SOIL SURVEYS

GEOTECHNICAL INVESTIGATION

PROJECT NO. 1-24684

NOVEMBER, 2021

CENTRE STORE PROPERTIES TRUST

PROPOSED STORAGE FACILITY &
RETAIL DEVELOPMENT

1 HOMESTEAD DRIVE, JIMBOOMBA

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1.0 INTRODUCTION

1.1 General

This report presents the results of the geotechnical investigation carried out by Soil Surveys Engineering Pty Limited on the 26th November and 8th December, 2021 for the Proposed Storage Facility & Retail Development, at 1 Homestead Drive, Jimboomba.

The report was carried out following authorisation from Brayden Larkin of Centre Store Properties Trust on 22nd November, 2021.

The objectives of this investigation were to assess subsurface conditions at the site in accordance with the Scope of Services detailed in Section 1.3.

1.2 Proposed Development

It is understood that the proposed development is to consist of the construction of a Proposed Storage Facility & Retail Development at the above site.

The proposed building (Stage 1) is an 'L' shaped building approx. 70m x 60m and of two suspended levels and an on grade ground floor.

Building loads have not been provided but based on the provided drawings/information and similar structures on other sites, it is expected that maximum column loads of the order of 1,000kN to 1,200kN would apply. This would need to be confirmed.

The Stage 2 building is roughly 30m x 20m in footprint. Building details are unknown.

General earthworks are expected to be minor (cuts and fills of < 0.5m) over the majority of the site, however excavation into the rear batter may be required. Provided drawings indicate this will be of the order of up to 2m (maximum).

1.3 Scope of Geotechnical Services

The scope of geotechnical services provided by Soil Surveys Engineering Pty Limited was directed towards evaluating the following items as detailed in our proposal 1-24684, 2021-11-17, PR VER 2, dated 19th November, 2021:-

- Investigation of the subsurface profile at the proposed building location and the pavement area by drilling, sampling and in-situ testing with twelve boreholes.
- Laboratory testing on selected samples to assess the material parameters of the subsurface material.
- Engineering analysis of site investigation and laboratory test results to evaluate:-
    - Civil works recommendations
        - Trafficability
        - Excavatability
        - Earthworks recommendations
        - Batter recommendations
    - Foundation recommendations
        - Site classification according to AS 2870 (i.e. Reactivity)

  - Site classification according to AS 1170.4 (Earthquake)
  - Footing options and parameters
- Retaining wall design parameters
- Pavement design parameters (CBR)
- Construction recommendations (where applicable)
- Site management recommendations

2.0 GEOTECHNICAL INVESTIGATION

2.1 Field Investigation

Subsurface conditions at the site were investigated by the drilling and sampling of twelve boreholes to depths of between 0.8m (BH09 and BH10) and 4.4m (BH03), using EVH1750 and a Jacro 105 4WD mounted drilling rigs.

All boreholes terminated at 'TC' bit refusal. In addition, dynamic cone penetrometer tests were carried out adjacent to each of the boreholes.

Additional three DCP's (DCP1 to DCP3) were undertaken up the embankment to the north of the site.

The description of the materials encountered in the field investigation is subjective, based on the experience and judgement of the rig/site supervisor and some variations in the description, from the actual material type may occur.

The soil classification descriptions, field and laboratory testing were carried out in general accordance with the following Australian Standards:-

- AS 1726 Geotechnical Site Investigations
- AS 1289 Methods of Testing Soils for Engineering Purposes

Notes relating to this report, borehole records and a site plan showing the location of the boreholes are included in the Appendices.

2.2 Site Description

The site is situated at 1 Homestead Drive, Jimboomba (refer Figure 1).

Access onto the site was off Commercial Circuit.

The site is generally square in shape with:-

- A rail line to the west
- Adjoining site to the east (McDonalds)
- An adjoining site along a portion of the southern boundary (vacant) with Commercial Circuit for remainder.
- Homestead Drive on top an embankment to the north.

At the time of the investigation, the site was free of any structures.

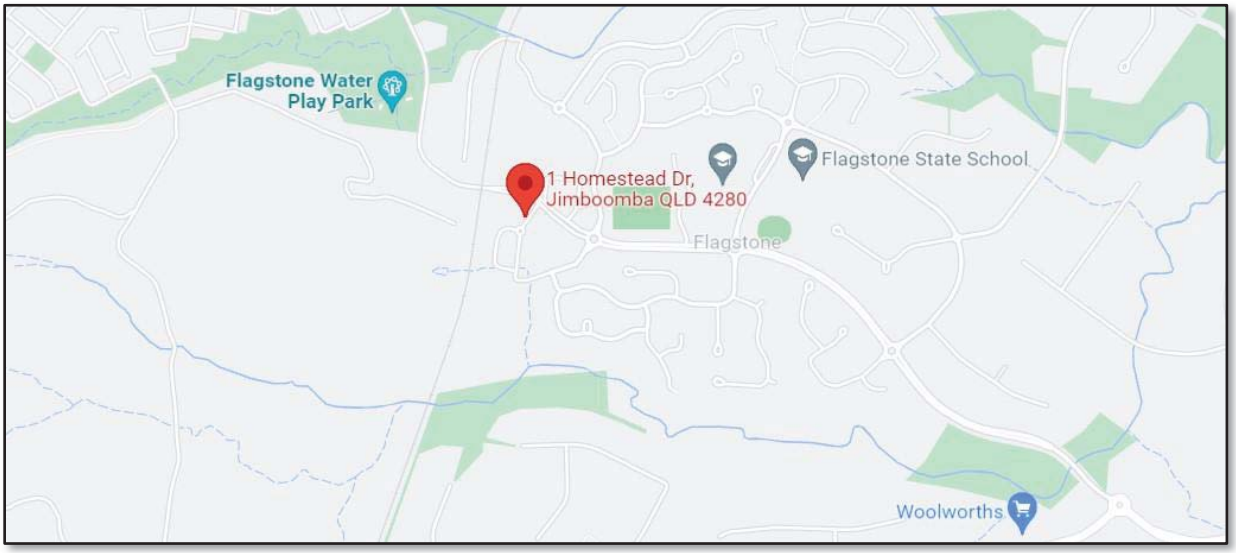


FIGURE 1 – SITE LOCATION

The site generally slopes to the south and east with a fall of between 5.5m and 6.0m from the north boundary to the toe of the northern embankment and 2.5m over the remainder of the site.

The area is well grassed with several small to medium sized trees on the embankment and long the western boundary.

The site has been described as poorly to moderately drained with no seepage noted.

Refer to following site photographs for typical site conditions.

PLATE 1 – SITE LOOKING EAST

PLATE 2 – SITE LOOKING SOUTH WEST CONE

PLATE 3 – SITE LOOKING SOUTH

PLATE 4 – SITE LOOKING NORTH

2.3 Geotechnical Model

2.3.1 Regional Geology

A review of Geological map (Ipswich 9442) covering this site indicates that the site is underlain by rock of the Marburg Formation. Typical lithologies of this unit consists of Sandstone, Siltstone, shale and coal.

The soil profile consists of sand and clay soils; completely weathered products of the underlying rock units.

2.3.2 Subsurface Profile

The subsurface profile intersected during the drilling program consisted of:-

- Fill - Identified in all the boreholes as a surface layer to a max. depth of 1.00m (BH05) and described as Silty, Silty Gravelly, Clayey Silty SAND and SAND (SC/SM/SP), very loose to medium dense and Silty Sandy and Sandy CLAY (CL/CI), very stiff with abundant organics in the near surface layers

  In the absence of documentation to confirm that the filling was placed and compacted in accordance with AS 3798-2007, then the filling must be considered as being 'uncontrolled'.
- Sand - Encountered in BH01 to BH04 and described as Silty SAND (SM), medium dense.
- Clay - Encountered in all boreholes except BH08 to BH10 and described as Silty Sandy CLAY (CI & CH) and Sandy CLAY (CI-CH & CH), very stiff to hard.

- Weathered Rock - Encountered in all the boreholes and described as Sandstone extremely weathered (XW) to distinctly weathered (DW), very low to low strength.

Note AS 1726-2017 'Geotechnical Site Investigations' requires that XW rock be described using soil terms.

A summary of the subsurface profile is presented in Table 1 with detailed borelogs included in the appendices.

TABLE 1 SUBSURFACE PROFILE SUMMARY

BH No.	RL (m)	Fill (m)	Sand (m)	Clay (m)	Weathered Rock (m)		Total Depth[5] (m)	DCP Refusal Depth[3] (m)
					XW[6]	DW		
1	48.2	0.00-0.60	0.60-0.80	0.80-1.10	NE	1.10-TD	1.20	1.10
2	48.9	0.00-0.15	0.15-0.30	0.30-0.70	NE	0.70-TD	0.90	0.70
3	48.5	0.00-0.60	0.60-0.80	0.80-1.90	1.90-4.30	4.30-TD	4.40	1.50
4	48.2	0.00-0.35	0.35-0.70	0.70-2.40	NE	2.40-TD	2.50	2.20
5	50.5	0.00-1.00	NE	1.00-1.80	1.80-2.00	2.00-TD	2.20	0.66
6	48.7	0.00-0.90	NE	0.90-2.10	2.10-2.40	2.40-TD	2.60	1.28
7	49.0	0.00-0.70	NE	0.70-1.00	NE	1.00-TD	1.10	0.99
8	49.0	0.00-0.90	NE	NE	NE	0.90-TD	1.00	0.93
9	49.5	0.00-0.70	NE	NE	NE	0.70-TD	0.80	0.72
10	48.7	0.00-0.70	NE	NE	NE	0.70-TD	0.80	0.67
11	49.4	0.00-0.70	NE	0.70-1.80	NE	1.80-TD	1.90	-
12	49.7	0.00-0.80	NE	0.80-1.40	1.40-TD	NE	1.80	1.44

Notes:-
1. NE = Not Encountered; NC = Not confirmed; TD = Total Depth.
2. All depths below existing ground level (26/11/2021 and 08/12/2021).
3. Blows >20 per 100mm.
4. RL's based on provided survey data.
5. TC bit (rig) refusal.
6. Note AS 1726-2017 'Geotechnical Site Investigations' requires that XW rock be described using soil terms.

2.3.3 Groundwater

The boreholes were drilled using open hole auger techniques to their total depths and groundwater was not encountered in the boreholes at the time of the investigation.

It should be noted that groundwater may be present, however due to the relatively short time that observations were made during the drilling of the boreholes and the possible effect of smear on the sides of the bore holes it was not able to be identified.

It should also be noted that the level of ground water may fluctuate due to seasonal variations and that localised seepage may occur during and following rainfall particularly along the fill/soil and soil/rock interfaces.

2.4 Laboratory Testing

Laboratory testing was carried out on selected samples retrieved from the site investigation program and included:-

- Shrink/Swell Index - to assess the reactivity of the subsurface material
- Swell Pressure - to assess the potential uplift effects resulting from moisture variation within the upper-level clays
- California Bearing Ratio - to assess the subgrade characteristics of the subsurface material under soaked conditions

The results of the laboratory testing are summarised in Table 2 with full laboratory certificates given in Appendix C.

TABLE 2 SUMMARY OF LABORATORY TESTING - REACTIVITY & CBR

BH No.	Depth (m)	Material Type	FMC (%)	Shrink Swell Index (%)	Swell Pressure (kPa)	CBR (%)	% Swell
1	0.10-0.60	Clayey SAND (SC)	11.3	NT	NT	13	0.0
2	0.30-0.70	Silty Sandy CLAY (CI)	19.2	NT	NT	2.0	3.0
3	1.00	Silty Sandy CLAY (CI)	10.9	0.8	60	NT	NT
4	0.80	Silty Sandy CLAY (CI)	11.2	1.1	NT	NT	NT
5	1.50	Silty CLAY (CH)	18.0	1.7	NT	NT	NT
6	0.60	Silty Sandy CLAY (CI)	12.8	1.7	50	NT	NT
11	0.70	Silty CLAY (CH)	25.9	3.8	90	NT	NT

Notes:
1. NT = Not Tested.
2. FMC = Field Moisture Content (Swell sample)

3.0 ENGINEERING ASSESSMENT

3.1 Civil Works

3.1.1 Trafficability and Site Preparation

At the time of the field investigation, trafficability was considered to be fair due to recent rainfall. Access over the site could be described as good.

The fieldwork for this investigation was carried out following wet weather conditions with a small 4WD truck mounted drilling rig. However, as is the case on most construction sites, some problems may be anticipated during wet weather for even light weight 4WD vehicles.

The contractor should fully inform himself of the ground conditions on site prior to commencement of earthworks. This requirement should be explicit in any earthworks specifications or contract.

The soils on site are sensitive to repetitive vehicle loading and water (i.e., they will lose strength through repetitive vehicle loading or if they become overly moist or wet). Further, seepage may also result in a subsequent loss of strength. This may limit trafficability and create difficulties for earthworks operations. This situation would be more pronounced if rainfall followed initial clearing, stripping and grubbing.

Where sands overlie clays, as is the situation on site, seepage may occur through the sands and along the sand/clay interface resulting in a subsequent loss of strength. This may limit trafficability and create difficulties for earthworks operations. This situation would be more pronounced if rainfall followed initial clearing, stripping and grubbing.

Problems may also arise from disturbance of the upper-level soil fabric with removal of vegetation. Depressions could be formed resulting in water traps and potential softening of adjacent and underlying soils.

Partial or complete removal of the surficial sands may be required should these soils become saturated and weakened at the time of construction. We recommend that the earthworks contract includes a PC item to account for the partial and complete removal scenario.

