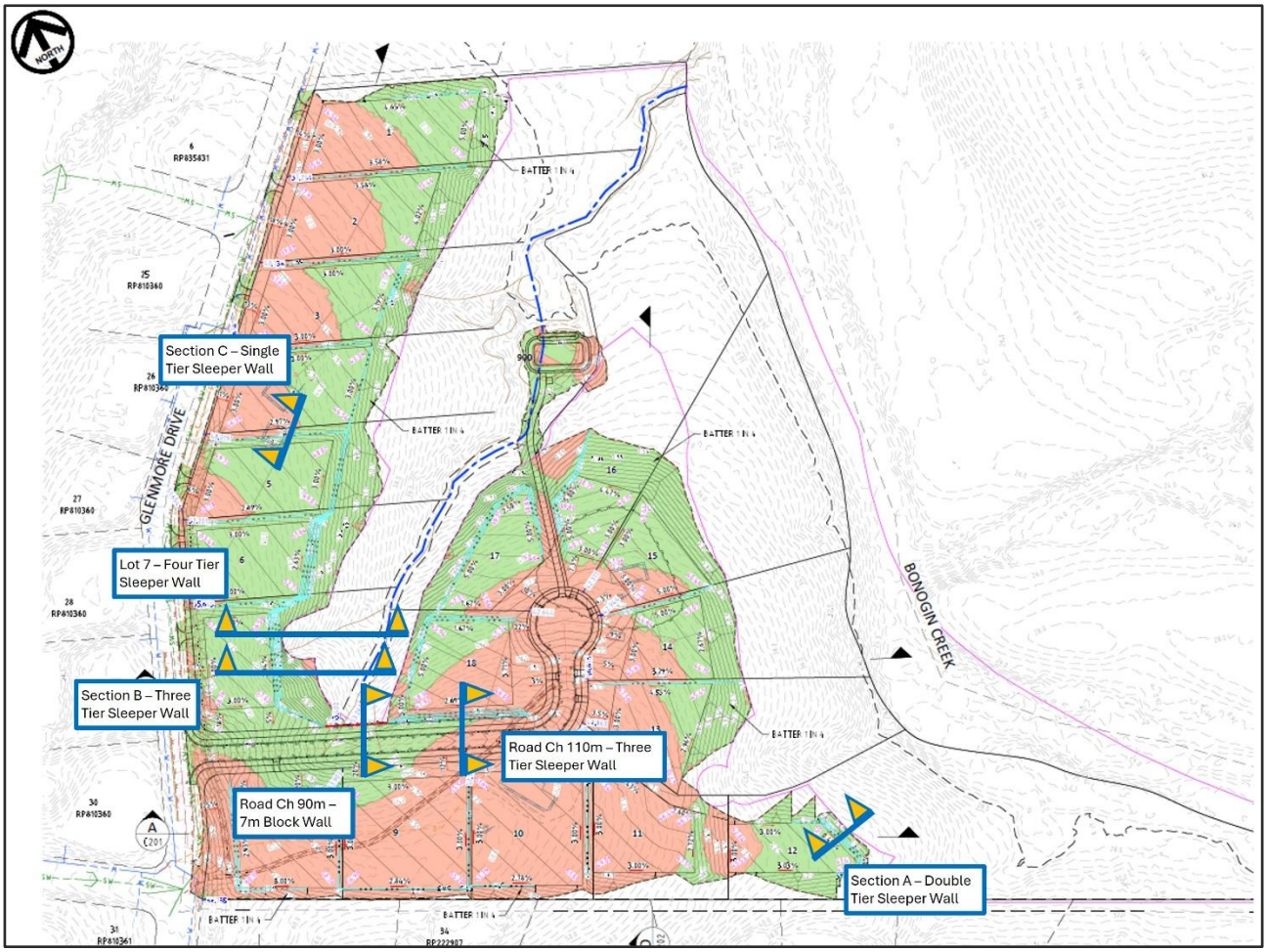


Figure 9: Drawing No. LC25079.C200 Rev B of the supplied plan set annotated with the locations of Cross-Sections considered within this global stability assessment.

At this stage, detailed designs of the retaining walls have not been completed, so assumptions have been made for the required foundations for the global stability assessment. Pier depths were initially analysed as approximate to the retained heights, and bored pier diameters of 0.45 m were implemented and spaced at 1.8 m centres. Where these initial design configurations did not achieve acceptable factors of safety, pier depths, diameters and spacing were revised to achieve working models.

Uniformly distributed loads of 10 kPa have been applied upslope of each retaining wall.

The results of the global stability analyses are summarised in Table 14 below. Figures 10 to 15 show excerpts of the global stability assessment of each wall section.

In summary, the results of the global stability analyses indicate that suitable global stability factors of safety (FoS) were achieved for the analysed sections for long-term conditions. Although, it is noted that some sections required specific minimum structural requirements to achieve suitable factors of safety of greater than 1.5.

Table 14: Summary of Global Stability Analyses

Section	Resultant FoS for Long-term case
Road Chainage 110 m – Three Tier Sleeper Wall	1.82(1)
Road Chainage 90 m – 7m Block Wall	1.55(2)
Lot 7 – Four Tier Sleeper Wall	1.50(3)
Section A – Double Tier Sleeper Wall	2.15(3)
Section B – Three Tier Sleeper Wall	1.61(3)
Section C – Single Tier Sleeper Wall	1.52

Note: (1, 2 etc.) *Additional Design Considerations required to achieve FoS > 1.5*

Notes:

(1) Directly adjacent and supporting the proposed roadway, bored piers for sleeper walls are required to be socketed a minimum of two (2) pile diameters, or 0.9 m, into rock.

(2) For the proposed block wall adjacent and supporting the proposed roadway, this is required to be underpinned with two rows of 0.6 m diameter bored piers spaced at 1.8 m centres. Additionally, bored piers are required to be socketed a minimum of two (2) pile diameters, or 1.2 m, into rock.

(3) Where sleeper walls are present on the leading downslope edge of a Lot formed with controlled FILL, it is required that bored piers are socketed a minimum of two (2) pile diameters, or 0.9 m, into rock.

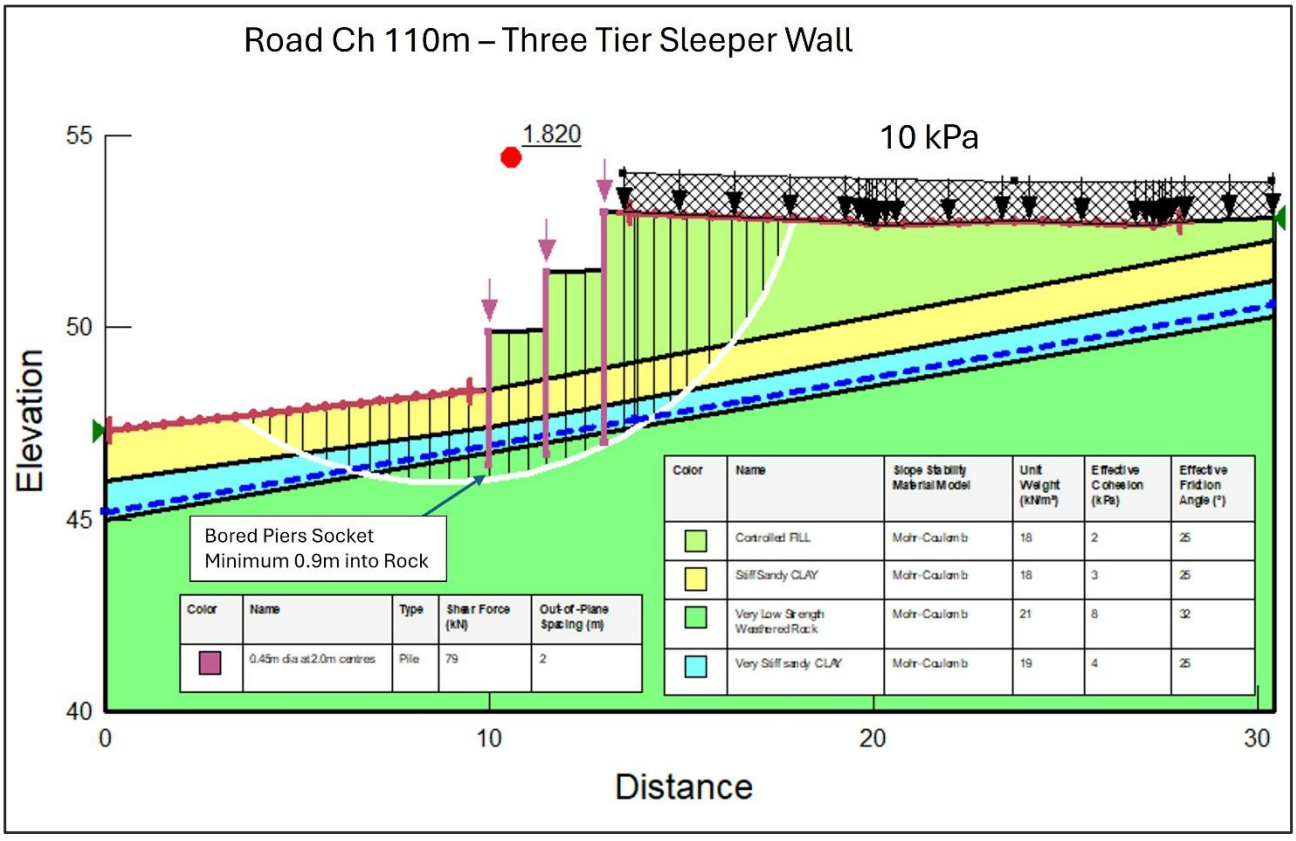


Figure 10: Cross-Section – Road Chainage 110 m – Three(3) Tier Sleeper Wall.

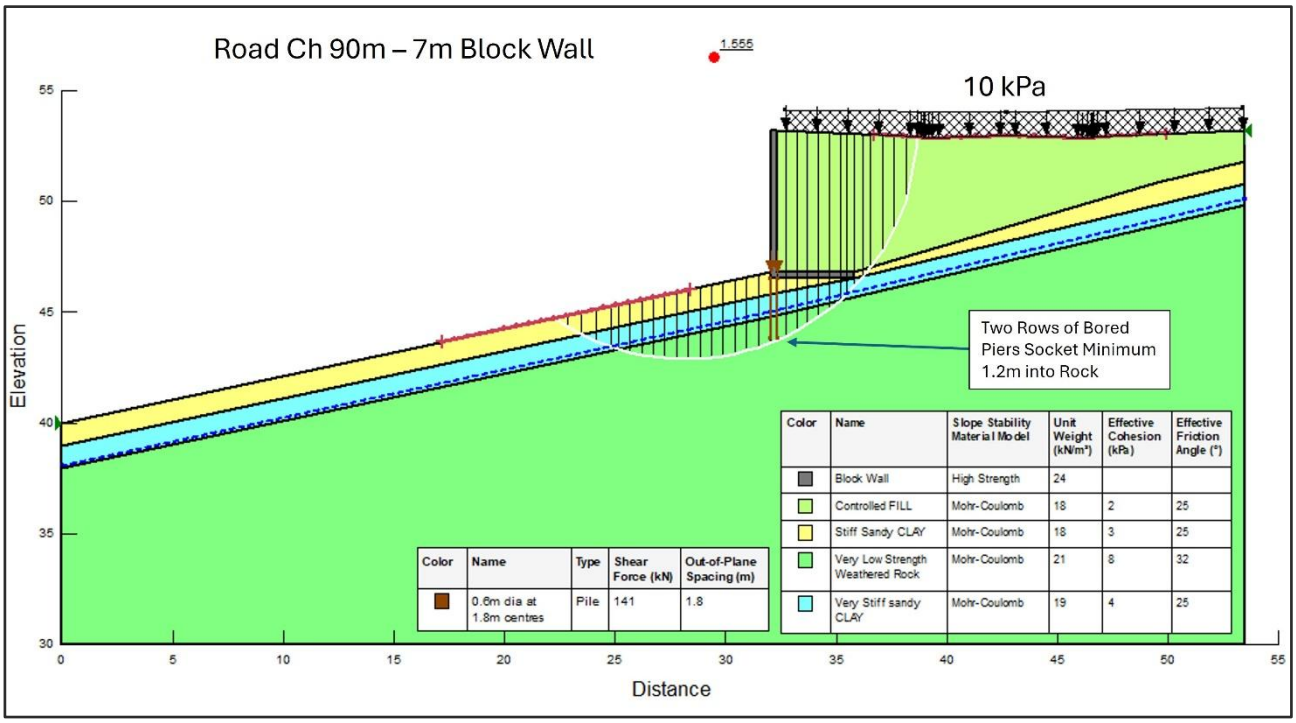


Figure 11: Cross-Section – Road Chainage 90 m – 7m Block Wall.