It is recommended that after stripping, clearing and grubbing, the exposed surface in the construction area be proof rolled (where appropriate) to assist in identifying weak areas and to improve trafficability. In areas of cut, proof rolling may be deferred until after the cut operation.

An important aspect of maintaining trafficability is seepage/drainage control.

Maintaining adequate drainage conditions is also essential. It should be ensured that runoff is diverted away from the construction area to prevent ponding of water. In addition, the construction area should be "sealed" at the completion of each day and in the event of rain.

Potential trafficability problems with this site should not be underestimated. The site will very quickly become untrafficable if appropriate seepage and drainage control measures, along with construction practices appropriate for site conditions, are not maintained.

Further, Soil Surveys Engineering offers a pre-construction meeting service. The primary objective of this service is to allow the Contractor to demonstrate to the Principal and Project Manager that they have a complete understanding of the earthwork challenges/risks associated with this site (i.e., trafficability conditions, treatment of silty/clayey sands, use of in-situ soils as structural fill, etc.) and that they have made appropriate cost and time allowances. Excavation of trial pits by the preferred contractor (just prior to commission) should form part of this exercise. Our standard rates will apply for this pre-construction meeting service. **Please note that this pre-construction meeting service is considered essential for this project.**

Working Platforms for Tracked Plant and Heavy Construction Vehicles

The scope of Soil Surveys Engineering's study **DOES NOT** include the design of a working platform for heavy construction vehicles or heavy tracked plant. If such platforms are required to be constructed on the site, general comments with respect to earthworks are included in Section 3.1.2 to allow for the preparation of costings for the project.

Detailed design of a working platform should be carried out considering the operation of actual machinery proposed to be used and the areas of work. This is particularly important when considering the use of **heavy** piling rigs and **heavy** cranes - the piling/crane contractor should be consulted regarding their requirements.

Demolition and Clearing Activities

Extreme care should be exercised during the demolition/clearing phase to ensure that excessive subgrade disturbance is not caused during removal of existing pavements, services, etc.

3.1.2 Earthworks

General

General earthworks are expected to be minor (cuts and fills of < 0.5m) over the majority of the site, however excavation into the rear batter may be required, provided drawings indicate that this will be of the order of up to 2m.

Earthwork procedures should be carried out in a responsible manner in accordance with AS 3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'. It is recommended that the earthworks contractor make themselves familiar with site conditions.

Note: The surface sandy soils will cause problems with trafficability/workability should this material become wet prior to or during construction. In general, the sandy soils have been described as clayey sand with some silty sand. Geotechnical experience on sites with similar profiles, that with similar sandy soils that contain a significant amount of silt fines, the “re wetting” of the soil to optimum may be difficult to achieve. The option of full removal prior to filling may be considered and should be assessed at the time of construction.

Subgrade Preparation Procedures

Subgrade preparation procedures should include the following:-

- Clearing, stripping and grubbing should be carried out in areas subject to earthworks. Also, all soils containing organic matter should be stripped from the construction area. This material is not considered suitable for use as structural fill.
- In construction areas where fill is to be placed, the existing ground surface should be proof rolled (where appropriate) under the supervision of Soil Surveys Engineering in accordance with methods and equipment as per Clause 5.5 of AS 3798-2007. In areas of cut, proof rolling may be deferred until after the cut operation. Areas demonstrating excessive movement should be treated (dried and recompacted) or removed and replaced with compacted fill, particularly loose surface clayey sands, should be compacted to the appropriate requirements. Soft, wet clays, should they be encountered, should preferably be removed. In areas of cut, proof rolling may be deferred until after the cut operation.
- Depressions formed by the removal of vegetation, existing structures, underground elements etc. should have all disturbed weakened soil cleaned out and be backfilled with compacted select material.
- Any fill material encountered should be considered uncontrolled and requiring treatment (i.e., excavate/condition/replace/compact as required). Please note that treatment standards may vary subject to slab on ground floor support requirements.
- Where fill is to be placed on sloping ground, particular care should be taken with respect to benching of the subgrade such that filling is carried out on a level, refer Section 2(i) and 2(j) of AS 3798-2007.
- Sloping ground, etc. should be benched to "key in" fill material and optimise compaction. The benches should slope back at 1V:10H and be at least 0.5m wide. Wider benches to accommodate the width of the roller may need to be adopted in some situations. Figure 2 refers.

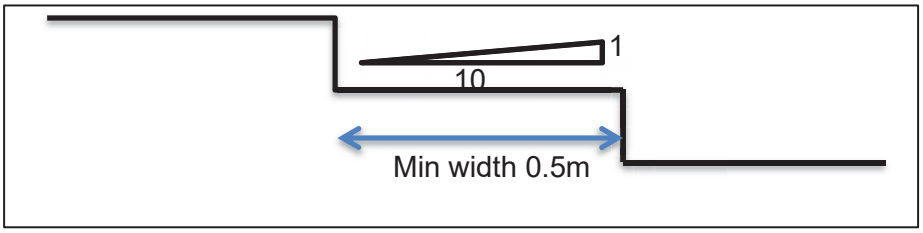


FIGURE 2

- Prior to stripping, test pitting at select locations to confirm subgrade conditions could be carried out. Should test pits indicate subsurface conditions different from borehole records, Soil Surveys Engineering should be contacted immediately.

- Please note that the onsite soils are sensitive to water and will lose strength if they become wet. Should these soils be wet at time of construction, significant works to treat these soils would be required.

Material Usage and Fill

Natural Soils

- The in-situ soils were described as moderately to highly reactive and whilst it may be able to be used for structural fill (provided they are free of organic and deleterious material) this material potentially could have a significant effect on the site reactivity. It should be noted that where reactive soils are recompacted there is the potential for over compaction of the soil to alter their reactivity. There is the potential for the reuse of this material in the lower levels of any filled area, where it affects onsite reactivity would be significantly reduced.
- It is expected that clay soils would be more likely to affect the site classification and sandy soil much less so.
- Soils selected from site for reuse should be selected on the basis of their likely effect on the site's reactivity.
- Use of the reactive clay soils may be considered with very close control on moisture content during placement and compaction. To minimise the potential for swelling and shrinkage movement a moisture content within the range of OMC -2% to OMC +2% is recommended. Foundation design must reflect the use of the potentially reactive clays if they are used as structural fill.
- Some soils may require conditioning to dry out/wet up, otherwise difficulties could be experienced in handling and achieving adequate compaction. This may require spreading, conditioning (i.e., drying/wetting up) and mixing to achieve a uniform improvement in the materials.
- However, it should be noted that silty/clayey sands and plastic clay soils could be expected to present difficulties in handling, placement and compaction if the appropriate moisture content could not be achieved, particularly if the soils were overly moist.
- Due to the water sensitive nature of the sandy soils (fill and natural), **it is recommended that the in-situ silty sand/clayey sand NOT be used as structural fill**.
- **Depending on weather conditions prior to the time of construction the soils may require conditioning to dry out/wet up soils for use in the earthworks depending if they are wet or dry of optimum.**

Weathered Rock

- The weathered rock, where broken down on extraction, may be used in areas of structural fill provided no rock over 75mm greatest dimension is included above a plane 300mm below the final subgrade/platform. Below this plane, rocks up to 150mm greatest dimension may be used. These rocks should however not represent more than 20% of the fill make-up. Rocks over 150mm greatest dimension, which cannot be broken down, should be removed.
- Consideration should be given to the exclusion of rock pieces with a greatest dimension of 35mm or greater from areas where trenching and piling may occur, as larger rock pieces

could impede the trenching and piling operations.
Quality testing to confirm particle size limits should be carried out; frequency of testing is subject to assessment by Soil Surveys Engineering; however, a sufficient number of tests should be carried out so that all parties are confident of material characteristics. Quality test results should be reviewed by Soil Surveys Engineering.

Existing Fill

- The existing fill has been described as uncontrolled and it is therefore suggested that this be completely excavated.
- Fill material, excluding silty/clayey sands, may be reused in the construction where Fill Specifications (see below) are met.

Imported Fill

- Imported select fill, if required for filling in structural areas/if needed to make up earthworks deficiencies, should conform to the minimum specification as set out below:-
  - Soaked CBR Minimum of 10%
  - Liquid Limit <45%
  - Plasticity Index <15%
  - Maximum Aggregate Size <75mm
  - Passing 19mm Sieve 80%, minimum
  - Passing 0.075mm Sieve 20%, minimum
  - Shrink/Swell Index Maximum of 1.0%
- Typical material that would conform to the above quality limits would be a good to fair quality overburden type material; such material would have a soaked CBR value of approximately 7% to 10%.
- The requirement to specify a minimum soaked CBR value is dependent on pavement design issues; this matter should be referred to the Civil Engineer.
- Pavement gravels should comply with the Local Council quality specifications for base, sub-base and blanket materials.

Compaction Procedures and Specifications

- Guidelines for minimum relative compaction values for in-situ soils and imported fill for the building and pavements are presented in Table 3 below.

TABLE 3 MINIMUM RELATIVE COMPACTION

Location	Minimum Dry Density Ratio (%)
Building Area	98[2]
Pavement Area	
• pavement base layer	98[1]
• pavement sub-base layer	95[1]
• < 0.4m below pavement subgrade	98[2]
• > 0.4m below pavement subgrade	95[2]

Note: The recommended compactions are percentages of the maximum dry density determined by
1. Australian Standard 1289 Test Series 5 (Modified Compaction).
2. Australian Standard 1289 Test Series 5 (Standard Compaction).

- Field density testing should be carried out to check the standard of compaction achieved and the placement moisture content. The frequency and extent of testing should be as per guidelines in AS 3798-2007, Section 8.0.
- Backfilling for service trenches etc. should use good quality material free of organic and deleterious matter, either select fill won from site or imported fill. The backfill should be placed in uniform layers over the full width of the excavations with the layers not exceeding 200mm loose thickness using wheeled plant and 100 mm loose thickness using vibrating plates. The backfill material should be compacted to the specifications outlined above for in-situ or imported cohesive material.
- The select fill material should be compacted in layers not exceeding 250 mm, loose thickness. However, layer thicknesses will be dependent on the compaction plant type and size, use of vibration, material type and condition. Final maximum placement layer thicknesses will need to be determined when compaction plant as well as material type and conditions are known. Fill batters should be overfilled and cut-back to design batter angles.
- **Fill batters should be overfilled and cut-back to design batter angles (refer to AS3798-2007 Section 6.2.4).**
- Other comparable compaction specifications may be adopted for earthwork procedures; however, Soil Surveys Engineering Pty. Limited should be consulted to confirm these.
- Provided the placement moisture content of the imported fill or select in-situ material approximates the optimum moisture content for compaction, suitable compaction should be achievable using typical compaction machinery, i.e., say a 5t-10t vibrating sheepsfoot roller or 25t-30t sheepsfoot compactor.

Trenching

Shoring of deep trench excavations is recommended. Suitable precautions to satisfy Health & Safety requirements must be adopted. Construction procedures (i.e., operation of plant, storage of materials, etc.) should also consider the nature of the site soils.

3.1.3 Earthworks Supervision and Certification

Engineering supervision of the earthworks operations by Soil Surveys Engineering Pty Limited is recommended.

Following production of AS 3798-2007, the terms "Level 1 and 2 Supervision" have been adopted in earthworks specifications to describe what could also be termed Engineering Supervision. Whilst there is no particular problem with using these terms, there does not seem to be wide agreement as to what Level 1 or 2 Supervision actually means or entails.

It should be noted that Level 1 fill may not be suitable as a founding layer and it is recommended that any filling, when the intention is for the fill to be used as a founding layer, be supervised and certified for a particular minimum bearing capacity by a RPEQ.

Regardless of terminology, it should be made clear in any earthworks specification as to what is actually required in terms of certification. It is recommended that the following objectives (as a minimum) be incorporated into the earthworks specification:-

- Engineering certification that all general earthworks operations (i.e., stripping, proof rolling of subgrade, subgrade treatment, etc.) have been carried out in accordance with the earthworks specification.
- Engineering certification that fills has been placed and compacted to the required minimum density in accordance with the earthworks specification.
- Engineering certification that embankment filling has been undertaken in accordance with AS3798-2007 Section 6.2.4 i.e., overfilled and cut back to the final profile.
- Engineering certification that the quality of any imported fill complies with the earthworks specification requirements.
- Engineering certification that the stability of cut/fill batters and trenches is adequate.

Engineering certification should be provided by a Registered Professional Engineer of Queensland.

Please note that Soil Surveys Engineering in our role as Earthworks Supervisor (under normal circumstances) cannot authorise variations to the contract or the use of provisional items. If the Contractor considers that any recommendation/instruction issued by Soil Surveys Engineering is a variation to the contract, the Contractor should advise the Superintendent and obtain written approval before proceeding with Soil Surveys Engineering's recommendation/instruction.

3.1.4 Definitions

The following terms have been used in this section:-

- Engineered Fill – Fill placed in a controlled manner and certified by a RPEQ to the following:-
    - Confirmation that appropriate high level footings can found in the fill.
    - Provide a design allowable bearing capacity for the footings
    - Confirm that all the works have been undertaken in accordance with AS3798 including the requirements outlined in 3.1.3 of this report.
- Controlled fill – fill placed in a controlled manner.

3.1.5 Excavation Characteristics

General

It is anticipated that excavations will consist of the following:-

- Bulk Cuts - for site stripping and excavation to create building platforms and carpark/driveway areas.
- Trenching - for high level footings and underground services.
- Drilling - for bored pier foundations.