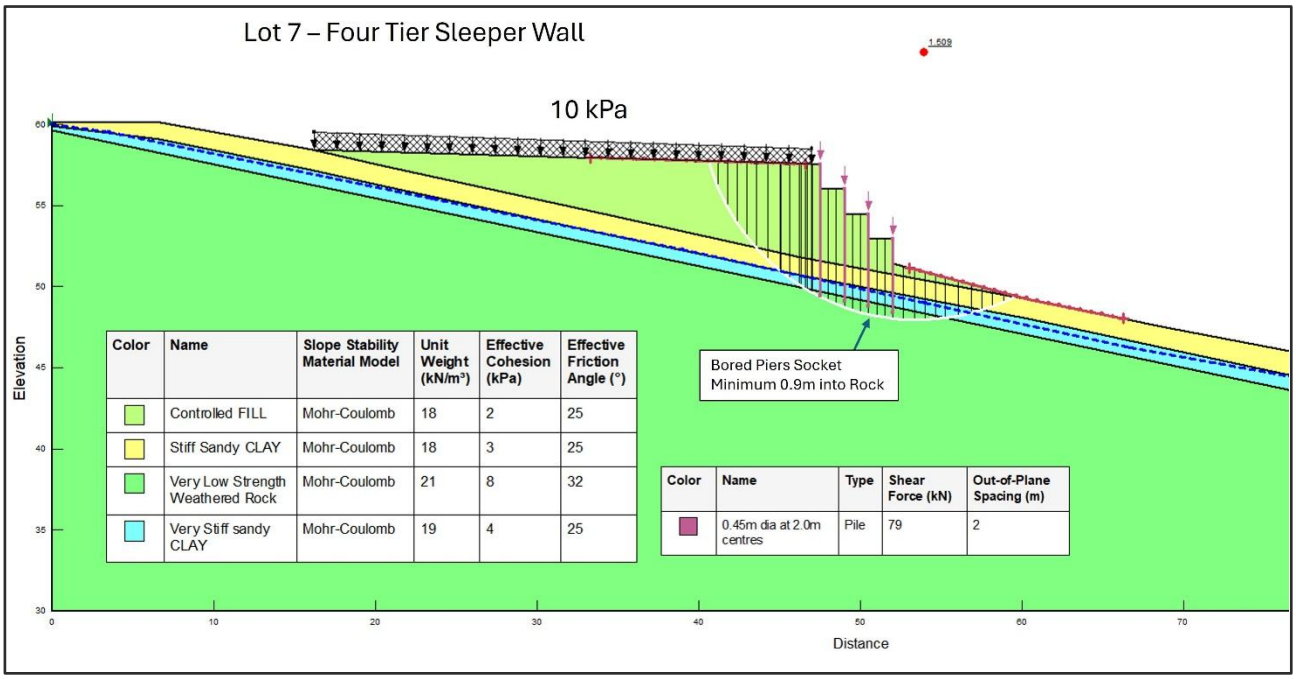


Figure 12: Cross-Section – Lot 7, Four (4) Tier Sleeper Wall.

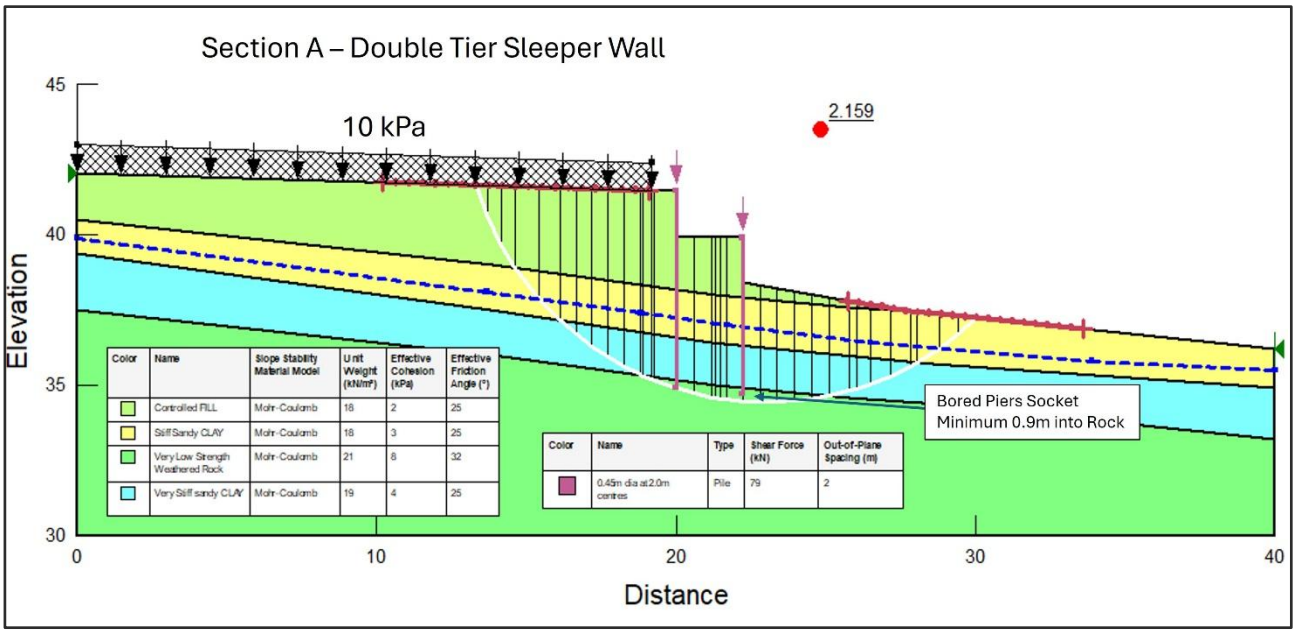


Figure 13: Cross-Section – Section A, Double Tier Sleeper Wall.

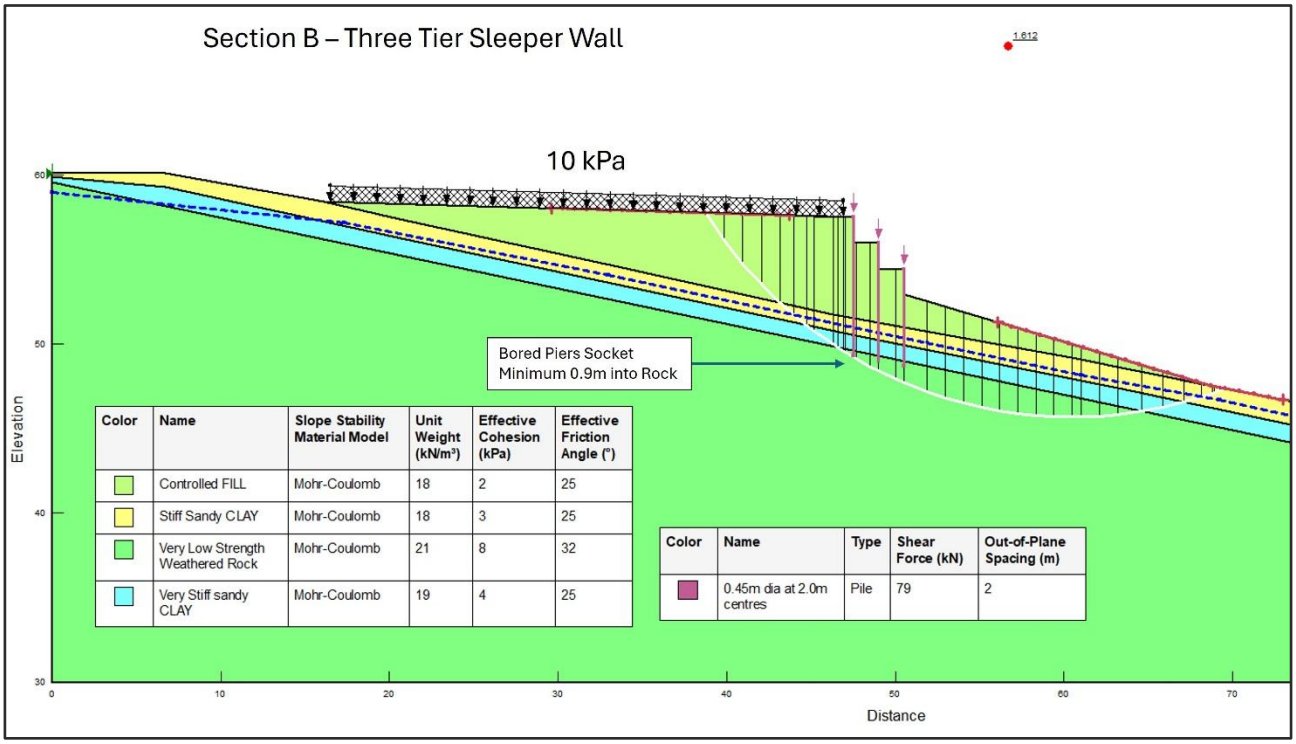


Figure 14: Cross-Section – Section B, Three (3) Tier Sleeper Wall.

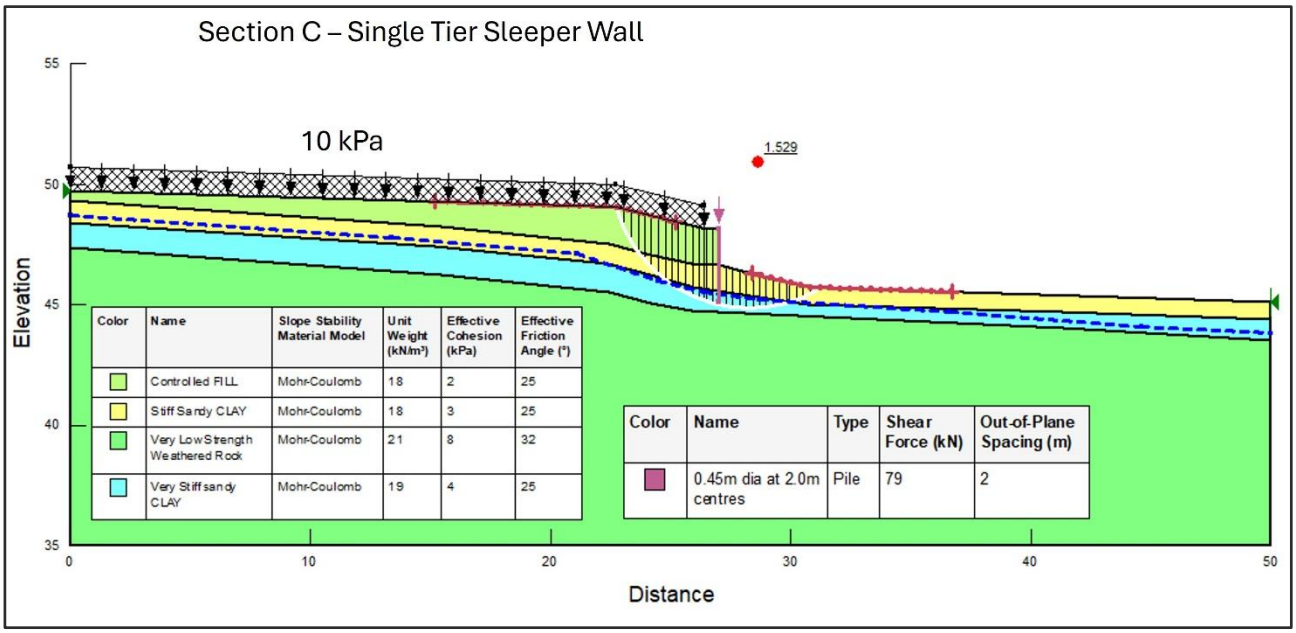


Figure 12: Cross-Section – Section C, Single Tier Sleeper Wall.