Excavatability Comments

Based on geotechnical knowledge of excavations/earthworks on projects in the local area and the findings of the investigation, the following comments can be made on excavation characteristics:-

- Bulk Works
    - Excavations in the soils and upper 0.5m to 1.0m, or so, of the very low to low strength weathered rock to 'TC' bit refusal depth (refer Table 1) should be within the capacity of a medium size backhoe (Case 580 or similar) or small excavator (e.g., 12t - 15t).
    - Below these levels (i.e., 'TC' bit refusal depths noted in Table 1), a larger excavator would be required for excavation further into the weathered rock (where required).
- Trenching
    - Trench excavations in the soils and upper 0.5m to 1.0m, or so, of the very low to low strength weathered rock to 'TC' bit refusal depth (refer Table 1) should be within the capacity of a medium size backhoe (Case 580 or similar) or small excavator (e.g., 12t - 15t).
    - Below these levels (i.e., 'TC' bit refusal depths noted in Table 1), a larger excavator would be required for excavation further into the medium to high strength weathered rock (where required).
- Bored Piers
    - It should be noted that the ability to drill piers in the weathered rock material is not only dependent on material characteristics but also the type (power and size) of the bored pier drilling rig, drilling teeth, size of pier, etc. It is recommended that the drilling contractors be consulted on this matter.
    - It is important that the drilling contractor have a 'clean-out' bucket to ensure adequate cleaning of the pier bases if hand cleaning of the bases is not possible.

3.1.6 Batters

General

It is understood that cut batters to 2.0m in height and minor fill batters if any are proposed.

Batter Angles

Maximum batter angles for different material types are outlined in Table 4 for **un-surcharged** cut and fill batters less than 3m high on the site. Also refer to Section 3.1.7.

TABLE 4 DESIGN MAXIMUM BATTER ANGLES (Slopes up to 3m high)

Material	Short Term	Long Term
Existing Fill	26° (1V:2H)	15° (1V:4H)
Clay Soils	45° (1V:1H)	26° (1V:2H)
Sandy Soils [2]	35° (1V:1.5H)	18° (1V:3H)
Weathered Rock XW [3]	45° (1V:1H)	26° (1V:2H)
Weathered Rock DW or Better [3]	60° (1V:0.6H)	45° (1V:1H)

Notes:-
1. Assumes earthworks are undertaken as per section 3.1 and the following section (Fill Batters) is undertaken.
2. These values assume no seepage. If seepage is present the recommended angles would need to be significantly reduced or the use of dewatering considered.
3. Subject to inspection by an experienced geotechnical engineer/engineering geologist.

Where surcharges (e.g., footings, live loads, etc.) are located within H (height of batter) of the top of the batter, then some reduction in design angle will occur.

Steeper batters are possible with suitable surface protection such as stone pitching, etc. or by use of retaining structures (temporary and permanent).

Note values above are maximum values in the case of fill and soils. Flatter angles may be considered for ease of maintenance.

In the case of weathered rock steeper angles may be possible but would require mapping during excavation and even then, some artificial support may still be required.

Regardless of the design, it is important that all cuts be inspected (progressively as construction proceeds) by an experienced Geotechnical Engineer/Engineering Geologist.

Scour Protection and Erosion Control

It is essential that permanent batters be suitably protected from erosion and scour by appropriate drainage and the establishment of ground cover and shrubs, etc. Pavement runoff should not be allowed to discharge directly across the batters without suitable scour protection.

If runoff velocities are sufficiently high, following cutting and construction of batters, erosion of the exposed soil could occur.

Top soiling and seeding or hydromulching on cut areas steeper than 1:5 (11 degrees) is suggested so that protection could be provided until such time as the grass cover is established.

Drain outlets would also need to consider the effects of scouring runoff water. These will need to be concrete lined near each entry and exit, with grassing further out.

The construction of asphalt surfaced roads with kerb and channelling and appropriate underground drainage will limit erosion on fill batters to the effects of localised surface runoff. Rutting, scouring and erosion is therefore possible.

It is suggested that top soiling and seeding or hydromulching also be used on all fill batters, regardless of slope, to provide protection to the slopes until permanent grass cover is established. The seed selection for the hydromulch will depend on the season when placed, but in any case, should include a rapid growing seasonal variety that could rapidly establish itself until such time as the regular grass variety is established.

It is recommended that where possible all batters have surface and subsurface drains installed above and below the slope so that water is collected and directed away from structures. This is particularly important when lots are located below the road level.

3.1.7 Temporary Cuts Assessment

General

As requested, an assessment of the potential affects of a temporary cut on the existing embankment at the northern end of the site has been undertaken.

Embankment Information

At this stage, no drilling was possible into this embankment. The design model has been developed based on the following:-

- A review of a provided Level 1 report on the construction of the embankment (ref. (Morrison Geotechnic Ref. 10693 dated 16th June, 2016).
- The provided site contour survey (ref. Veris Dwg No. 30109-DP-25024 dated 22nd March, 2019).
- Three DCP tests (DCP1 to DCP3, refer Dwg. No. 1-24684-01) SSE has undertaken near the line of the proposed temporary cut.
- The geometry of the cut is based on the supplied drawings indicating the alignment and floor levels for the proposed structure in this area.
- A review of historical air photos of the site.

Embankment Assessment Data

Based on the above, the following information has been assessed:-

- Based on air photos and site observations, there may have been an area of elevated ground in the area of the embankment prior to earthworks, however this could not be confirmed.
- The road bridge is founded into weathered rock with shallow weathered rock exposed in the cutting under the bridge and around the bridge piers.
- Construction commenced on the embankment in late 2016/early 2017.
- The embankment appears to have been constructed in stages with the section to the east of BH09 completed by late 2016. The rest of the embankment to the west of this point was completed by mid 2017. Visual evidence would suggest that the construction methodology consisted of overfilling and cutting back to the final profile to ensure complete compaction to the final surface.
- A review of the contour survey suggests an even slope along the entire embankment with a slope of 1V:3H from the top to the base of the embankment.
- The DCP testing indicated good compaction from the surface and shallow refusal in DCP01 and DCP03. The upper 0.9m in DCP02 was lower than expected but significantly improved below that to refusal at 1.53m. This appears to be close to the change in construction stages noted above and may relate to the interface between these two

stages. The point of maximum cut is to the west of this location closer to DCP3 which reached refusal at <0.5m.

- A review of the Level 1 report indicates:-
  - The embankment consisted of fill.
  - The fill was placed under Level One Inspection and testing as per AS3798 & Logan City Council Project Specifications.
  - Numerous test locations were marked on a supplied plan (but not able to be referred to specific test results to location) as Figure 3.

FIGURE 3

  - Based on the colour coded test locations, the pink tests were between RL 45.0m and RL 49.99m and the light blue between RL 50.0m and RL 54.99m.
  - A review of the provided site contour suggests most tests were more than likely in the upper 1-2m of the embankment.
  - A review of all test results indicates Density Ratio (HILF) in the range 95% to 103%.
  - The report does not cover the fill immediately behind the abutments but this is likely to be outside the subject site.
  - All surfaces where fill was to be placed were stripped and cleared of all visible organic matter, deleterious, loose and unsuitable material to depths exposing competent ground. Based on the description in the report, the exposed surface was natural soils in the section of embankment on the subject site.
  - The fill material consisted of Sandy CLAY (CI) and Clayey SAND (SC).
  - The fill was placed in layers, details of layer thickness was not provided.

Geotechnical Model and Analysis

A geotechnical model was developed from the information noted above as well as the details of the site investigation undertaken for this report. A four-layer model was adopted consisting of the

embankment fill, general site fill, residual soils and weathered rock. Material parameters were adopted based on an assessment of the provided information and experience with similar materials on other sites.

The model was analysed using a 2D slope stability computer program. Worst likely parameters were adopted with respect the subsurface profile and water conditions.

Using estimated parameters (based on the information provided above), a worst likely factor of safety (FOS) of 1.68 was calculated for the existing embankment (Figure 4A). This would most likely be a reasonable value for this type of embankment. Generally, a long-term minimum FOS of 1.5 is adopted.

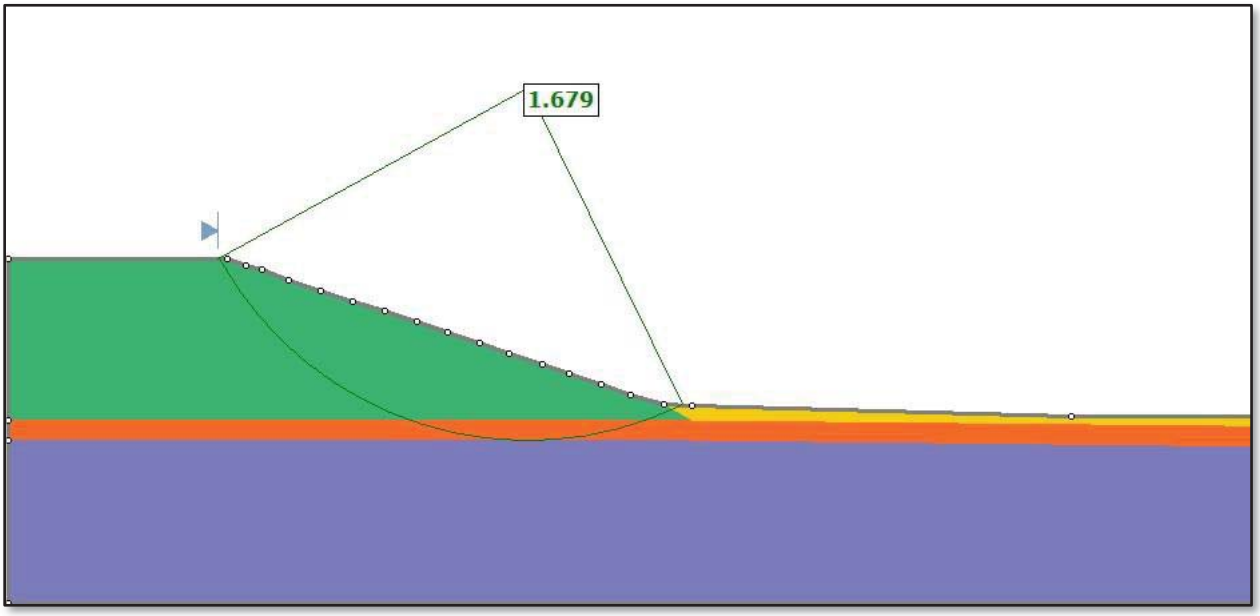


FIGURE 4A – EXISTING SLOPE

An assessment was then done for the temporary batter cut to excavate and install the northern retaining wall. A worst-case model (maximum cut) was adopted. Temporary batter angles of 90º, 60º and 45º were analysed with the calculated FOS of <1.0, 1.1 and 1.3 respectively (Figure 4B).

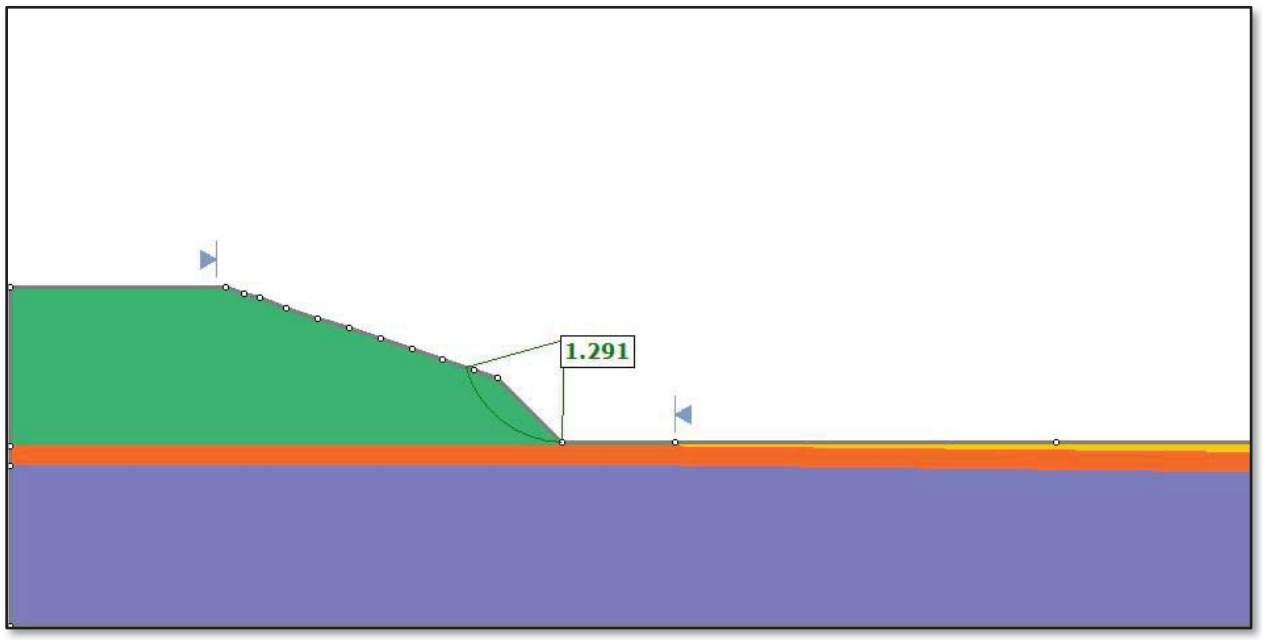


FIGURE 4B – 45º BATTER

On this basis it is recommended that a 45º temporary batter be adopted for the excavation to allow installation of the rear wall.

It is recommended that:-

- Excavation and retaining wall construction be undertaken as quickly as possible
- The works should preferably be done following a period of dry weather
- The backfill adopted be non-compressible and contain suitable voids to allow it to drain rapidly, i.e. no fine concrete (for at least the lower 1m of the backfill).
- The top of the backfill be sealed to minimise water ingress into the backfill
- Drains be installed in the backfill to allow rapid drainage of any seepage out from behind the wall.
- The retaining wall be designed for the top slope (refer Section 3.3) and using the Design Ko value.