12 ADDITIONAL COMMENTS

Future retaining walls must be constructed with adequate and suitably designed drainage to limit the build-up of groundwater pressures behind the wall. Providing adequately designed, constructed, and maintained surface and subsurface drainage is important to the long-term performance of the developed site in terms of slope stability and erosion.

The retaining wall embedment depths must be confirmed during construction by a suitably qualified and competent engineer. Any change in the soil profile may require reanalysing the global stability.

The retaining walls must not be undermined. Excavations shall not be carried out adjacent to the retaining walls.

Further geotechnical investigation may be required for lot specific design once clearing and earthworks have commenced.

Consideration may be given to alternative retaining wall solutions. For soil retention along the downslope leading edge of raised fill platforms for both residential lots as well as the proposed roadway, reinforced earth systems may prove to be a feasible option considering both design requirements and constructability.

13 LIMITATIONS

PTG Consulting has prepared this report (or services) for this project in accordance with PTG's proposal and acceptance received from the Client. These limitations apply whether the report was created under PTG's own terms and conditions or otherwise.

This report is provided for the exclusive use of the Salt Development Services Pty Ltd for the Geotechnical scope of works at 98 Glenmore Drive, Bonogin, QLD 4213. The report should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of PTG, does so entirely at its own risk and without recourse to PTG for any loss or damage. In preparing this report, PTG has necessarily relied upon information provided by the client and/or their agents.

PTG's advice is based on information gained from limited subsurface excavations and sampling supplemented by knowledge of local geology and experience. The accuracy of the advice provided by PTG in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. For this reason our reports include an interpretation of conditions between the test points. There are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted. Such variations may occur after PTG's field testing has been completed. The precision and reliability of interpretive assessment between discrete points is dependent on the uniformity of the subsurface strata, as well as the frequency, detail, and method of sampling or testing.

Geotechnical information represents an opinion and is based extensively on judgment of both data and interpretive assessments or observation. This report and its associated documentation are provided explicitly based on PTG's opinion of the site at the time of inspection, and cannot be extended beyond this. Any recommendations or design suggestions will need to be verified on site during project implementation or construction. Inspection and verification on site may be conducted by a suitably qualified geotechnical consultant or engineer, and where subsurface conditions or interpretations differ from those provided in this document or otherwise anticipated, PTG must be notified and be provided with an opportunity to review the recommendations

The report has been prepared by qualified personnel, and is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. The information and interpretation may not be relevant if the development proposal is changed. If this happens then PTG Engineering will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, and the discussion and recommendations or suggestions relating to the geotechnical aspects of the scope of works. However, PTG Engineering cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions.
- Changes in policy or interpretations of policy by statutory authorities.
- The actions of contractors responding to commercial pressures.

The contents of this report do not constitute formal design components, as required by Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to the likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of PTG.

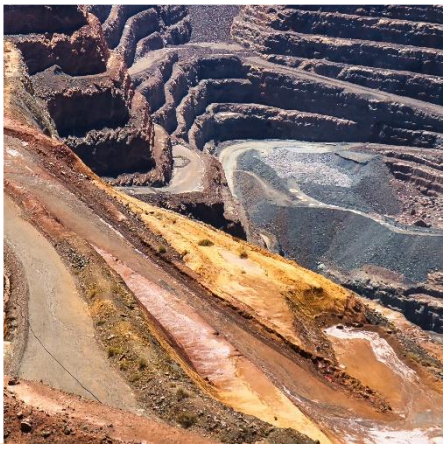
This report must be read in conjunction with all of the attached documents and should be kept in its entirety without separation of individual pages or sections. PTG cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome, or conclusion stated in this report.

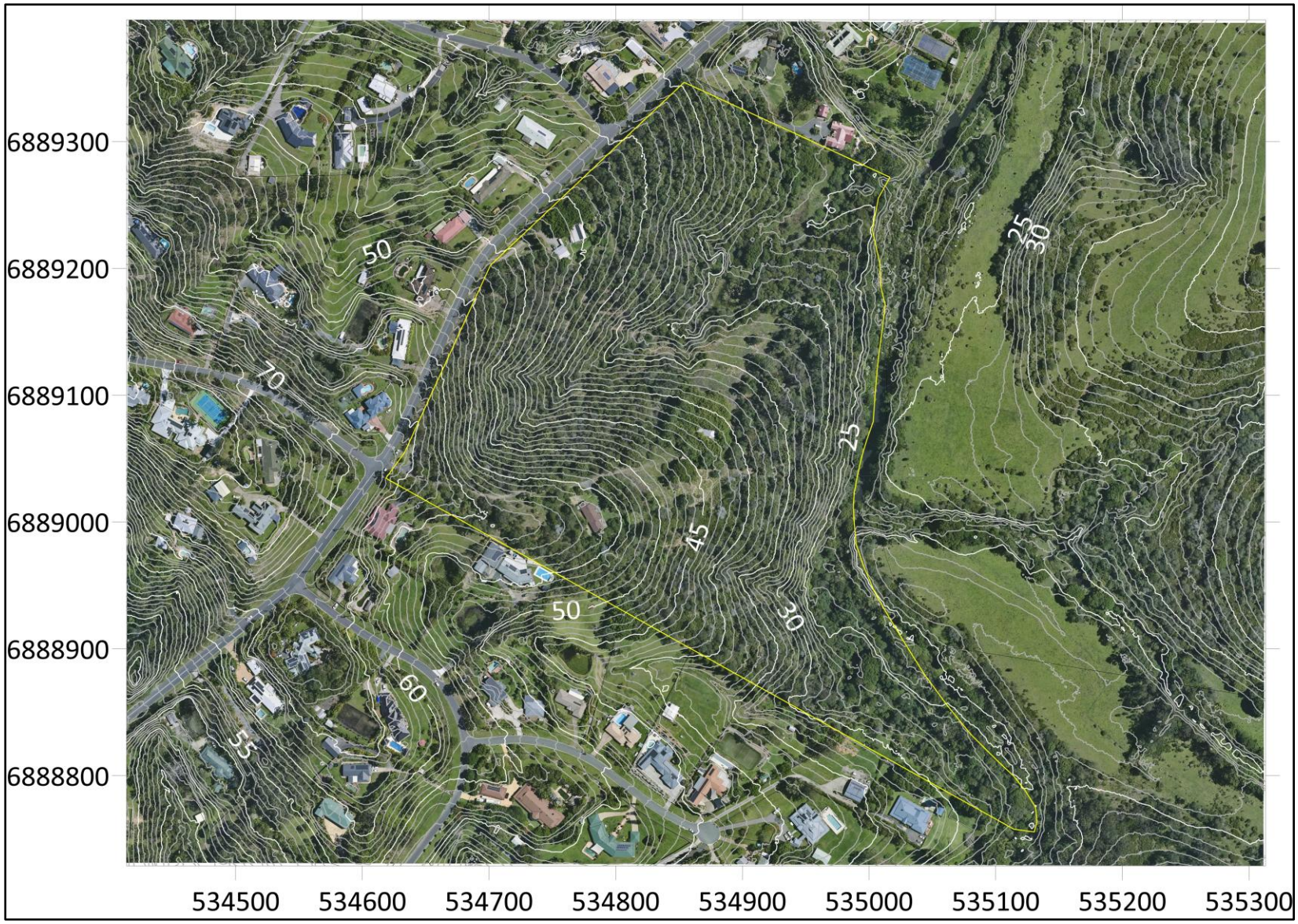
01



Appendix 1
Test Location Plan







N

Site locality



Legend

ptg consulting

Client:	Salt Development Services Pty Ltd
Site:	98 Glenmore Drive, Bonogin, QLD, 4213
Title:	1 m Contour LiDAR Data overlay MetroMaps Aerial Image

Date:	Drawn:	Checked:
02/03/2026	MK	JC
Project:	**Drawing No:**	**Revision**
PTG/04039	1	0



N

Site locality



Legend

Approximate Borehole Location and Number

ptg consulting

Client:	Salt Development Services Pty Ltd
Site:	98 Glenmore Drive, Bonogin, QLD, 4213
Title:	Test Location Plan

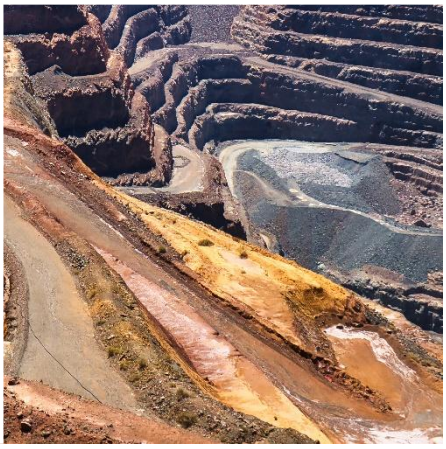
Date:	Drawn:	Checked:
02/03/2026	MK	JC
Project:	**Drawing No:**	**Revision**
PTG/04039	2	0

02



Appendix 2
Boreholes Logs





BOREHOLE 1

CLIENT: Salt Development
PROJECT: Proposed Subdivision
LOCATION: 98 Glenmore Drive, Bonogin
PROJECT NUMBER: PTG/04039
DRILLER: PTG Consulting **RIG:** 4WD Drill Rig

DATE: 05/02/2026
EASTING: 507454 m
NORTHING: 6935201 m
SURFACE ELEV:
LOGGED: JS **CHECKED:** TL

RL (m)	Depth (m)	Drilling Method	Graphic Log	Layer Depths	Material Description	Water	Strength (Consistency, Relative Density, Rock Strength)	Sampling & Testing: Type	Sampling & Testing: Results & Comments	Dynamic Penetrometer Test (blows per 100 mm)
				0	SM silty SAND, brown, medium dense, fine to coarse grained, moist (Topsoil)		Medium Dense			3
				0.2	CH sandy CLAY, light grey and light brown, stiff, high plasticity, fine to coarse grained sand, moist		Stiff			3
	0.5			0.4	- very stiff					5
							Very Stiff			3
				0.7	- hard			0.6 D 0.9		6
	1.0									6
										9
							Hard			10
	1.5			1.5	CI sandy CLAY, white light brown, stiff, medium plasticity, fine to coarse grained sand, moist			1.6 D 1.9		11
										12
	2.0									13
							Stiff			
	2.5									
	3.0			3	GW sandy GRAVEL, light brown, very dense, fine sized, fine to coarse grained sand, dry (extremely weathered sandstone)		Very Dense	3.2 D 3.4		
				3.3	SANDSTONE, light brown, very low strength, highly weathered		Very Low Strength			
	3.5				Bore terminated at 3.4 m. 4WD Drill Rig refusal on very low strength or stronger sandstone.					
	4.0									
	4.5									

Remarks:

PTG - BOREHOLE REPORT (NORMAL) PTG_04039.GPJ GINT.GPJ DRAFT.GDT 2/3/26

BOREHOLE 2

CLIENT: Salt Development
PROJECT: Proposed Subdivision
LOCATION: 98 Glenmore Drive, Bonogin
PROJECT NUMBER: PTG/04039
DRILLER: PTG Consulting **RIG:** 4WD Drill Rig

DATE: 05/02/2026
EASTING: 507464 m
NORTHING: 6935185 m
SURFACE ELEV:
LOGGED: JS **CHECKED:** TL

RL (m)	Depth (m)	Drilling Method	Graphic Log	Layer Depths	Material Description	Water	Strength (Consistency, Relative Density, Rock Strength)	Sampling & Testing: Type	Sampling & Testing: Results & Comments	Dynamic Penetrometer Test (blows per 100 mm)
	0.5			0	TOPSOIL - SM silty SAND, brown, medium dense, fine to coarse grained, moist		Medium Dense			5
				0.1	CH sandy CLAY, light brown mottled red grey, stiff, high plasticity, fine to coarse grained sand, moist					3
										3
										4
							Stiff			5
										5
				0.6	- light brown and light grey					4
										4
				0.8	- very stiff					6
	1.0									8
							Very Stiff			8
										6
										9
				1.3	- very stiff to hard					10
	1.5									11
										9
										9
										10
										12
	2.0									10
				2	pale grey					11
										12
	2.5						Very Stiff to Hard			
				2.5	light brown and yellow					
	3.0									
	3.5									
				3.6	GW sandy GRAVEL, light brown, dense, fine to medium gravel, fine to coarse grained sand, moist (Extremely weathered sandstone)		Dense			
				3.9	SANDSTONE, light brown, very low strength, highly weathered		Very Low Strength			
	4.0									
					Bore terminated at 4 m. 4WD Drill Rig refusal on very low strength or stronger sandstone.					
	4.5									

Remarks:

PTG - BOREHOLE REPORT (NORMAL) PTG_04039 GINT.GPJ DRAFT.GDT 2/3/26

BOREHOLE 3

CLIENT: Salt Development
PROJECT: Proposed Subdivision
LOCATION: 98 Glenmore Drive, Bonogin
PROJECT NUMBER: PTG/04039
DRILLER: PTG Consulting **RIG:** 4WD Drill Rig

DATE: 05/02/2026
EASTING: 507462 m
NORTHING: 6935174 m
SURFACE ELEV:
LOGGED: JS **CHECKED:** TL

RL (m)	Depth (m)	Drilling Method	Graphic Log	Layer Depths	Material Description	Water	Strength (Consistency, Relative Density, Rock Strength)	Sampling & Testing: Type	Sampling & Testing: Results & Comments	Dynamic Penetrometer Test (blows per 100 mm)
	0.5			0	TOPSOIL - SM Silty SAND, brown, dense, fine to coarse grained, moist		Medium Dense			3
				0.2	CI Sandy CLAY, light brown orange, stiff, medium plasticity, fine to coarse grained sand, moist		Stiff			3
				0.4	- pale brown, hard			0.4		4
								B		5
	1.0			1	SANDSTONE, light brown, very low strength, highly weathered		Hard	0.7		9
										11
										12
										14
							Very Low Strength			
	1.5				Bore terminated at 1.1 m. 4WD Drill Rig refusal on very low strength or stronger sandstone.					
	2.0									
	2.5									
	3.0									
	3.5									
	4.0									
	4.5									

Remarks:

PTG - BOREHOLE REPORT (NORMAL) PTG_04039.GPJ DRAFT.GDT 2/3/26

BOREHOLE 4

CLIENT: Salt Development
PROJECT: Proposed Subdivision
LOCATION: 98 Glenmore Drive, Bonogin
PROJECT NUMBER: PTG/04039
DRILLER: PTG Consulting **RIG:** 4WD Drill Rig

DATE: 05/02/2026
EASTING: 507459 m
NORTHING: 6935179 m
SURFACE ELEV:
LOGGED: JS **CHECKED:** TL

RL (m)	Depth (m)	Drilling Method	Graphic Log	Layer Depths	Material Description	Water	Strength (Consistency, Relative Density, Rock Strength)	Sampling & Testing: Type	Sampling & Testing: Results & Comments	Dynamic Penetrometer Test (blows per 100 mm)
				0	SM Silty SAND, brown, medium dense, fine to coarse grained, moist (top soil)		Medium Dense			6
				0.2	Cl Sandy CLAY, light brown yellow, stiff, medium plasticity, fine to coarse grained sand, moist		Stiff			3 2 3 5 7
	0.5			0.5	- very stiff		Very Stiff	0.6 D 0.9		9 11 12 14
	1.0			0.7	- hard		Hard			
	1.5			1.5	SANDSTONE, light brown, very low strength, highly weathered		Very Low Strength			
					Bore terminated at 1.6 m. 4WD Drill Rig refusal on very low strength or stronger sandstone.					
	2.0									
	2.5									
	3.0									
	3.5									
	4.0									
	4.5									

Remarks:

PTG - BOREHOLE REPORT (NORMAL) PTG_04039.GPJ DRAFT.GDT 2/3/26

BOREHOLE 5

CLIENT: Salt Development
PROJECT: Proposed Subdivision
LOCATION: 98 Glenmore Drive, Bonogin
PROJECT NUMBER: PTG/04039
DRILLER: PTG Consulting **RIG:** 4WD Drill Rig

DATE: 05/02/2026
EASTING: 507463 m
NORTHING: 6935181 m
SURFACE ELEV:
LOGGED: JS **CHECKED:** TL

RL (m)	Depth (m)	Drilling Method	Graphic Log	Layer Depths	Material Description	Water	Strength (Consistency, Relative Density, Rock Strength)	Sampling & Testing: Type	Sampling & Testing: Results & Comments	Dynamic Penetrometer Test (blows per 100 mm)
	0			0	SM Silty SAND, brown, medium dense, fine to coarse grained, moist (top soil)		Medium Dense			5
				0.1	CI sandy CLAY, yellow, very stiff, medium plasticity, fine to coarse grained sand, moist		Very Stiff	0.2		6
				0.2	- dense			D		9
	0.5			0.4	GW Sandy GRAVEL, light brown, very dense, fine sized, fine to coarse grained sand, dry (extremely weathered sandstone)		Very Dense	0.4		14
	1.0			1.1	SANDSTONE, light brown, very low strength, highly weathered					
					Bore terminated at 1.2 m. 4WD Drill Rig refusal on very low strength or stronger sandstone.					
	1.5									
	2.0									
	2.5									
	3.0									
	3.5									
	4.0									
	4.5									

Remarks:

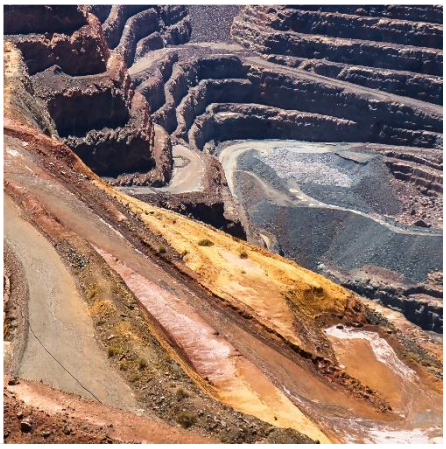
PTG - BOREHOLE REPORT (NORMAL) PTG_04039.GPJ DRAFT.GDT 2/3/26

03



Appendix 3
Laboratory Test Results





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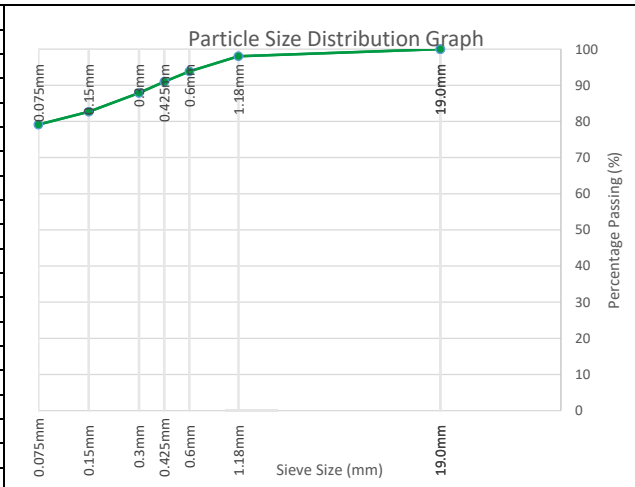
Material Quality Report

Client :	**SALT DEVELOPMENT SERVICES PTY LTD**	Report Number :	**SR/PTG/04039 - 1/1**
Client Address :	**Unit 31/41 Macadie Way, Merrimac, 4226, QLD**	Report Date :	**25/02/2026**
Project Name :	**98 Glenmore Drive, Bonogin**	Test Request :	**test**
Project Number :	**PTG/04039**	**Page 1 of 1**	
Location :	**98 Glenmore Drive, Bonogin, QLD, 4213**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1,AS1289.1.1,**
Material Description	**(CH) CLAY with Sand, High Plasticity, Grey, Mottled Brown, Moist**

Sample Number :	**S/339600**	Sampling Location :	**Random**
Date(s) Tested :	**09/02/2026 - 25/02/2026**	Sampling Method :	**As Received**
Material Source :	**insitu**	Date Sampled :	**9/02/2026**
Material Type :	**-**	Location 1 :	**Borehole 1**
Lot Number :	**-**	Location 2 :	**0.6 - 0.9 m**
		Location 3 :	**-**
PSD Specification Number :	**N/A**	Location 4 :	**-**
ATT Specification Number :	**N/A**		
Emerson Specification Number :	**N/A**		

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0		
37.5		
26.5		
19.0	**100**	
16		
13.2		
9.5		
6.7		
4.75		
2.36	**100**	
1.18	**98**	
0.600	**94**	
0.425	**91**	
0.300	**88**	
0.150	**83**	
0.075	**79**	
	-	



Atterberg Limits :	Test Methods:	Test Results :	Specification Limits :		Test Results :	Specifications Limits :
Liquid Limit (%) :	**AS1289.3.1.2**	**69**		WPI : Q252	**3930**	
Plastic Limit (%) :	**AS1289.3.2.1**	**25**		WLS : Q106	**1507**	
Plasticity Index (%) :	**AS1289.3.3.1**	**44**		FR : Q253	**0.87**	
Linear Shrinkage (%) :	**AS1289.3.4.1**	**16.5**		Linear Shrinkage Mould Length (mm):		**125**
Emerson Number :	-	-		-	-	

Notes :	**History of Sample: Oven Dried, Method of Preparation: Dry Sieved, Linear Shrinkage: Nil Occurred**
Pre-treatment (CAn) :	-
Pre-treatment (Wn) :	-
Mass Retained (R) :	-
Remarks :	

NATA
WORLD RECOGNISED ACCREDITATION

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Protest CMT (Gold Coast) Accreditation Number - 19667