3.2 Building Foundations

3.2.1 Site Classification as per AS 2870-2011

General

A site classification, in accordance with AS 2870 'Residential Slabs and Footings' (it is recommended that the reader satisfy themselves that the use of AS 2870 is applicable for the proposed design) has been carried out with the following information:-

- Subsurface profile
    - Up to 1.0m of fill in BH05
    - Residual soils over weathered rock
- Proposed earthworks
    - Minimal (<0.5m) cut/fill over the majority of the site

- Soil Moisture Model
    - A zone of moisture variation of 1.8m
    - A crack zone of 0.9m
    - ∆pF = 1.2
- Laboratory test results
    - Refer to Section 2.4 of this report and attached certificates

Site Classification

Based on the site investigation the site has been assessed as being a reactive site according to AS 2870-2011 Section 1.8.44.

According to AS 2870-2011 Clause 2.1.3 the site has been designated Class 'P' due to:-

- The site being potentially subject to moisture changes due to site conditions more severe than normal site conditions or other factors resulting in foundation movement beyond the reactive soil movements resulting from moisture changes due to the normal site conditions refer AS 2870-2011 Clause 1.3.2 (i.e., Clause 1.3.3 abnormal moisture conditions). Abnormal moisture conditions can occur on reactive site when there is:-
    - presence of trees on the building site or adjacent site,
    - unusual moisture conditions caused by drains, channels, ponds, dams, swimming pools, effluent disposal areas of tanks, which are to be maintained or removed from the site.
- The presence of uncontrolled or controlled fill as defined in AS 2870-2011 Clause 2.5.3 i.e., in excess of 0.4m in depth;

The above site classification has been assessed based on the provided/assumed earthworks, should the extent of earthworks change, the site classification may need to be reassessed by Soil Surveys Engineering to confirm it has not changed.

Should a site classification with respect to plumbing and sanitary drainage be required please refer to the Section 3.2.2.

It should also be noted that the site classification provided above applies to the design of the structural foundation system. Further comments are provided in Section 3.2.3.

3.2.2 Site Classification for the Purpose of Sanitary Drainage

It should be noted that the soil classification to AS 2870 for the purpose of design of plumbing and sanitary drainage systems (Form 1 Section 5) is ‘M’. Reference to Section 5.6.4 of AS 2870-2011 is recommended.

3.2.3 Further Comments Regarding Foundations

As noted above this site has been classified as ‘P’, however, the site can be classified by the soils reactivity alone. Based on the site investigation results, laboratory testing and adopting the **EXISTING SURFACE** and **PROFILE FROM EACH BOREHOLE**, a maximum ground surface movement (ys) of <40mm has been calculated, i.e., ‘M’ Class site.

The recommendation above may change if any:-

- Filling in excess of 0.40m occurs on the site
- Cuts in excess of 0.45m occurs on the site

The above calculation has also been based on the recommendations outlined in Sections 3.1 'Civil Works' and 3.2.12 'Site Management' being complied with. Where these recommendations cannot be met then the ys value and classification will need to be reviewed.

It should also be noted that the methodology adopted for determination of the site classification assumes the structure has performance requirements similar to domestic type construction.

Effect of Reactivity on Services

It should be noted that a site classification of 'M' was assessed for this site as such the detailing of services at the edge of the buildings should be carefully considered to take into effect the potential for movement differentials at the edges of the structure and the potential effect on service lines. Reference to Section 5.5.4 of AS 2870-2011 is recommended.

The effect of this possible movement should also be considered in points of egress and ingress to the structure to ensure that differential movement does not result in a safety hazard.

Trees

As noted in AS 2870-2011 Section 1.3.3, if trees are subsequently planted 'close' to future building locations, significantly greater movements than those nominated above may occur due to an increased soil suction magnitude and depth. Also, if trees proposed to be removed are not removed well in advance of construction, significantly greater shrink-swell movements could also occur on 'wetting up' following tree removal.

Further, AS 2870-2011 Appendix H, includes an informative section on the design of footings for trees and in particular the calculations of the maximum potential surface movement due to the tree-induced suction change (that is in addition to the normal design suction profile). The Designer should refer to AS 2870-2011 for detailed discussion on this matter.

Development of Abnormal Soil Conditions

It is recommended that design works for the proposed development take into account the long term effect of any design elements on the subsurface moisture conditions under and around the structure.

These design works should consider aspects of the design that may contribute to the development of abnormal moisture conditions i.e.:-

- Site drainage
- Gardens and landscaping
- Future planting of trees and shrubs
- Services and repair of leaks

The designer is directed to AS 2870-2011 Appendix B and Section 3.2.12 'Site Management' of this report which outlines measures that should be considered.

3.2.4 Hazard factor and Site Sub-soil Class as per AS 1170.4-2007

It is recommended that the following coefficients be adopted for the design of the structure on this site according to AS 1170.4-2007 Structural design actions Part 4: Earthquake actions in Australia :-

- Hazard Design Factor (Z) = 0.08 - Figure 3.2 (F)
- Site sub-soil class, depending on founding level for the main structure shall be (Refer Section 4 of code) Class B_e – Rock Site

3.2.5 Settlement

A preliminary assessment of likely settlements of footings is required. The assessment of settlement depends upon the following factors:-

- The properties of the subsurface profile at and below the footings
- The type of footings adopted on the site
- The size of the footing
- The applied loads

Given the supplied information with respect to the proposed structure (proposed earthworks and design loads) and the results of the geotechnical investigation; provided the recommendations contained in this report are followed it is expected that the total settlement of the footings to be <10mm. It should be noted that the effects of closely spaced footings have not been taken into account and this may need to be reviewed once the footing layout and applied loads have been finalised.

3.2.6 Foundation Options

Given the subsurface profile encountered and the expected loads, a high-level foundation system or a combination high-level/deep foundation system dimensioned for the loads and the bearing capacity of the founding material would generally be acceptable for the proposed development.

It should be noted that the use of the same type of footing system founding in similar material is recommended to minimise the potential for differential settlement over the structure.

3.2.7 High Level Footings

It should be noted that the use of high-level footings in highly reactive clay soils may result in shrink or swell movements of the footings adopted for the structure.

The amount of movement will depend upon:-

- the depth and size of footings,
- the material parameters of the founding layer,
- the potential for change in the moisture regime around and under the footings (i.e. in general the shallower the footing the greater the potential).

Where high level footings are adopted, our recommendation is that all footings:-

- Should be founded at least 200mm into natural hard CLAYS or WEATHERED ROCK.

- Found at least (assuming masonry veneer construction)
    - 400mm below platform level for strip footings
    - 500mm below platform level for pad footings
- Not be founded in Topsoil, FILL, soft, firm or stiff CLAYS, SANDS.
- All footings be founded in similar stratum material.

Footings may be dimensioned for an allowable bearing pressure as outlined in Table 5.

TABLE 5 ALLOWABLE BEARING CAPACITIES FOR HIGH LEVEL FOOTINGS

Material		Allowable Bearing Capacity (kPa)[2]	
		Strip Footing	Pad Footing
Fill	- Uncontrolled	NR	NR
Clay	- Very Stiff - Hard	NR 350	NR 425
Sand	- Loose - Medium Dense	NR NR	NR NR
Weathered Rock	- Above 'TC' Bit Refusal - Below 'TC' Bit Refusal	500 650	550 750

Notes:
1. NR = Not Recommended.
2. To be confirmed by inspection.

Where necessary, footings deeper than the values indicated above may be made up with mass concrete poured to the underside of the footings, or alternatively, footings may be constructed over mass concrete filled, backhoe excavated pedestals.

Field and laboratory test results indicate that the existing natural soils, along with any controlled fill, are suitable for slab on ground construction provided that earthworks are carried out in accordance with Section 3.1.

3.2.8 Deep Foundations

General

A deep foundation system utilizing bored piers/screw piles founding into the top of the weathered rock/below the base of services could be considered are recommended.

Ultimate Strength Design

The design of a deep foundation system should consider the following:-

- Compressional capacity i.e. base bearing and skin friction design values
- Tensional capacity and effects i.e. potential uplift due to expansive clays
- Lateral capacity of the piles
- Design considerations
- Construction considerations

Compressional Capacity

It is recommended that the deep foundation system on this project be designed in accordance with AS 2159-2009 'Piling - Design and Installation'. This code uses the limit state design method.

In the limit state design method the following must be taken into account:-

- Considering limit state analysis (AS 2159-2009), the design geotechnical strength $R_{d,g}$ is calculated by multiplying the ultimate geotechnical strength $R_{d,ug}$ by the geotechnical strength reduction factor ϕ_g, i.e.

$$R_{dg} = R_{d,ug}\ \phi_g \qquad \text{AS 2159-2009 1.3.7}$$

- Ultimate strength - the design of a single pile or a pile group must be such that both the design geotechnical strength ($R_{d,g}$) and the structural strength ($R_{d,s}$) are greater than or equal to the Design action effect (E_d) i.e.

$$R_{d,g} \geq E_d \text{ and } R_{d,s} \geq E_d \qquad \text{AS 2159-2009 3.2.2 (d)}$$

- Serviceability - Single piles and pile groups shall be designed for serviceability by controlling or limiting pile movements.
- Durability - This is outlined in Section 6 of AS 2159-2009 and will not be discussed any further here.
- Any other factors that need to be considered i.e. stability, scour, fatigue, cyclic loading or seismic actions - As we are not aware that any of these factors will affect the pile design they will not be considered any further.

The design geotechnical strength ($R_{d,g}$) can be calculated as the design ultimate geotechnical strength ($R_{d,ug}$) multiplied by the geotechnical strength reduction factor (ϕ_g). The ultimate geotechnical strength parameters for the materials encountered on the site are outlined in Table 6.

TABLE 6 ULTIMATE GEOTECHNICAL STRENGTH PARAMETERS ($R_{d,ug}$)

Material		Base Bearing (kPa)		Skin Friction (kPa)
		L<4D	L>4D	
Fill		NR	NR	NC
Clay		NR	NR	30
Sand		NR	NR	NR
Rock	- Above 'TC' Bit Refusal	1500	2200	60
	- Below 'TC' Bit Refusal	3000		100

Notes:
1. NR - Not Recommended; NC - Not considered in skin friction calculations.
2. Recommended geotechnical strength reduction factor (ϕ_g) - Refer AS 2159-2009 - for a moderate risk category and a low redundancy system a value of 0.48 is recommended. This should be confirmed by designer.
3. Considering limit state analysis (AS 2159-2009), the design geotechnical strength $R_{d,g}$ is calculated by multiplying the ultimate geotechnical strength $R_{d,ug}$ by the geotechnical strength reduction factor ϕ_g, i.e. $R_{d,g} = R_{d,ug} \times \phi_g$.
4. Should a "working stress" approach be adopted, a minimum factor of safety of 3.0 on base and 2.0 on skin friction is recommended.
5. Ignore top 1.8m of clay profile in skin friction calculations; shrinkage of the upper-level clays may occur.
6. The above parameters are for single piers. If piers are spaced at closer than three diameters, a reduction factor (Group Efficiency Ratio) may apply.
7. All values to be confirmed by inspection.

Tensional Effects - Potential Uplift Due to Swelling Soils

General

It is recommended that individual piers be assessed for uplift capacity as well as the overall pier capacity. The following sections of the Piling Code AS 2159-2009 should be considered:-

Section 3 Design Requirements and Procedures

A review of Section 3 of the piling code indicates that in Section 3.3 ACTIONS AND COMBINATIONS FOR STRENGTH AND SERVICEABILITY DESIGN that:-

"Where a pile is situated in swelling soils, such as reactive clays or those subjected to frost action, allowance shall be made for the compressive and tensile actions (F_{ex}) that may be developed in the pile." AS 2159-2009 3.3.1.2(b).

Section 3.3.2 Load combinations for strength design and where the actions are induced by ground movement, they shall be computed as below:-

- Structural Design – AS 2159-2009 3.3.2(b)(i)(B) - compressive and tensile actions – refer Section 5.
- Geotechnical Design – AS 2159-2009 3.3.2(b)(ii) - "Loads induced by soil movement shall not be taken into account"

Section 4 Geotechnical Design

In the case of geotechnical design, the effects of swelling soils are mentioned in several sections of AS 2159-2009 Section 4 Geotechnical Design. The designer is directed to review the following sections with respect to their design:-

- 4.4.6 Soil Swelling
- 4.6.4 Pile heave due to soil swelling

Section 5 Structural Design

In the case of structural design, the effect of swelling soils should be considered as part of the structural design of the foundation and as noted above:-

$$S_u = 1.5F_{es}$$ **AS 2159-2009 3.3.2 (b)(i)(B)**

Where Su is the "Ultimate value of various actions appropriate for particular combinations" AS 2159-2009 Table 1.1 (refer also AS 1170) and Fes is the tensile (in this case) actions in the pile induced by vertical ground movements.

F_{es} can be calculated using the "Rational Pier Formula" as

$$F_{es} = 0.15 * SP * A_{mv}$$

- SP = Assessed Swell Pressure of soil (kPa)
- A_{mv} = Surface area of pile in intimate contact with soil in the zone affected by swelling (i.e. above 1.8m)

Based on testing carried out on samples from the site, for design purposes SP = 90kPa.

Uplift may be reduced by constructing a separation e.g. sleeving between the pile shaft and the soil in the unstable zone.

3.2.9 Slab on Ground

General

The expected subgrade following the likely earthworks is existing fill or natural clay soils.