Base Laboratory Site Number - 22838 - Gold Coast

Base Laboratory Address - 8/36 Blanck Street, Ormeau, 4208, QLD

APPROVED SIGNATORY

Joshua Andres - Signatory

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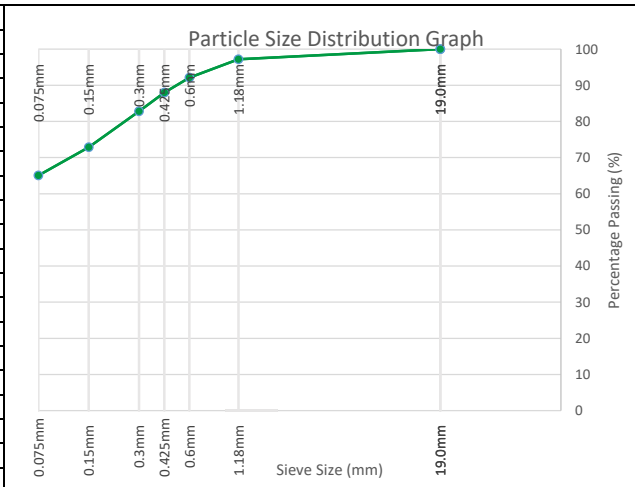
Material Quality Report

Client :	**SALT DEVELOPMENT SERVICES PTY LTD**	Report Number :	**SR/PTG/04039 - 2/1**
Client Address :	**Unit 31/41 Macadie Way, Merrimac, 4226, QLD**	Report Date :	**25/02/2026**
Project Name :	**98 Glenmore Drive, Bonogin**	Test Request :	**test**
Project Number :	**PTG/04039**	**Page 1 of 1**	
Location :	**98 Glenmore Drive, Bonogin, QLD, 4213**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1,AS1289.1.1,**
Material Description	**(CL) Sandy CLAY, Low Plasticity, Brown, Moist**

Sample Number :	**S/339601**	Sampling Location :	**Random**
Date(s) Tested :	**09/02/2026 - 25/02/2026**	Sampling Method :	**As Received**
Material Source :	**insitu**	Date Sampled :	**9/02/2026**
Material Type :	**-**	Location 1 :	**Borehole 1**
Lot Number :	**-**	Location 2 :	**1.5 - 1.9 m**
		Location 3 :	**-**
PSD Specification Number :	**N/A**	Location 4 :	**-**
ATT Specification Number :	**N/A**		
Emerson Specification Number :	**N/A**		

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0		
37.5		
26.5		
19.0	**100**	
16		
13.2		
9.5		
6.7		
4.75		
2.36	**100**	
1.18	**97**	
0.600	**92**	
0.425	**88**	
0.300	**83**	
0.150	**73**	
0.075	**65**	
	-	



Atterberg Limits :	Test Methods:	Test Results :	Specification Limits :		Test Results :	Specifications Limits :
Liquid Limit (%) :	**AS1289.3.1.2**	**30**		WPI : Q252	**1239**	
Plastic Limit (%) :	**AS1289.3.2.1**	**16**		WLS : Q106	**683**	
Plasticity Index (%) :	**AS1289.3.3.1**	**14**		FR : Q253	**0.74**	
Linear Shrinkage (%) :	**AS1289.3.4.1**	**8**		Linear Shrinkage Mould Length (mm):		**123**
Emerson Number :	-	-		-	-	

Notes :	**History of Sample: Oven Dried, Method of Preparation: Dry Sieved, Linear Shrinkage: Nil Occurred**
Pre-treatment (CAn) :	-
Pre-treatment (Wn) :	-
Mass Retained (R) :	-
Remarks :	

NATA
WORLD RECOGNISED ACCREDITATION

Note: The results contained in this report relate only to the item/s that were tested/sampled

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Protest CMT (Gold Coast) Accreditation Number - 19667

Base Laboratory Site Number - 22838 - Gold Coast

Base Laboratory Address - 8/36 Blanck Street, Ormeau, 4208, QLD

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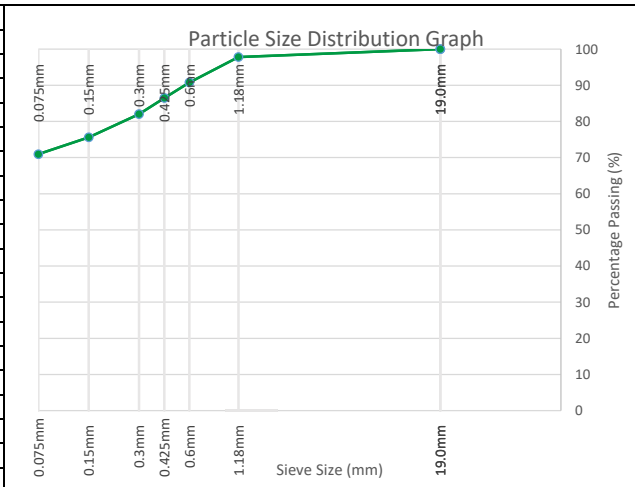
Material Quality Report

Client :	**SALT DEVELOPMENT SERVICES PTY LTD**	Report Number :	**SR/PTG/04039 - 3/1**
Client Address :	**Unit 31/41 Macadie Way, Merrimac, 4226, QLD**	Report Date :	**25/02/2026**
Project Name :	**98 Glenmore Drive, Bonogin**	Test Request :	**test**
Project Number :	**PTG/04039**	**Page 1 of 1**	
Location :	**98 Glenmore Drive, Bonogin, QLD, 4213**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1,AS1289.1.1,**
Material Description	**(CI) CLAY with Sand, Medium Plasticity, Brown, Mottled Grey, Moist**

Sample Number :	**S/339602**	Sampling Location :	**Random**
Date(s) Tested :	**09/02/2026 - 25/02/2026**	Sampling Method :	**As Received**
Material Source :	**insitu**	Date Sampled :	**9/02/2026**
Material Type :	**-**	Location 1 :	**Borehole 3**
Lot Number :	**-**	Location 2 :	**0.4 - 0.7 m**
		Location 3 :	**-**
PSD Specification Number :	**N/A**	Location 4 :	**-**
ATT Specification Number :	**N/A**		
Emerson Specification Number :	**N/A**		

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0		
37.5		
26.5		
19.0	**100**	
16		
13.2		
9.5		
6.7		
4.75		
2.36	**100**	
1.18	**98**	
0.600	**91**	
0.425	**86**	
0.300	**82**	
0.150	**76**	
0.075	**71**	
	-	



Atterberg Limits :	Test Methods:	Test Results :	Specification Limits :		Test Results :	Specifications Limits :
Liquid Limit (%) :	**AS1289.3.1.2**	**38**		WPI : Q252	**1923**	
Plastic Limit (%) :	**AS1289.3.2.1**	**16**		WLS : Q106	**904**	
Plasticity Index (%) :	**AS1289.3.3.1**	**22**		FR : Q253	**0.82**	
Linear Shrinkage (%) :	**AS1289.3.4.1**	**10.5**		Linear Shrinkage Mould Length (mm):		**128**
Emerson Number :	-	-		-	-	

Notes :	**History of Sample: Oven Dried, Method of Preparation: Dry Sieved, Linear Shrinkage: Nil Occurred**
Pre-treatment (CAn) :	-
Pre-treatment (Wn) :	-
Mass Retained (R) :	-
Remarks :	

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Note: The results contained in this report relate only to the item/s that were tested/sampled

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Protest CMT (Gold Coast) Accreditation Number - 19667

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California Bearing Ratio Report

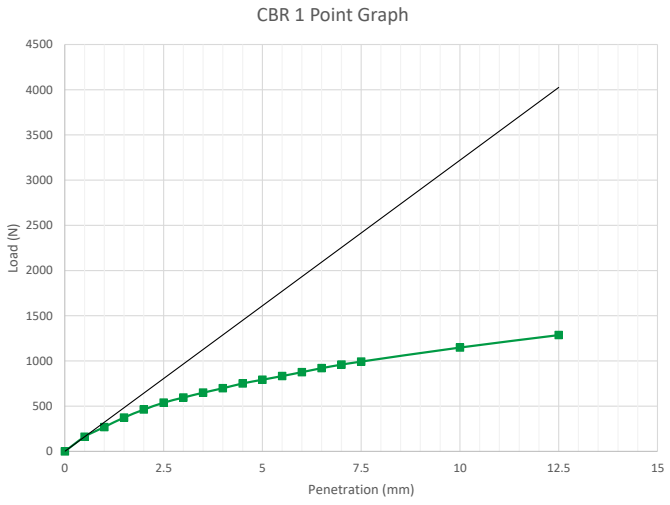
Client :	**SALT DEVELOPMENT SERVICES PTY LTD**	Report Number :	**SR/PTG/04039 - 4/1**
Client Address :	**Unit 31/41 Macadie Way, Merrimac, 4226, QLD**	Report Date :	**25/02/2026**
Project Name :	**98 Glenmore Drive, Bonogin**	Test Request :	**test**
Project Number :	**PTG/04039**	**Page 1 of 1**	
Location :	**98 Glenmore Drive, Bonogin, QLD, 4213**		

Test Methods :	**AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1**
Material Description :	**(CI) CLAY with Sand, Medium Plasticity, Brown, Mottled Grey, Moist**

Sample Number :	**S/339602**	Sampling Location :	**Random**
Date(s) Tested :	**09/02/2026 - 25/02/2026**	Sampling Method :	**As Received**
Material Source :	**insitu**	Time :	**00:00**
For Use As :	-	Location 1 :	**Borehole 3**
Lot Number :	-	Location 2 :	**0.4 - 0.7 m**
Specification (CBR Value) :	-	Location 3 :	-
		Location 4 :	-

MDD (t/m³) : **1.69**	Nominated % of MDD : **100.0%**	Target Dry Density (t/m³) : **1.69**	Achieved % of MDD : **100.0%**
OMC (%) : **17.2**	Nominated % of OMC : **100.0%**	Target Moisture Content (%) : **17.2**	Achieved % of OMC : **100.0%**

Compactive Effort :	**Standard**
Dry Density Before Soak (t/m³) :	**1.69**
Dry Density After Soak (t/m³) :	**1.65**
Field Moisture Content (%) :	**10.0%**
Compaction Moisture Content (%) :	**17.2%**
After Penetration - Top Moisture (%) :	**20.2%**
After Penetration - Total Moisture (%) :	**19.1%**
Period of Soaking (Days) :	**4**
Mass of Surcharge (kg) :	**4.5**
Oversize (%) :	**0.0%**
Oversize Included :	**Excluded**
Method of Determining Plasticity :	**Tactile/Visual Assessment**
CBR Sample Curing Time :	**51 Hours**
-	-
-	-
Swell (%) :	**2.0%**
CBR Value at 2.5mm :	**4.0%**



Pre-treatment (CAn) :	-
Pre-treatment (Wn) :	-
Mass Retained (R) :	-

Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

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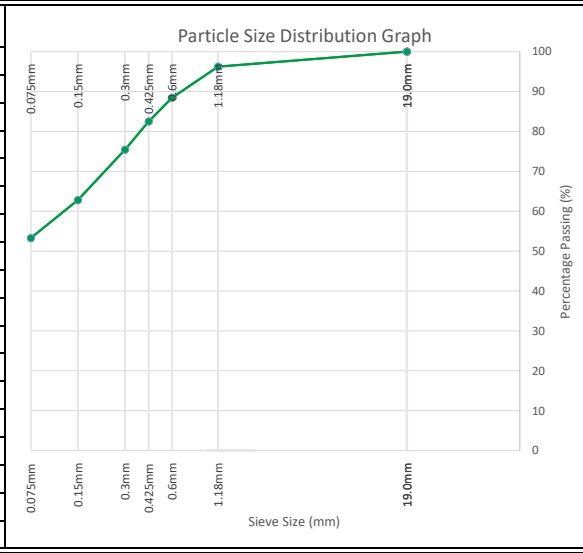
Particle Size Distribution Report

Client :	**SALT DEVELOPMENT SERVICES PTY LTD**	Report Number :	**SR/PTG/04039 - 5/1**
Client Address :	**Unit 31/41 Macadie Way, Merrimac, 4226, QLD**	Report Date :	**25/02/2026**
Project Name :	**98 Glenmore Drive, Bonogin**	Test Request :	**test**
Project Number :	**PTG/04039**	**Page 1 of 1**	
Location :	**98 Glenmore Drive, Bonogin, QLD, 4213**		

Test Methods :	**AS1289.3.6.1, AS1289.2.1.1,**
Material Description	**(CI) Sandy CLAY, Medium Plasticity, Brown, Moist**

Sample Number :	**S/339603**	Sampling Location :	**Random**
Date(s) Tested :	**09/02/2026 - 25/02/2026**	Sampling Method :	**As Received**
Material Source :	**insitu**	Time :	**00:00**
For Use As :	-	Location 1 :	**Borehole 5**
Lot Number :	-	Location 2 :	**0.2 - 0.4 m**
		Location 3 :	-
PSD Specification Number :	**N/A**	Location 4 :	-

AS Sieve Size (mm) :	Percent Passing (%) :	Specification Limits :
75.0		
63.0		
53.0		
37.5		
26.5		
19.0	**100**	
16		
13.2		
9.5		
6.7		
4.75		
2.36	**100**	
1.18	**96**	
0.600	**88**	
0.425	**83**	
0.300	**75**	
0.150	**63**	
0.075	**53**	



Moisture Content (%) :	**4.8**
Remarks :	-

Note: The results contained in this report relate only to the item/s that were tested/sampled

Accredited for Compliance with ISO/ IEC 17025 - Testing

Protest CMT (Gold Coast) Accreditation Number - 19667

Base Laboratory Site Number - 22838 - Gold Coast

Base Laboratory Address - 8/36 Blanck Street, Ormeau, 4208, QLD

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04



Appendix 4
Landslide Susceptibility Analysis



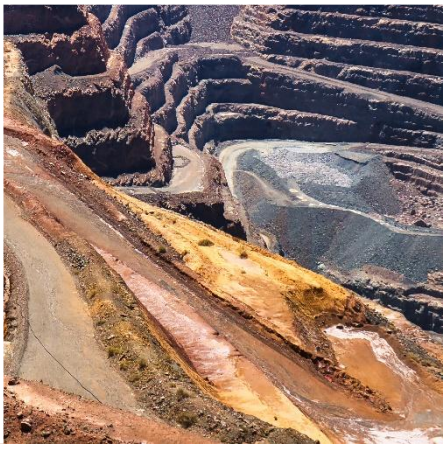


Table 15: Landslide Susceptibility Analysis – Proposed Lot - Existing

1. Natural Slope Angle	Level	Factor
Less than 5°	L	0.1
Between 5° & 15°	M	0.5
Between 15° & 30°	M	0.8
Between 30° & 45°	H	1.2
More than 45^0	M	0.8

2. Slope Shape	Level	Factor
Crest or Ridge	L	0.7
Planar/Convex	M	0.9
Rough/Irregular	H	1.2
Concave	H	1.5

3. Site Geology	Level	Factor
Volcanic Extrusive rock	H	1.1
Sedimentary rock	M	1.0
Low grade metamorphic rock	M	1.0
High grade metamorphic rock	L	0.9
Volcanic Intrusive rock	M	1.0

4. Soils	Level	Factor
Rock at surface	VL	0.1
Residual soil <1m deep	L	0.5
Residual soil 1-3m deep	M	0.9
Residual soil >3m deep	H	1.5
Colluvial soil <1m deep	H	1.5
Colluvial soil 1-3m deep	VH	2.0
Colluvial soil >3m deep	VH	4.0

5. Fill Height	Level	Factor
None	L	0.9
Less than 1m	M	1.1
Between 1m & 3m	M	1.3
Between 3m & 6m	H	1.7
More than 6m	VH	2.5

6. Evidence of Groundwater	Level	Factor
Non-apparent	L	0.7
Minor moistness	M	0.9
Generally wet	H	1.5
Surface springs	VH	3.0

7. Cut Height	Level	Factor
None (proceed to section 11)	L	0.9
Less than 1m	M	1.1
Between 1m and 3m	M	1.3
Between 3m and 6m	H	1.7
More than 6m	VH	2.5

8. Slope of Cut Face	Level	Factor
Less than 30°	L	0.5
Between 30° and 45°	M	1.0
Between 45° and 60°	H	1.5
More than 60^0	VH	3.0

9. Material in Cutting	Level	Factor
High strength rock	L	0.5
Medium strength rock	L	1.0
Low strength rock	M	1.2
Very low strength rock and soil	H	1.5
Soil	VH	2.0

10. Cut Slope Support	Level	Factor
Concrete Wall	L	0.5
Crib Wall	M	0.9
Gabion Wall	M	1.0
Rock Wall	H	1.5
Unsupported	H	2.0

11. Concentration of Surface Water	Level	Factor
Ridge	L	0.7
Crest	M	0.8
Upper Slope	M	0.9
Mid Slope	H	1.2
Lower Slope	H	1.5

12. Wastewater Disposal	Level	Factor
Fully Sewered	M	1.0
Onsite disposal – Surface	M	1.2
Onsite disposal – Soak pit / trenches	H	1.5

13. Stormwater Disposal	Level	Factor
All stormwater piped into road drainage	L	0.7
Rainwater tank with overflows	M	1.0
Stormwater discharge on site	H	1.5

14. Evidence of Instability	Level	Factor
No sign of instability	L	0.8
Soil Creep	H	1.2
Minor irregularity	VH	2.0
Major irregularity	VH	5.0
Active instability	VH	10.0

Summary	Factor
1. Natural Slope Angle	0.5
2. Slope Shape	0.9
3. Site Geology	1
4. Soils	0.9
5. Fill Height	0.9
6. Evidence of Groundwater	0.7
7. Cut Height	0.9
8. Slope of Cut Face	n/a
9. Material in Cutting	n/a
10. Cut Slope Support	n/a
11. Concentration of Surface Water	0.8
12. Wastewater Disposal	n/a
13. Stormwater Disposal	1.5
14. Evidence of Instability	0.8
Relative Susceptibility (1x2x3x4x6x7x9x10x11x12x13x14)	0.22

Note:
The analysis values applicable to the site assessment are shown in the grey shaded cells.
Where a susceptibility factor has been considered not applicable, a factor rating of 1.0 has been applied.

Table 16: Landslide Susceptibility Analysis – Proposed Lot with Cut Earthworks (between 1-3m)

1. Natural Slope Angle	Level	Factor
Less than 5°	L	0.1
Between 5° & 15°	M	0.5
Between 15° & 30°	M	0.8
Between 30° & 45°	H	1.2
More than 45^0	M	0.8

2. Slope Shape	Level	Factor
Crest or Ridge	L	0.7
Planar/Convex	M	0.9
Rough/Irregular	H	1.2
Concave	H	1.5

3. Site Geology	Level	Factor
Volcanic Extrusive rock	H	1.1
Sedimentary rock	M	1.0
Low grade metamorphic rock	M	1.0
High grade metamorphic rock	L	0.9
Volcanic Intrusive rock	M	1.0

4. Soils	Level	Factor
Rock at surface	VL	0.1
Residual soil <1m deep	L	0.5
Residual soil 1-3m deep	M	0.9
Residual soil >3m deep	H	1.5
Colluvial soil <1m deep	H	1.5
Colluvial soil 1-3m deep	VH	2.0
Colluvial soil >3m deep	VH	4.0

5. Fill Height	Level	Factor
None	L	0.9
Less than 1m	M	1.1
Between 1m & 3m	M	1.3
Between 3m & 6m	H	1.7
More than 6m	VH	2.5

6. Evidence of Groundwater	Level	Factor
Non-apparent	L	0.7
Minor moistness	M	0.9
Generally wet	H	1.5
Surface springs	VH	3.0

7. Cut Height	Level	Factor
None (proceed to section 11)	L	0.9
Less than 1m	M	1.1
Between 1m and 3m	M	1.3
Between 3m and 6m	H	1.7
More than 6m	VH	2.5

8. Slope of Cut Face	Level	Factor
Less than 30°	L	0.5
Between 30° and 45°	M	1.0
Between 45° and 60°	H	1.5
More than 60^0	VH	3.0

9. Material in Cutting	Level	Factor
High strength rock	L	0.5
Medium strength rock	L	1.0
Low strength rock	M	1.2
Very low strength rock and soil	H	1.5
Soil	VH	2.0

10. Cut Slope Support	Level	Factor
Concrete Wall	L	0.5
Crib Wall	M	0.9
Gabion Wall	M	1.0
Rock Wall	H	1.5
Unsupported	H	2.0

11. Concentration of Surface Water	Level	Factor
Ridge	L	0.7
Crest	M	0.8
Upper Slope	M	0.9
Mid Slope	H	1.2
Lower Slope	H	1.5

12. Wastewater Disposal	Level	Factor
Fully Sewered	M	1.0
Onsite disposal – Surface	M	1.2
Onsite disposal – Soak pit / trenches	H	1.5

13. Stormwater Disposal	Level	Factor
All stormwater piped into road drainage	L	0.7
Rainwater tank with overflows	M	1.0
Stormwater discharge on site	H	1.5

14. Evidence of Instability	Level	Factor
No sign of instability	L	0.8
Soil Creep	H	1.2
Minor irregularity	VH	2.0
Major irregularity	VH	5.0
Active instability	VH	10.0

Summary	Factor
1. Natural Slope Angle	0.5
2. Slope Shape	0.9
3. Site Geology	1
4. Soils	0.9
5. Fill Height	0.9
6. Evidence of Groundwater	0.7
7. Cut Height	1.3
8. Slope of Cut Face	3
9. Material in Cutting	2.0
10. Cut Slope Support	0.5
11. Concentration of Surface Water	0.8
12. Wastewater Disposal	1.5
13. Stormwater Disposal	1.5
14. Evidence of Instability	0.8
Relative Susceptibility (1x2x3x4x5x6x7x8x9x10x11x12x13x14)	1.43

Note:
The analysis values applicable to the site assessment are shown in the grey shaded cells.
Where a susceptibility factor has been considered not applicable, a factor rating of 1.0 has been applied.