Field and laboratory test results indicate that the existing natural soils, along with any controlled fill, are suitable for slab on ground construction provided that earthworks are carried out in accordance with recommendations in Section 3.1.

However, the existing fill is not considered to be suitable in its current state to support slab on ground floors. Should earthworks operations not result in a subgrade suitable for slab support, the slab on ground floor should be supported on pedestals/piers founding in competent natural soils.

Options

Depending on movement sensitivity of the structure design, the following slab on ground floor options include:-

- Conventional slab on ground floor
- Conventional industrial type floor
- Fully suspended slab
- Stiffened raft

Conventional Slab On Ground Floor

As noted in Section 3.2.3 the slab on ground floor should be designed to accommodate the anticipated potential ground surface movement.

Generally, a conventional slab on ground floor is only adopted for A or S class sites.

Considering the potentially moderately reactive nature of the founding soils, a conventional 'floating slab' system may not be appropriate. The risk of differential movement between slab panels, with the magnitude of this movement varying with the prevailing weathered conditions, is considered to be high.

Works to reduce potential ground surface movements would be required to allow the use of a conventional floating slab system. It is considered that a floating slab would only be suitable for "general commercial" applications provided some movement is acceptable. It is recommended that the extent of works be sufficient to reduce ground surface movements to approximately 20mm.

Conventional Industrial Type Floor

Provided that the performance criteria that would be normally applied to an industrial floor or pavement is consistent with the expected performance of a slab on ground floor for this project, an "industrial floor" could be adopted.

For design purposes, it is recommended that the slab on ground floor be designed adopting principles as contained in the Cement & Concrete Association of Australia, Industrial Floors & Pavements, Guidelines for Design, Construction & Specification.

For design of the industrial floor, a design CBR value of 2.0% is recommended (assuming the subgrade is natural clays). Inspection and testing should be carried out following stripping to fully assess subgrade conditions.

It is recommended that the slab on ground be suitably jointed and dowelled to allow some movement and also structurally separated from footings.

Stiffened Raft

A stiffened raft comprises perimeter and internal beams and is designed to accommodate potential ground surface movements.

This option does generally not suit large slab areas and the possible differential movement before the footing for the structure and the slab must be taken into account.

However, it may be prudent to consider use of a stiffened raft for movement sensitive slab areas (i.e. office, amenities, etc.) within the building.

Fully Suspended

A fully suspended slab system involves the support of the slab on piers with provision of a void beneath the slab to accommodate potential reactive clay movement, span over service trenches or areas above retaining walls to limit additional surcharges on the walls. The design of piers should be in accordance with Section 3.2.8.

Sub-Base

It is **suggested** that a layer of sub-base be provided under all concrete slabs. The sub-base material should be compacted to a density not less than 95% of maximum dry density in accordance with AS 1289 5.2.1 (Modified compaction). The sub-base is provided under a concrete slab to:-

- Provide a stable 'working platform' on which to operate construction equipment;
- Facilitate the provision of a uniform bearing surface under the slab.

Sub-base material should be of good quality conforming to requirements (minimum) of Material Type 2.4 as specified in the Queensland Department of Transport and Main Roads, Technical Specification MRTS05, Unbound Pavements (July 2021).

3.2.10 Design Considerations

Articulation

Given the potentially reactive nature of the subsurface material, the importance of architectural and structural detailing cannot be over-emphasised. It is essential that the building be suitably articulated/detailed to allow for ground surface movement. In addition, the overall design of the building and surrounds should consider the likely ground surface movement and site classification, with the objective being to maintain a stable moisture environment. Your attention is drawn to recommendations contained in Sections 3.2.1, 3.2.3 and 3.2.12.

It is recommended that any masonry walls be articulated. This articulation may be achieved by the use of full height (footings to eaves) openings or vertical construction joints at regular

intervals. Guidelines on articulation are contained in the Cement and Concrete Association's Technical Note 61, 'Articulated Walling'.

Underground Services/Retaining Walls

Where footings are located adjacent to underground services or retaining walls, the footings should extend to base a minimum of 200mm below the trench/wall base level for a distance of 1.0m out from the trench/wall. Beyond 1.0m the footings should be taken a minimum of 200mm below an imaginary line drawn up at 45° from the trench/wall base level. Figure 5 refers.

These requirements do not override minimum footing levels.

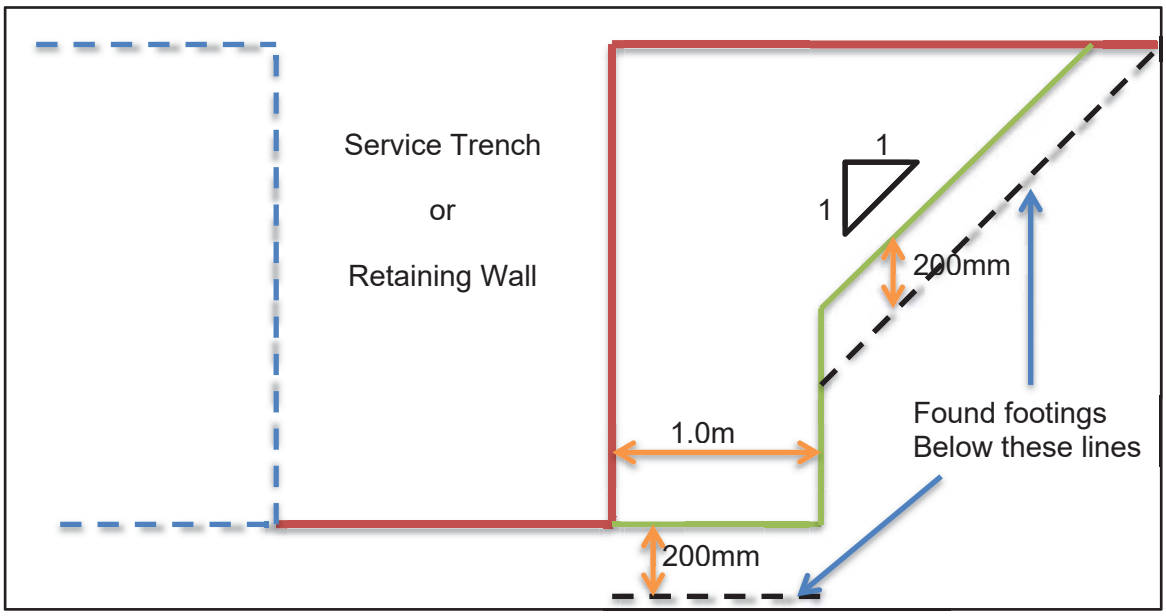


FIGURE 5

3.2.11 Construction Considerations

Inspections

It is recommended that inspections be undertaken by an experienced and qualified geotechnical engineer or engineering geologist following footing excavations and during pier excavations to confirm the adequacy of the founding material. **Inspections should be carried out prior to placement of reinforcing steel and ordering of concrete.**

High Level Footings

Given the properties of the founding materials it is recommended that the footings be poured as soon as possible following excavation, to minimise the potential for desiccation/wetting up of the founding material. Where the footings cannot be poured the same day as excavation, it is recommended that a blinding layer of concrete, at least 50mm thick, be placed immediately following excavation, cleaning and inspection of the footing bases.

Bored Piers

Some difficulty with fall-in may occur with bored piers, particularly when drilling through fill material and clayey sand. It should be ensured that all loose material is removed from the base of piers prior to pouring of concrete. The use of a 'clean-out' bucket should be explicit in

instructions to the drilling contractor. The practice of 'using water and spinning the augers' to remove loose material from the pier base is generally unacceptable.

Although groundwater was not encountered in the boreholes (refer Section 2.3.3) at the time of the investigation:-

- It is recommended that, should a bored pier foundation system be adopted, some allowance for dewatering and the use of liners should be made. In addition, it may be prudent to drill a "trial pier" to fully assess construction difficulties.
- The potential for seepage still exists particularly if the piers are not poured straight after drilling. If the piers exhibit seepage or if left for a significant period (e.g. over night), at the very least it is recommended that the pier holes should be covered and/or soil placed around the piers to minimise the possibility of water entering the pier from the surface. It is also likely that the piers will need to be cleaned and deepened to remove any softened material.

Considering the depth of fill encountered in some of the boreholes, liners may need to be considered in those holes to minimise the issue of wall collapse during the installation of the piers.

Given the nature and strength of the subsurface material encountered, it is recommended that inspections are undertaken by a qualified geotechnical engineer/engineering geologist from Soil Surveys Engineering Pty Limited during pier excavations to confirm the adequacy of the founding material. Inspections should be carried out prior to placement of reinforcing steel and following cleaning of pier bases.

Given the properties of the founding materials, it is recommended that the pier holes be poured as soon as possible following boring, to minimise the potential for desiccation/wetting up of the founding material.

3.2.12 Site Management

It is important that proper site management methods be observed for the existing soil conditions by both the builder at the time of the construction and the owner throughout the life of the proposed development.

Particular reference to this is set out in AS 2870-2011. It should be noted that where proper site management particularly with respect to change in moisture conditions is not followed the foundation recommendations contained in this report could be considered void.

The following are some specific comments with respect to site management and the reader is also directed to CSIRO pamphlet, 10-91, 'to Home Owners on Foundation Maintenance and Footing Performance' for further information.

- It is important that the site be well drained. The ground around the structures should slope away at 1 in 20 for 2 metres and then fall to the stormwater system to prevent ponding of water adjacent to the building.
- Founding soils should not be allowed to become saturated.
- It is recommended that service trenches under the structures be minimised as disruption or breakage of these service lines could lead to saturation of the under-slab/footing material resulting in an increase to the site classification. If this were to occur all footing

recommendations contained within this report would be void. Where service trenches are adopted the possible effects of leakage should be considered in the design

- Where service lines are placed under a structure it is recommended that the base of these trenches fall towards the outside of the structure and that these trenches are backfilled in an appropriate manner to minimise the potential for seepage into the trench and therefore under the structure.
- Footings should be placed with minimal delay after excavation to avoid desiccation or wetting of the founding soils. If footings cannot be poured on the same day as excavation, a blinding layer of 50mm thickness is recommended. Piers should be poured immediately following excavation.
- Do not let the slab subgrade "dry out" prior to casting.
- Future shrubs and trees should be planted at a distance at least equivalent to three quarters times their mature height away from the building to avoid shrinkage movement in the potentially expansive founding soils. Existing trees that may encroach within this restriction should be removed. It is recommended that trees to be removed as early as possible prior to building construction to enable soil moisture to reach equilibrium. Should this not be done the effect of these trees must be taken into account in the design of the structure.

3.3 Retaining Walls

3.3.1 General

It is understood that retaining walls may be required for sections of the proposed development. It is expected that the maximum retained height will be up to 2.0 metres.

The lateral earth pressure distribution that affects the retaining walls on the site will depend upon the following parameters:-

- In-situ and backfill material properties
- Design water regime at the rear of the wall
- Wall and cut geometry
- Surcharges affecting the wall
- Wall type
- The structural bracing of the wall and the timing of backfilling behind the wall

3.3.2 Design Requirements

It is recommended that any retaining structure is designed in accordance with AS 4678-2002 ‘Earth Retaining Structures’. Section 3 of this code outlines the design requirements for these retaining structures which specifically includes both Ultimate and Serviceability Limit Modes, it is recommended that the retaining structures be assessed for each of these modes.

Note the following sections provide general recommendations with respect to some of these limit modes however it doesn't provide a detailed assessment in full accordance with the above-mentioned modes for AS 4678 as this will require additional information. A detailed assessment can be undertaken of the geotechnical aspects of the Limit Modes for the proposed retaining

structures once details of the wall have been provided. **Of particular importance is the assessment for Limit Mode U5 Global Failure for the proposed walls.**

3.3.3 Pressure Distribution

The following situations should be considered:-

- For cantilever walls, which allow some movement at the top, (i.e., at least 0.005H in clays) the active case (K_a) applies with a triangular distribution in both the short- and long-term situations.
- For cantilever walls which cannot tolerate this movement, the at rest case (K_o) applies with a triangular distribution in both the short- and long-term situations.
- For structurally braced walls the wall design should be checked for both a trapezoidal (clay soils - short term conditions) and triangular distribution with K_o values (long term conditions).

The pressure distributions as referred to above are shown in Figures 6 and 7. The parameters selected for use in the figures are dependent on the preconstruction geometry of the face being retained. Where the material has been cut using the recommendations as outlined in Sections 3.1.6 and 3.1.7, the backfill parameters will control. Where a steeper angle is used the earth parameters will control.