Table 17: Landslide Susceptibility Analysis – Proposed Lot with Cut and Fill Earthworks (between 1-3m)

1. Natural Slope Angle	Level	Factor
Less than 5°	L	0.1
Between 5° & 15°	M	0.5
Between 15° & 30°	M	0.8
Between 30° & 45°	H	1.2
More than 45^0	M	0.8

2. Slope Shape	Level	Factor
Crest or Ridge	L	0.7
Planar/Convex	M	0.9
Rough/Irregular	H	1.2
Concave	H	1.5

3. Site Geology	Level	Factor
Volcanic Extrusive rock	H	1.1
Sedimentary rock	M	1.0
Low grade metamorphic rock	M	1.0
High grade metamorphic rock	L	0.9
Volcanic Intrusive rock	M	1.0

4. Soils	Level	Factor
Rock at surface	VL	0.1
Residual soil <1m deep	L	0.5
Residual soil 1-3m deep	M	0.9
Residual soil >3m deep	H	1.5
Colluvial soil <1m deep	H	1.5
Colluvial soil 1-3m deep	VH	2.0
Colluvial soil >3m deep	VH	4.0

5. Fill Height	Level	Factor
None	L	0.9
Less than 1m	M	1.1
Between 1m & 3m	M	1.3
Between 3m & 6m	H	1.7
More than 6m	VH	2.5

6. Evidence of Groundwater	Level	Factor
Non-apparent	L	0.7
Minor moistness	M	0.9
Generally wet	H	1.5
Surface springs	VH	3.0

7. Cut Height	Level	Factor
None (proceed to section 11)	L	0.9
Less than 1m	M	1.1
Between 1m and 3m	M	1.3
Between 3m and 6m	H	1.7
More than 6m	VH	2.5

8. Slope of Cut Face	Level	Factor
Less than 30°	L	0.5
Between 30° and 45°	M	1.0
Between 45° and 60°	H	1.5
More than 60^0	VH	3.0

9. Material in Cutting	Level	Factor
High strength rock	L	0.5
Medium strength rock	L	1.0
Low strength rock	M	1.2
Very low strength rock and soil	H	1.5
Soil	VH	2.0

10. Cut Slope Support	Level	Factor
Concrete Wall	L	0.5
Crib Wall	M	0.9
Gabion Wall	M	1.0
Rock Wall	H	1.5
Unsupported	H	2.0

11. Concentration of Surface Water	Level	Factor
Ridge	L	0.7
Crest	M	0.8
Upper Slope	M	0.9
Mid Slope	H	1.2
Lower Slope	H	1.5

12. Wastewater Disposal	Level	Factor
Fully Sewered	M	1.0
Onsite disposal – Surface	M	1.2
Onsite disposal – Soak pit / trenches	H	1.5

13. Stormwater Disposal	Level	Factor
All stormwater piped into road drainage	L	0.7
Rainwater tank with overflows	M	1.0
Stormwater discharge on site	H	1.5

14. Evidence of Instability	Level	Factor
No sign of instability	L	0.8
Soil Creep	H	1.2
Minor irregularity	VH	2.0
Major irregularity	VH	5.0
Active instability	VH	10.0

Summary	Factor
1. Natural Slope Angle	0.5
2. Slope Shape	0.9
3. Site Geology	1
4. Soils	0.9
5. Fill Height	1.3
6. Evidence of Groundwater	0.7
7. Cut Height	1.3
8. Slope of Cut Face	3
9. Material in Cutting	2.0
10. Cut Slope Support	0.5
11. Concentration of Surface Water	0.8
12. Wastewater Disposal	1.5
13. Stormwater Disposal	1.5
14. Evidence of Instability	0.8
Relative Susceptibility (1x2x3x4x6x7x9x10x11x12x13x14)	2.07

Note:
The analysis values applicable to the site assessment are shown in the grey shaded cells.
Where a susceptibility factor has been considered not applicable, a factor rating of 1.0 has been applied.

Table 18: Landslide Susceptibility Analysis – Proposed Lot with Cut and Fill Earthworks (Cut 1-3m; Fill <1m)

1. Natural Slope Angle	Level	Factor
Less than 5°	L	0.1
Between 5° & 15°	M	0.5
Between 15° & 30°	M	0.8
Between 30° & 45°	H	1.2
More than 45^0	M	0.8

2. Slope Shape	Level	Factor
Crest or Ridge	L	0.7
Planar/Convex	M	0.9
Rough/Irregular	H	1.2
Concave	H	1.5

3. Site Geology	Level	Factor
Volcanic Extrusive rock	H	1.1
Sedimentary rock	M	1.0
Low grade metamorphic rock	M	1.0
High grade metamorphic rock	L	0.9
Volcanic Intrusive rock	M	1.0

4. Soils	Level	Factor
Rock at surface	VL	0.1
Residual soil <1m deep	L	0.5
Residual soil 1-3m deep	M	0.9
Residual soil >3m deep	H	1.5
Colluvial soil <1m deep	H	1.5
Colluvial soil 1-3m deep	VH	2.0
Colluvial soil >3m deep	VH	4.0

5. Fill Height	Level	Factor
None	L	0.9
Less than 1m	M	1.1
Between 1m & 3m	M	1.3
Between 3m & 6m	H	1.7
More than 6m	VH	2.5

6. Evidence of Groundwater	Level	Factor
Non-apparent	L	0.7
Minor moistness	M	0.9
Generally wet	H	1.5
Surface springs	VH	3.0

7. Cut Height	Level	Factor
None (proceed to section 11)	L	0.9
Less than 1m	M	1.1
Between 1m and 3m	M	1.3
Between 3m and 6m	H	1.7
More than 6m	VH	2.5

8. Slope of Cut Face	Level	Factor
Less than 30°	L	0.5
Between 30° and 45°	M	1.0
Between 45° and 60°	H	1.5
More than 60^0	VH	3.0

9. Material in Cutting	Level	Factor
High strength rock	L	0.5
Medium strength rock	L	1.0
Low strength rock	M	1.2
Very low strength rock and soil	H	1.5
Soil	VH	2.0

10. Cut Slope Support	Level	Factor
Concrete Wall	L	0.5
Crib Wall	M	0.9
Gabion Wall	M	1.0
Rock Wall	H	1.5
Unsupported	H	2.0

11. Concentration of Surface Water	Level	Factor
Ridge	L	0.7
Crest	M	0.8
Upper Slope	M	0.9
Mid Slope	H	1.2
Lower Slope	H	1.5

12. Wastewater Disposal	Level	Factor
Fully Sewered	M	1.0
Onsite disposal – Surface	M	1.2
Onsite disposal – Soak pit / trenches	H	1.5

13. Stormwater Disposal	Level	Factor
All stormwater piped into road drainage	L	0.7
Rainwater tank with overflows	M	1.0
Stormwater discharge on site	H	1.5

14. Evidence of Instability	Level	Factor
No sign of instability	L	0.8
Soil Creep	H	1.2
Minor irregularity	VH	2.0
Major irregularity	VH	5.0
Active instability	VH	10.0

Summary	Factor
1. Natural Slope Angle	0.5
2. Slope Shape	0.9
3. Site Geology	1
4. Soils	0.9
5. Fill Height	1.1
6. Evidence of Groundwater	0.7
7. Cut Height	1.3
8. Slope of Cut Face	3
9. Material in Cutting	2.0
10. Cut Slope Support	0.5
11. Concentration of Surface Water	0.8
12. Wastewater Disposal	1.5
13. Stormwater Disposal	1.5
14. Evidence of Instability	0.8
Relative Susceptibility (1x2x3x4x6x7x9x10x11x12x13x14)	1.75

Note:
The analysis values applicable to the site assessment are shown in the grey shaded cells.
Where a susceptibility factor has been considered not applicable, a factor rating of 1.0 has been applied.

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Appendix 5
Relative Susceptibility Correlation



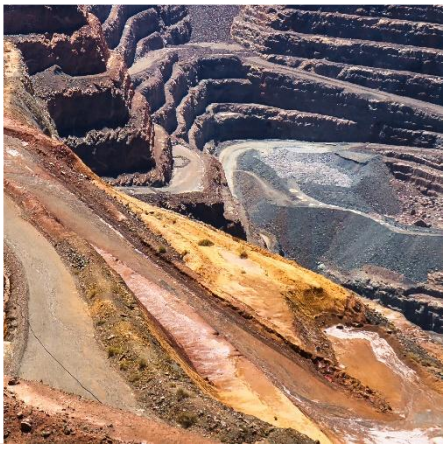


Table 19: Relative Landslide Susceptibility Value and Landslide Susceptibility ***Rating***

Relative Landslide Susceptibility Value	Landslide Susceptibility Rating
Less than 0.2	Very Low
0.2 – 0.6	Low
0.6 – 2.0	Moderate
2.0 – 6.0	High
Greater than 6.0	Very High

Risk ratings and their implications are described in Table 20 as sourced from the AGS 2007 Guidelines.

Table 20: Implications of Risk Ratings

Risk Rating	Implications
Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
Moderate	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
Low	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
Very Low	Acceptable. Manage by normal slope maintenance procedures.

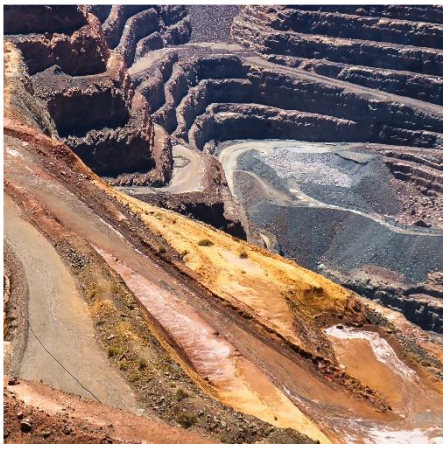
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Appendix 6