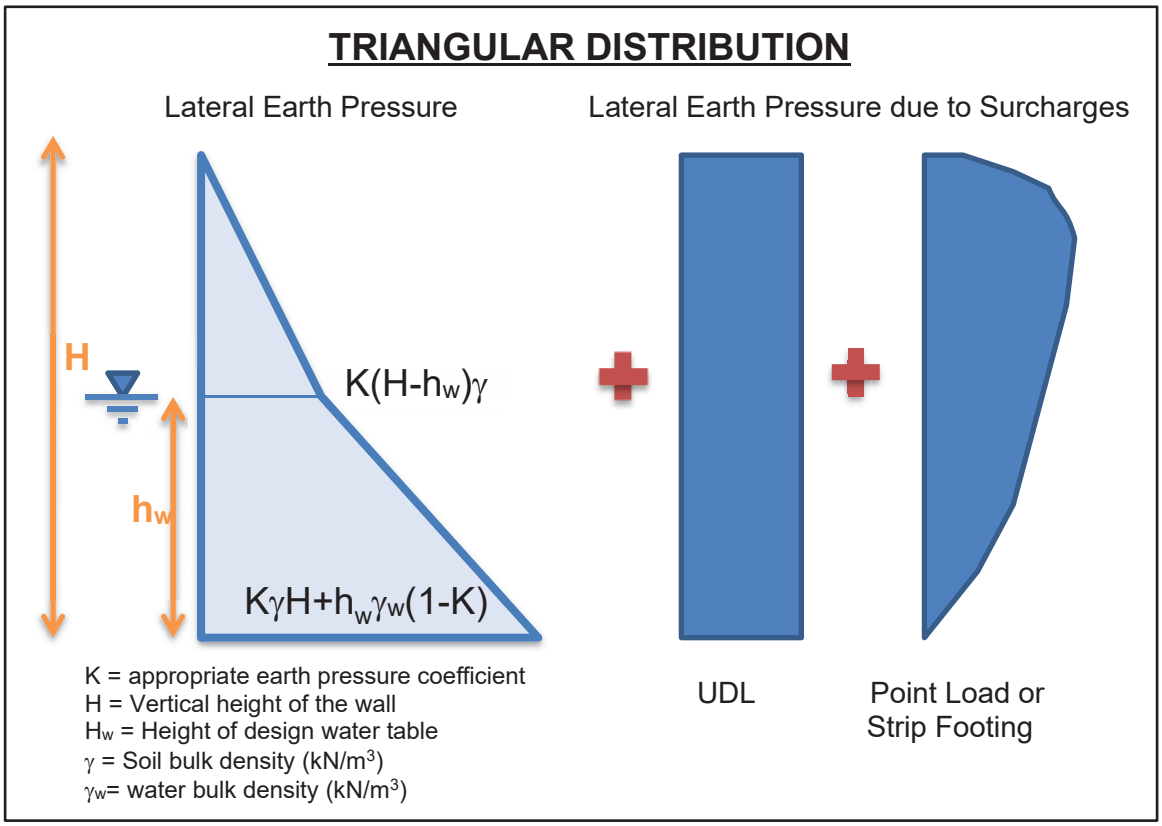


FIGURE 6

The lateral pressure distributions shown in Figures 6 and 7 include hydrostatic pressure and show typical pressure distributions due to surcharge loadings. It is recommended that where the retaining walls are expected to be surcharged (e.g., by footings, traffic loads, sloping ground

surface, etc.) Soil Surveys Engineering should be contacted to provide a recommended lateral earth pressure distribution.

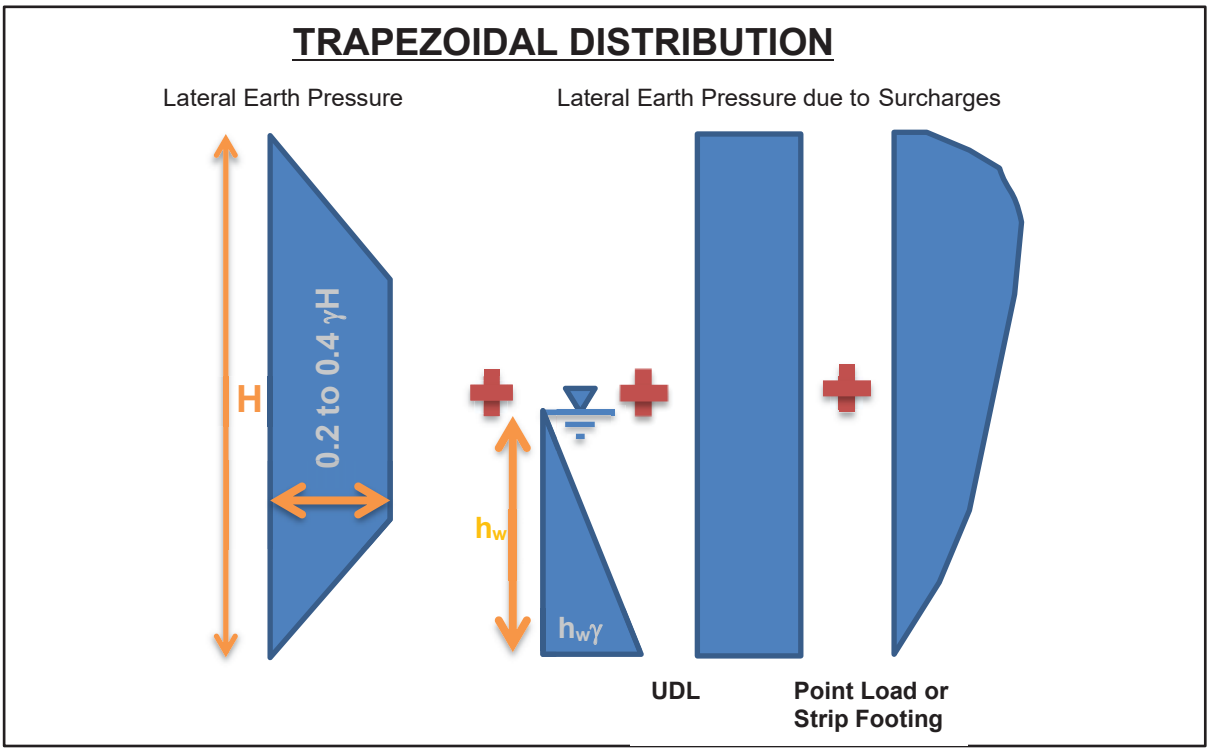


FIGURE 7

Parameters (unfactored) for assessment of lateral earth pressures are outlined in Table 7.

TABLE 7 RETAINING WALL DESIGN PARAMETERS (UNFACTORED)

Material	Density (kN/m^3)	Earth Pressure Coefficient Vertical Wall			Long Term Drained ϕ (°)
		K_a	K_o	K_p	
Existing Embankment Fill	18	0.55	1.0	NR	25
Compacted Fill	19	0.5	0.80	2.0	28
Gravel Back Fill[2]	20	0.33	0.70	NR	35
Hard Clay	19	0.5	0.80	2.0	28
Weathered Rock	21	0.33	0.70	3.0	35

Notes:-
1. NC = Not Considered, NR = Not recommended.
2. Drainage gravel.

The above recommend values are based on a drained model but has assumed a cohesion value of 0kPa for all materials. Whilst testing will indicate a value in excess of 0kPa there is some concern that in the long term a very low cohesion would be more appropriate for design. Should an undrained model be more appropriate values can be provided.

3.3.4 Resistance To Lateral Forces

Retaining walls can be designed to resist lateral pressure distribution in several ways i.e.:-

- Passive resistance at the toe of the wall
- Passive resistance at the key of the wall
- Frictional resistance due to the weight of the wall

- Dowelling into rock
- Positive resistance at the base for Bored pier walls (Figure 8)

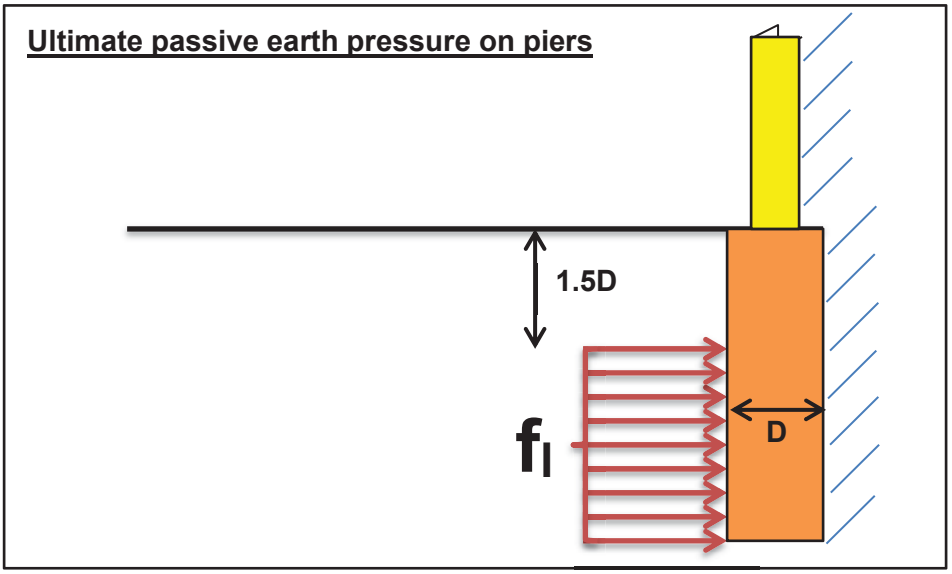


FIGURE 8

Because the resistance can be affected by various parameters, Soil Surveys Engineering should be contacted once the general wall geometry has been identified to provide further comment. For design purposes adopt f_l (design ultimate lateral capacity) values equal to the Ultimate base bearing pressure for the various material types as outlined in Table 6 in Section 3.2.8.

3.3.5 Surcharge Loads

AS 4678 requires that all structures are designed to resist live loads resulting from the intended use of the structure but not less than the values outlined in Table 4.1 of the code.

AS 4678 (Appendix J) also provides some guidance on the effect of earth pressures resulting from:-

- The geometric shape of the retaining structure.
- The effect of compaction adjacent to the retaining structure.
- Various types of surcharges.

As a general guide (using an elastic model) line loads located 2.5H away from the wall (where H is the wall height) results in lateral forces of less than 10% of the line load.

3.3.6 Backfill and Drainage

Any backfill placed behind the wall should be loose granular material. The backfill should not be heavily compacted since research has shown that compaction can raise the earth pressure to above the 'at rest' pressure (refer AS 4678 Appendix J).

Adequate surface and subsoil drainage should be provided for all retaining walls on the site. Cut-off/interceptor drains should also be provided around the high side of the wall to ensure stormwater runoff from the area above the wall is suitably diverted.

The placement of a filter fabric between the retained soil and the drainage material (e.g., granular backfill) for protection against silting of the drainage material is recommended. The outlets to subsoil pipe drains must be located beyond the ends of the walls and connected to a proper drainage system. It is suggested the pipes be wrapped in filter fabric to minimise silting.

In weather exposed locations, to reduce infiltration by surface runoff, the surface of the backfill should be sealed. This can be achieved by either compacting a material of low permeability i.e., on site clay or concrete, etc. with a slope towards an open drain.

Due to possible long-term problems with blocking of gravel filters and drains and short-term storm conditions that could flood the fill behind retaining walls, it is recommended that all retaining walls be designed for some water pressure distribution. For ultimate limit state the suggested water pressure distribution for retaining walls on this site would be half height water pressure.

During installation of any retaining walls, the in-situ soils should be battered back to minimise fall-in and subsequent disruption of works. Temporary batter angles are given in Sections 3.1.6 and 3.1.7. Suitable precautions to satisfy Health & Safety requirements must also be adhered to.

3.4 Pavements

3.4.1 General

It is understood that a flexible pavement is proposed for the majority of the driveway and carparking areas along with some rigid pavement areas.

Boreholes BH01 and BH02 were drilled to assess subgrade conditions. Following earthworks, it is envisaged that a Sandy CLAY or Clayey SAND subgrade will be exposed.

Laboratory testing was carried out on the natural clay material sampled from Boreholes BH01 and BH02 to determine this material's California Bearing Ratio (CBR); the CBR value represents the 'strength' of this material, compacted to 100% standard density ratio, under saturation. The Soaked CBR test produced values of 2.0% and 13.0%.

Given the above and considering the reactive nature of the subgrade soils, a design CBR value of 2.0% and a modulus of subgrade reaction of 19kPa/mm – Austroads (2009)[1] are recommended for design. It should be noted that the design value will be highly dependant on the amount of earthworks required to construct the building platform.

3.4.2 Subgrade Treatment

As noted in Section 2.3.2, uncontrolled fill material exists on site. For pavement construction, a full subgrade treatment is recommended in areas where uncontrolled fill exists.

Full subgrade treatment involves complete removal of uncontrolled fill so that a controlled/certified fill platform is created.

3.4.3 Design for Reactive Soils

Pavement design should also consider the presence of reactive soils.

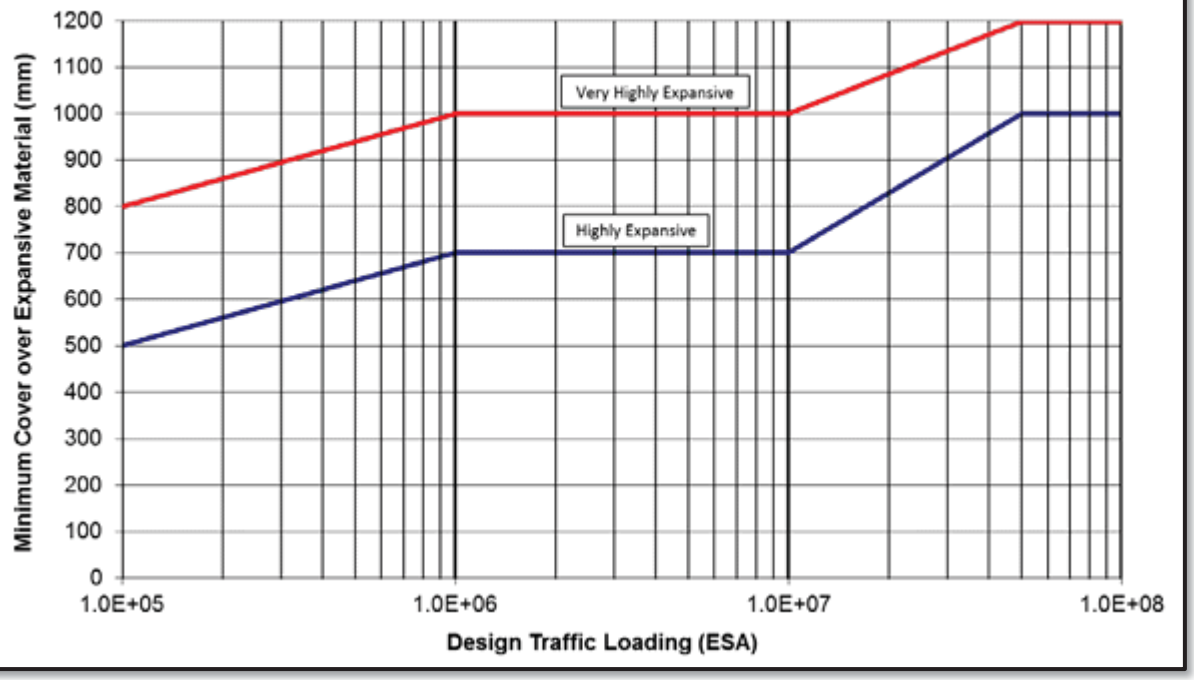
[1] Austroad (2009) Review of relationship to predict Subgrade Modulus from CBR, Pub No. AP-T130/09.

Testing indicates subgrade swell values of 0.0% and 3.0% (refer Table 2).

A review of the Department of Transport and Main Roads (DTMR) document, Supplement to 'Part 2: Pavement Structural Design' of the Austroads Guide to Pavement technology suggest the following approach:-

- Assess the expansive nature of the subgrade (Table 5.3.5 in DTMR document):-
  - CBR Swell <0.5% - Low
  - CBR Swell 0.5% to 2.5% - Moderate
  - CBR Swell 2.5% to 5.0% - High
  - CBR Swell 5.0% to 10.0% - Very High
  - CBR Swell >10.0% - Extreme
- The DTMR document noted that in the case of Low or Moderate the document indicates that additional cover beyond that provided by the pavement and support layers is not typically required.
- The DTMR recommendation was for highly and very highly expansive soil, the use of Table 5.3.5 (reproduced below) is recommended.

Figure 5.3.5 – Typical cover thickness over highly and very highly expansive material for flexible pavements (thickness includes the pavement)



3.4.4 Additional Comments

Along with recommendations contained in Section 3.1, the following general earthworks recommendations are made:-

- Incorporate a perimeter drain at the pavement edges to prevent possible deterioration under wet weather.

- Pavements should be well drained both during and upon completion of construction. Water should not be allowed to pond on or near pavement surfaces.
- Pavement gravel should comply with the Local Council or Queensland Department of Main Roads quality specifications for sub base and base course material.
- Subgrades should be compacted to achieve the minimum density ratios as outlined in Section 3.1.2 'Earthworks'.
- **It is recommended that inspection and testing be carried out following general earthworks to confirm subgrade conditions.**
- Concrete pavements should preferably be keyed and dowelled at transverse joints and keyed and tied at longitudinal joints.

4.0 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill, footing excavations, and cut batter slopes in soil and rock together with pavement subgrades should be inspected by Soil Surveys Engineering Pty. Limited or a duly qualified Geotechnical Engineer. Should subsurface conditions other than those described in this report be encountered, Soil Surveys Engineering Pty. Limited should be consulted immediately and appropriate modifications developed and implemented if necessary.

5.0 LIMITATIONS

We have prepared this report for the use of **Centre Store Properties Trust**, for design purposes in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for use by parties other than **Centre Store Properties Trust**; it may not contain sufficient information for purposes of other parties or for other uses. Please note that any third party relying on the information contained in this report for any purpose whatsoever does so entirely at its own risk, and any duty of care to that third party is excluded.

Any interpretation or recommendation given by Soil Surveys Engineering shall be understood to be based on judgement and experience and not on greater knowledge of the facts than the reported investigations would imply. The interpretation and recommendations are therefore opinions provided for our Client's sole use in accordance with the specific brief. As such they do not necessarily address all aspects of ground behaviour on the subject site. Information provided by others has been taken in good faith, but no liability can be accepted for information provided by others.

Your attention is drawn to 'Appendix A', 'Notes Relating to this Report'. Interpretation of factual data given in this report is based on judgement, not a greater knowledge of facts other than those reported.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing and depth of boreholes, the method of drilling, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes. Subsurface conditions between and below boreholes may vary significantly from conditions encountered at the borehole locations.

Please note that should, following detailed design, footings or piers/piles be required to extend within 3B (B = footing width/pier diameter) above the termination level of the boreholes/pits/CPTU or any excavations extend below borehole/pit/CPTU termination levels, Soil Surveys Engineering should be contacted immediately. In this case, geotechnical data in this report should be considered preliminary only; additional investigation is likely to be required.

In the event that conditions encountered on site during construction appear to vary from those expected from the information contained in the report, the Company strongly recommends that it immediately be notified. Most problems are more readily resolved when conditions are exposed than at some later stage, after the event. Should Soil Surveys Engineering not be notified or if this notification is delayed, then Soil Surveys can not be held responsible for the affect that any variation has on any aspect of the development.

Soil Surveys Engineering consider that a documentation review service (during the design phase and prior to construction) to verify that the intent of geotechnical recommendations is properly reflected in the design, along with construction inspections, forms a very important component of the geotechnical engineering design service/process.

The geotechnical review ensures geotechnical risks to our Client and their project are minimised at the design and tender stage of the project. Further, with Soil Surveys Engineering being commissioned to carry out geotechnical construction inspections, an opportunity at the time of construction to confirm any assumptions made in the preparation of the report and allow the effect of any normally occurring variation in ground conditions to be assessed with respect to construction becomes available.

The above statements are not intended to reduce the level of responsibility accepted by Soil Surveys Engineering in accordance with our commission, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so and the risks they accept should they decline to have Soil Surveys Engineering carry out a geotechnical documentation review and geotechnical construction inspections.

It is highly recommended that the Client avail themselves of these review and inspection services; our standard rates will apply.

N.T. PERKINS (RPEQ 7527)
PRINCIPAL GEOTECHNICAL ENGINEER

For and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

APPENDICES

APPENDIX A

NOTES RELATING TO THIS REPORT

INTRODUCTION

These notes are provided by Soil Surveys Engineering Pty Limited (the Company) to complement the geotechnical report in regard to classification methods and field procedures. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited information about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such information obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and at the time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

Soils - The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726-2017 (Geotechnical Site Investigations), where appropriate. In general, descriptions cover the following properties - soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the dominant particle size and behaviour as set out in AS 1726-2017.

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, shear vane, laboratory testing or engineering examination. The strength terms are defined in AS 1726-2017 Table 11.

Non-cohesive soils are classified on the basis of relative density usually based on insitu testing or engineering examination (see AS 1726-2017 Table 12).

Rocks - Rock types are classified by their geological names (AS 1726-2017 Tables 15 to 18), together with descriptive terms regarding weathering (AS 1726-2017 Table 20), strength (AS 1726-2017 Table 19), defects (AS 1726-2017 Table 22), etc.

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon sample disturbance, (information on strength and structure).

Undisturbed samples are taken by pushing a thin walled sample tube, usually 50mm diameter (U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength, volume change potential and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

SAMPLE STORAGE – SOIL, ROCK AND WATER SAMPLES

Soil samples (not subject to testing) are not stored beyond a period of 90 days of taking or receiving said soil sample. Rock core (not subject to testing) is not stored beyond a period of six months of taking or receiving said rock core.

Should any party require that soil samples (not subject to testing) be stored beyond 90 days, or rock core (not subject to testing) be stored beyond six months, please contact Soil Surveys Engineering.

Water samples (not subject to testing) are not stored beyond a period of seven days of taking or receiving water samples.

TEST LOCATIONS

Test locations (e.g. boreholes, CPT's, test pits etc.) were based on available access at the time of testing. Test locations may have been shifted if access was not suitable.

Unless noted otherwise, accuracy of test locations are to the accuracy of hand held GPS equipment.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application.

Test Pits - These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to approximately 3.0m for a backhoe and up to 6.0m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling - A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the augers can occur on a variety of materials such as hard clay, gravel or rock fragments and does not necessarily indicate rock level.

Continuous Spiral Flight Augers - The borehole is advanced using 75mm to 300 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the augers. Information from the drilling (as distinct from specific sampling) is of relatively lower reliability due to remoulding, inclusion of cuttings from above or softening of samples by groundwater, or

uncertainties as to the original depth of the samples. Augering below the groundwater table has a lower reliability than augering above the water table. Various drill bits are attached to the base of the augers during the drilling. The depth of refusal of the different bit types can provide information as to the strength of the material encountered. Generally the 'TC' bit (a tungsten carbide tipped screw type bit) is used.

Wash Boring - The borehole is usually advanced by a rotary bit with water or fluid pumped down the hollow drill rods and returned up in the space between the rods and the soil or casing, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration. More accurate information on soil strata is gained by regular testing and sampling using the Standard Penetration Test (SPT) and undisturbed thin walled tube samples (U50).

Mud Stabilized Drilling - Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilize the borehole. The term "mud" encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from regular intact sampling (e.g. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling - A continuous core sample is obtained using a diamond or tungsten carbide tipped core barrel. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable method of investigation. In rocks, NMLC coring (nominal 52 mm diameter) is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses is determined on site by the supervisor. If the location of the loss is uncertain, it is placed at the top end of the run, when the core is placed in a storage tray and recorded on the log.

Standard Penetration Tests - Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" - Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm, the upper 150 mm being neglected due to possible disturbance from the drilling method. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued at a reduced penetration.

In the case where full penetration is obtained with successive blow counts for each 150 mm of, say 4, 6 and 7 blows, the record shows,

4, 6, 7 N = 13

In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm, the record shows:

15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, it is noted on the borehole logs.

A modification to the SPT test is where the same driving system is used with a solid 600 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid SPT are shown as "N_c" on the borehole logs, together with the number of blows per 150 mm penetration.

Cone Penetration Tests - Test Method - Cone Penetration Tests (CPT) are carried out in accordance with AS 1289 Test 6.5.1-1999, using an electrical friction-cone penetrometer.

The test essentially comprises the measurement of resistance to penetration of a cone of 35.7 mm diameter pushed into the soil at a rate of 10-20 mm per second by hydraulic force. The resistance to penetration is recorded in terms of pressure on the end area of the cone (cone resistance, q_c, in MPa) and friction on the side of the 135 mm long sleeve immediately above the top of the cone (friction resistance, f_s, in kPa). These forces are measured by electrical transducers (strain gauges) within the cone device. The ratio between friction resistance and cone resistance is also calculated as a percentage, i.e.-

$$\text{Friction Ratio (FR)} = \frac{\textit{Friction Resistance, } f_s\,(kPa)\ x\ 100}{\textit{cone resistance, } q_c\,(kPa)}$$

The friction ratio, FR, is generally low in sands (less than 1% or 2%) and generally higher in clays (say 3% or more). The interpretation of sandy clays, clayey sands and material with a high silt content is more difficult, but intermediate values (between 1% and 3%) would be expected. Highly organic clays and peats generally have a friction ratio in excess of 5%.

Static cone data is recorded in the field on disc for later presentation using computer aided drafting.

The equipment can be operated from any conventional drill rig. A total applied load in the range of 4 to 10 tonnes is required for practical purposes, although lighter loads may be used. The cone penetrometers are available with various capacities of cone resistance ranging up to 100 MPa for general purpose investigations, while a range of 0 to 10 MPa can be used where more sensitive investigations of soft clay are required.

The cone resistance value provides a continuous measure of soil strength or density, and together with the friction ratio, provide very useful indications of the presence of narrow bands of geotechnically significant layers such as thin, soft clay layers or lenses of sand which might otherwise be missed using conventional drilling methods.

The lithology of the encountered soils is interpreted from static cone data and is generally presented on the static cone log sheets.

It is important to note that the lithology is interpreted information and is based on research by Schmertmann (1970), Sanglerat (1972), Robinson and Campinalli (1986), modified to suit local conditions as indicated by borehole information and laboratory testing.

As soils generally change gradually it is sometimes difficult to accurately describe depths of strata changes, although greater accuracy is obtained with the static cone compared with conventional drilling. In addition, friction ratios decrease in accuracy with low cone resistance values, and in desiccated soils. As a result, some overlap and minor discrepancies may exist between static cone and nearby borehole information.

Portable Dynamic Cone Penetrometers - Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 100mm increments of penetration.

The DCP comprises a Cone of 20 mm diameter with 30 degree taper attached to steel rods of smaller section.

The cone end is driven with a 9 kg hammer falling 510 mm (AS 1289 Test 6.3.2). The test was developed initially for pavement subgrade investigations, and empirical correlations of the test results with California Bearing Ratio have been published by various Road Authorities. The Company has developed their own correlations with Standard Penetration tests and Density Index tests in sands.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems.

- Although groundwater may be present in lower permeability soils, it may enter the hole slowly or perhaps not at all during the time the hole is open.
- A localized perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be bailed out of the bore and mud must be washed out of the hole or "reverted" if water observations are to be made.

More reliable measurements can be made by use of standpipes which are read after stabilizing at periods ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (e.g. bricks, steel, etc.) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is important to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms and the attached explanatory notes summarize important aspects of the Laboratory Test Procedures adopted.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. The information provided in Soil Surveys Engineering reports is opinion and interpretation and not factual. The client/contractor increases their risk by not retaining the person who authored the geotechnical report, to carry out site inspection and review (overseeing role) during construction, to confirm opinion and interpretation expressed in the report is accurate. Where the report has been prepared for a specific design proposal the information and interpretation may not be relevant if the design proposal is changed. If this happens, the Company 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, discussion of geotechnical aspects and recommendations or suggestions for design and construction. Since the test sites in any exploration represent a very small proportion of the total site and since the exploration only identifies actual ground conditions at the test sites, even under the best circumstances actual conditions may vary from those inferred to exist. No responsibility is taken for:-

- Unexpected variations in ground and/or groundwater conditions.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of other persons.
- Any work where the company is not given the opportunity to supervise the construction using the Companies designs/recommendations.