AGS Hillside and Effluent Guidelines

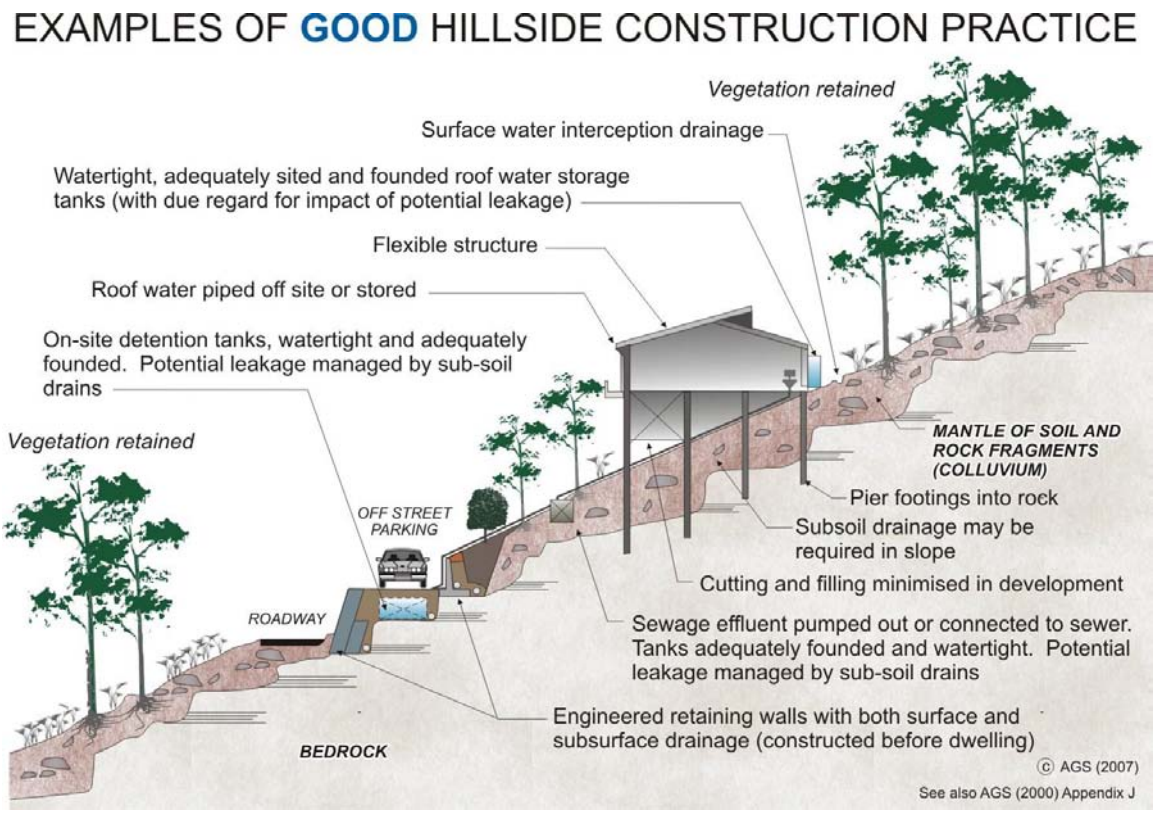




AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

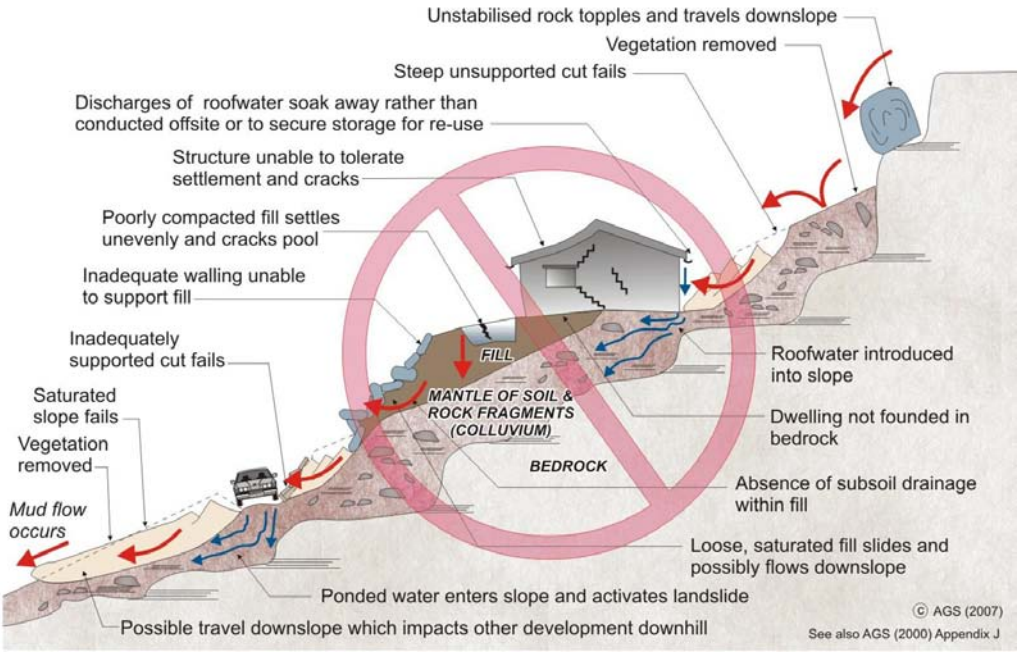
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF **POOR** HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

AUSTRALIAN GEOGUIDE LR9 (EFFLUENT DISPOSAL)

EFFLUENT AND SURFACE WATER DISPOSAL

EFFLUENT AND WASTEWATER

All households generate effluent and wastewater. The disposal of these products and their impact on the environment are key considerations in the planning of safe and sustainable communities. Cities and townships generally have reticulated water, sewer and stormwater systems, which are designed to deliver water and dispose of effluent and wastewater with minimal impact on the environment. However, many smaller communities and metropolitan fringe suburbs throughout Australia are un-sewered. Some of these are located in hillside or coastal settings where landslides present a hazard.

Processes by which wastewater can affect slope stability

As explained in GeoGuides LR3 and LR5, groundwater variations have a significant impact on slope stability. Inappropriate disposal of effluent and wastewater may result in the ground becoming saturated. The result is equivalent to a localised rise of the groundwater table and may have the potential to cause a landslide (GeoGuides LR2, LR5 and LR8).

On-site effluent disposal

In un-sewered areas disposal of effluent must be achieved through suitable methods. These methods usually involve containment within the boundaries of the site ("on-site disposal"). State environment protection agencies and local government authorities can usually provide advice on suitable disposal systems for your area. Such systems may include:

- *Septic systems,* which involve a storage/digestion tank for solids, with disposal of the liquid effluent via absorption trenches and beds, leach drains, or soak wells. Such systems are best suited to areas not prone to landslides.
- *Aerobic treatment units* which incorporate an individual household treatment plant to aid breakdown of the waste into a higher quality effluent. Such effluent is further treated and disposed of by surface or sub-surface irrigation, sub-soil dripper, or shallow leach drain system.
- *Nutrient retentive leaching systems* which utilise septic tanks to process the solid and liquid wastes in conjunction with discharge of the effluent through sand filters, media filters, mound systems and nutrient retentive leaching systems, which strip the effluent of nutrients.

Toilet (and sometimes kitchen) waste is known as *black water.* Other, less contaminated, wastewater streams from showers, baths and laundries are known as *grey water*. *Grey water re-use systems* allow a household to conserve water from bathrooms, kitchens and laundries, for re-use on gardens and lawns.

Recommendations for effluent disposal

In areas prone to landslide hazard, it is recommended that whatever effluent disposal system is employed, it should be designed by a qualified professional, familiar with how such a system can impact on the local environment. Local council, and in some instances state environment protection agency, approval is usually required as well. Many local authorities require a site assessment report, which covers all relevant issues. If approved, the report's recommendations must be incorporated in the system design. Reduction in the volume of effluent is beneficial so composting toilets and highly rated (i.e. low consumption) water appliances are recommended. It should be noted that in some state and local government jurisdictions there are restrictions on the alternative measures that can be applied. Consideration should be given to applying treated wastewater to land at low rates and over as large an area as possible. Further guidance can be found in Australian Standard AS/NZS 1547:2000 On-site domestic wastewater management.

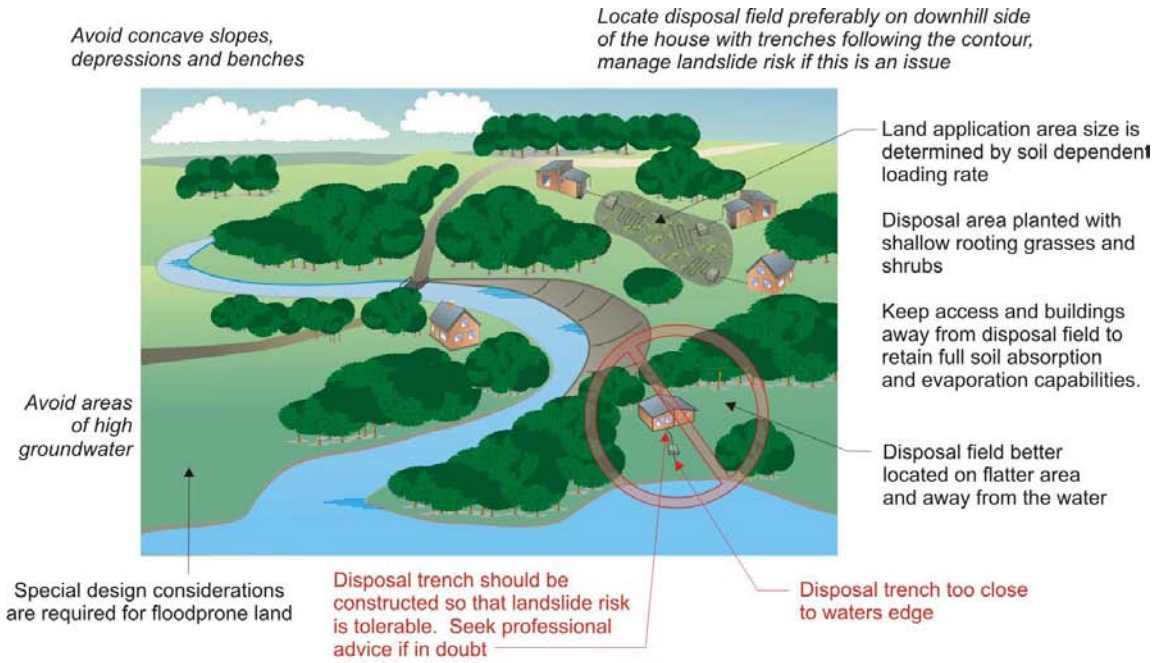
Effluent disposal fields should be sited with due consideration to the overall landscape and the individual characteristics of the property. Some guidance is provided. In particular, effluent fields should be located downslope of the building, away from stormwater, or *grey water*, discharge areas and where there is minimal potential for downstream pollution. Set backs and buffer distances vary from state to state and local requirements should be adhered to. All systems require regular maintenance and inspection. Efficient operation of the system must be a priority for property owners/occupiers to ensure safe and sustainable communities. Responsibility for maintenance rests with owners.

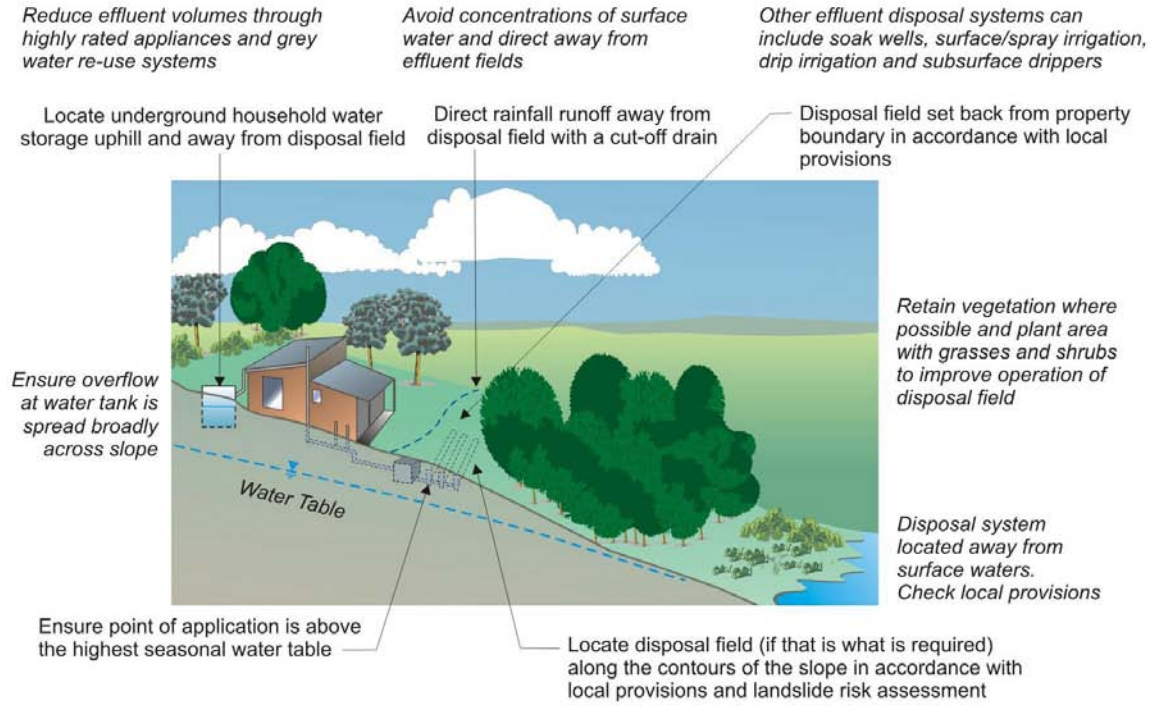
SURFACE WATER DRAINAGE

Attention to on-site surface water management is also important. Runoff from developments, including buildings, decks, access tracks and hardstand areas should be collected and discharged away from the development and other effluent disposal fields. Particular care must be given to the design of overflows on water tanks, as this is often overlooked. Discharge from any development should be spread out as much as possible, unless it can be directed to an existing natural water course. Ponding of water on hillsides and the concentration of water flows on slopes must be avoided.

It is recommended that a specific drainage plan and strategy should be developed in conjunction with the effluent disposal system for sites with a high potential for slope instability. Maintenance of the surface water drainage system is as important as maintenance of the effluent disposal system and again the responsibility rests with owners.

AUSTRALIAN GEOGUIDE LR9 (EFFLUENT DISPOSAL)





Note: Adapted from EPA Vic. Publication 451 (March 1996) "Code of Practice - Septic Tanks", which was sourced from Vic. Department of Planning and Loddon-Campaspe Regional Planning Authority.

More information relevant to your particular situation may be found in other Australian GeoGuides:

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