If differences occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are more readily resolved when conditions are exposed than at some later stage, well after the event.

Extreme events including but not limited to the results of climate change, e.g. flood levels above previously identified levels, beach scour or erosion beyond normal expectations (as identified by local authorities) extreme rainfall events, war, espionage, sabotage may result in different conditions between time of investigation and time of construction.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document “Guidelines for the Provision of Geotechnical Information in Construction Contracts (1987)”, published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances, where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are propose or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer. We would be happy to assist in this regard as an extension of our investigation commission. Construction drawings should be reviewed by Soil Surveys Engineering, with sufficient time to allow changes if required, prior to inspections. Otherwise Soil Surveys Engineering reserves the right to refuse to carry out inspections.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

i. Site visits during construction to confirm reported ground conditions
ii. Site visits to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, the stability of a filled or excavated slope; or
iii. Full-time engineering presence on site.

In the vast majority of cases it is advantageous to the principal for the geotechnical engineer who wrote the investigation report to be involved in the construction stage of the project.

The geotechnical engineer cannot take responsibility for variations in encountered conditions, where he is not given the opportunity to review plans for the proposed development with sufficient time to allow review and make changes to the proposed development if required, and where he is not given the opportunity to inspect the site and oversee construction methods with regard to site conditions with sufficient time to observe all relevant site conditions and operations.

RESPONSIBLE USE OF GEOTECHNICAL INFORMATION

Recommendations in our report are for design purposes only and provided on the basis that inspections are carried out to allow finalisation of opinions and recommendations contained in our report.

The geotechnical investigation consisting of field and laboratory testing has been carried out to indicate typical conditions by indicating conditions and parameters at the specific locations of boreholes/test pits. Subsurface conditions are indicated at these locations only and the inference of conditions between or away from these locations (interpolation and extrapolation) involves a certain degree of risk. Persons inferring such conditions or carrying out such inferences should do so with a degree of caution and conservatism which is commensurate with the consequences of the risk of error.

Estimates of volumes based on our findings require interpolation and extrapolation between test locations and as such may be significantly different from actual volumes.

APPENDIX B

BOREHOLE RECORD SHEETS

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 01

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 26/11/2021 Page: 1 OF 1

Easting: 494949 Northing: 6924016 RL: 48.2 m
Logger: RH Operator: RH Machine: EVH1750

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		FILL Silty SAND (SM): Loose, fine to coarse grained, dark brown, with organics, trace fine sized gravel, moist		CBR
	0.5		FILL Sandy CLAY (CL-CI): Very stiff, low to medium plasticity, dark brown mottled dark grey, fine to coarse grained sand, trace fine to coarse sized gravel, w<pl (tending to clayey sand)		
	0.60		NATURAL Silty SAND (SM): Medium dense, fine to medium grained, light brown, moist		
	0.80		Sandy CLAY (CH): Very stiff to hard, high plasticity, dark grey mottled red brown, fine to medium grained sand, w<pl		
	1.0				
	1.10				
	1.20		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light brown, indistinct moist		
			BOREHOLE BH 01 TERMINATED AT 1.20 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 1.10m.
3. TC bit refusal at 1.20m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 02

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 26/11/2021 Page: 1 OF 1

Easting: 494936 Northing: 6924062 RL: 48.9 m
Logger: RH Operator: RH Machine: EVH1750

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.15		FILL Silty SAND (SM): Loose, fine to coarse grained, dark grey, with organics, trace fine sized gravel, moist		
	0.30		NATURAL Silty SAND (SM): Medium dense, fine to coarse grained, light brown, trace fine sized gravel, moist		
	0.5		Sandy CLAY (CH): Very stiff, high plasticity, dark brown mottled dark grey, fine to medium grained sand, w=pl		CBR
	0.70				
	0.90		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light brown mottled light grey, indistinct moist		
	1.0		BOREHOLE BH 02 TERMINATED AT 0.90 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 0.70m.
3. TC bit refusal at 0.90m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 03

Project Number: 1-24684

Project Name: Storage Facility & Retail Development

Location: 1 Homestead Drive, Jimboomba

Client: Centre Stores Properties Trust

Date: 26/11/2021 Page: 1 OF 1

Easting: 494921 Northing: 6924018 RL: 48.5 m

Logger: RH Operator: RH Machine: EVH1750

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		FILL Silty SAND (SM): Loose, fine to coarse grained, dark brown, with organics, trace fine sized gravel, moist		
	0.5		FILL Silty SAND (SM): Loose to medium dense, fine to coarse grained, dark brown, with sandy clay bands, trace fine sized gravel, moist		D
	0.60		NATURAL Silty SAND (SM): Medium dense, fine to coarse grained, dark brown, trace low plasticity clay, moist		
	0.80		Sandy CLAY (CH): Hard, high plasticity, dark grey mottled dark brown, fine to medium grained sand, w<pl		
	1.0				U50 PP=>600 Rec = 70%
	1.40		Sandy CLAY (CI-CH): Hard, medium to high plasticity, light grey mottled dark grey, fine to coarse grained sand, with extremely weathered sandstone bands, trace fine sized gravel, w<pl		
	1.5				
	1.90		Extremely weathered Sandstone (XW) recovered as Clayey SAND (SC): Very dense, fine to coarse grained, mottled dark grey drk brown, low to medium plasticity clay, trace fine sized gravel, moist		
	2.0				D
	2.5				
	3.0				
	3.5				
	4.0				
	4.30				
	4.40		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, mottled light brown light grey, indistinct moist		
	4.5		BOREHOLE BH 03 TERMINATED AT 4.40 m		
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 1.50m.
3. TC bit refusal at 4.40m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 04

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 26/11/2021 Page: 1 OF 1

Easting: 494962 Northing: 6924026 RL: 48.2 m
Logger: RH Operator: RH Machine: EVH1750

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.12		FILL Silty SAND (SM): Medium dense, fine to coarse grained, dark brown, with low to medium plasticity clay, with organics, trace fine sized gravel, moist		
	0.35		FILL Silty SAND (SM): Medium dense, fine to coarse grained, dark brown, with low to medium plasticity clay, trace fine sized gravel, moist		
	0.5		NATURAL Silty SAND (SM): Medium dense, fine to coarse grained, dark brown, moist		
	0.70		Sandy CLAY (CH): Very stiff, high plasticity, mottled dark grey dark brown, fine to coarse grained sand, w<pl		U50 PP=>600 Rec = 64%
	1.0				
	1.20		Hard		
	1.5				U50 PP=560 Rec = 64%
	1.90		Sandy CLAY (CI-CH): Hard, medium to high plasticity, dark grey mottled dark brown, fine to coarse grained sand, trace fine sized gravel, w<pl		
	2.0				
	2.40				
	2.5		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light grey, indistinct moist		
	2.50		BOREHOLE BH 04 TERMINATED AT 2.50 m		
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 2.20m.
3. TC bit refusal at 2.50m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 05

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494896 Northing: 6924084 RL: 50.5 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.20		FILL Silty SAND (SM): Loose, fine to medium grained, dark grey, trace fine to medium sized gravel, moist		
	0.40		FILL Clayey Silty SAND (SC): Medium dense, fine to medium grained, dark grey mottled light brown, low plasticity clay, moist		D
	0.5		FILL SAND (SP): Medium dense, fine to medium grained, light brown, moist		D
	0.70		FILL SAND (SP): Dense, fine to medium grained, light brown, moist		
	1.0				
	1.00		NATURAL Silty CLAY (CH): Hard, high plasticity, light grey mottled light brown, trace fine to medium grained sand, w<pl		D
	1.5				U50 PP=>600 Rec = 72%
	1.80		Extremely weathered Sandstone (XW) recovered as Clayey SAND (SC): Dense, fine to medium grained, light grey, low plasticity clay, moist		D
	2.00		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light grey, indistinct moist		
	2.20		BOREHOLE BH 05 TERMINATED AT 2.20 m		
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 0.66m.
3. TC bit refusal at 2.20m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 06

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494963 Northing: 6924072 RL: 48.7 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		FILL Silty Gravelly SAND (SM): Loose, fine to medium grained, dark grey, fine to coarse sized gravel, trace organics, moist		
	0.40		FILL Silty Gravelly SAND (SM): Loose, fine to medium grained, dark grey, fine to coarse sized gravel, moist		
	0.5		FILL Silty Sandy CLAY (CH): Very stiff, high plasticity, dark grey mottled light brown, fine to medium grained sand, w>pl		U50 PP=>600 Rec = 87%
	0.90				
	1.0		NATURAL Silty Sandy CLAY (CI): Very stiff, medium plasticity, dark grey mottled light brown, fine to medium grained sand, w<pl		
	1.10		Hard		
	1.5				U50 PP=>600 Rec = 80%
	1.80		Silty Sandy CLAY (CL): Hard, low plasticity, cream, fine to medium grained sand, w<pl		D
	2.0				
	2.10		Extremely weathered Sandstone (XW) recovered as Clayey SAND (SC): Dense, fine to medium grained, cream mottled orange, low plasticity clay, moist		D
	2.40		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, cream mottled orange, indistinct moist		
	2.5				
	2.60		BOREHOLE BH 06 TERMINATED AT 2.60 m		
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 1.28m.
3. TC bit refusal at 2.60m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 07

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494888 Northing: 6924022 RL: 49.0 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.5		FILL Silty SAND (SM): Very loose to loose, fine to medium grained, dark grey, trace fine to medium sized gravel, moist		
	0.70		NATURAL Silty Sandy CLAY (CH): Very stiff, high plasticity, dark grey mottled light brown, fine to medium grained sand, w=pl		U50 PP=>600 Rec = 90%
	1.0				
	1.00				
	1.10		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, orange brown mottled dark grey, indistinct moist		
	1.5		BOREHOLE BH 07 TERMINATED AT 1.10 m		
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 0.99m.
3. TC bit refusal at 1.10m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 08

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494924 Northing: 6924052 RL: 49.0 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		FILL Silty SAND (SM): Loose, fine to medium grained, light brown mottled dark brown, trace organics, moist		
	0.5 0.50		FILL Silty SAND (SM): Loose, fine to medium grained, light brown mottled dark brown, moist		
	0.90		FILL Silty Sandy CLAY (CH): Very stiff, high plasticity, dark grey mottled light brown, fine to medium grained sand, w>pl		U50 PP=>600 Rec = 95%
	1.0 1.00		NATURAL SANDSTONE (DW): Distinctly weathered, low strength, fine grained, yellow brown, indistinct moist		
			BOREHOLE BH 08 TERMINATED AT 1.00 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 0.93m.
3. TC bit refusal at 1.00m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 09

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494924 Northing: 6924074 RL: 49.5 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.10		FILL Clayey Gravelly SAND (SC): Medium dense, fine to medium grained, yellow brown mottled dark grey, low plasticity clay, fine to coarse sized gravel, moist		D
	0.40		FILL Silty SAND (SM): Loose, fine to medium grained, dark grey, moist		D
	0.5		FILL Silty SAND (SM): Loose, fine to medium grained, light grey, wet to moist		
	0.70				
	0.80		NATURAL SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light brown mottled orange, indistinct moist		
	1.0		BOREHOLE BH 09 TERMINATED AT 0.80 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 0.72m.
3. TC bit refusal at 0.80m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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BOREHOLE RECORD SHEET

Location Number: BH 10

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494946 Northing: 6924052 RL: 48.7 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.30		FILL Silty SAND (SM): Loose, fine to medium grained, dark grey, trace organics, moist		
	0.5		FILL SAND (SP): Loose, fine to medium grained, light brown, wet to moist		D
	0.70				
	0.80		NATURAL SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, yellow brown mottled light grey, indistinct moist		
	1.0		BOREHOLE BH 10 TERMINATED AT 0.80 m		
	1.5				
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 0.67m.
3. TC bit refusal at 0.80m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 11

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494907 Northing: 6924059 RL: 49.4 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.20		FILL Silty SAND (SM): Loose, fine to medium grained, dark brown, trace fine to medium sized gravel, moist		
	0.50		FILL Silty SAND (SM): Loose, fine to medium grained, dark brown, trace low plasticity clay, trace fine to medium sized gravel, moist		
	0.70		FILL Clayey Silty Sandy GRAVEL (GC): Medium dense, fine to coarse sized, dark brown mottled light brown, high plasticity clay, fine to medium grained sand, moist		
	1.00		NATURAL Silty Sandy CLAY (CH): Hard, high plasticity, dark grey mottled light brown, fine to medium grained sand, w=pl		U50 PP=>600 Rec = 87%
	1.80		Silty Sandy CLAY (CH): Hard, high plasticity, dark grey mottled light brown, fine to medium grained sand, w<pl		U50 PP=>600 Rec = 100%
	1.90		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light grey, indistinct moist		
			BOREHOLE BH 11 TERMINATED AT 1.90 m		

Comments:
1. Groundwater not encountered during augering.
2. TC bit refusal at 1.90m.

Water First Noted Water Steady Level Water Loss

Weathering Grades: RS - Residual Soil; XW - Extremely weathered; HW - Highly weathered; DW - Distinctly weathered; MW - Moderately weathered; SW - Slightly weathered; FR - Fresh

Rock Strength: RS - Residual Soil; VL - Very low; L - Low; M - Medium; H - High; VH - Very high; EH - Extremely high

Samples: U50; SPT; Disturbed Sample; Bulk Sample

Approved:
Date:

SOIL SURVEYS 2.00 LIB 2017-07-13.GLB Log SOIL SURVEY AUGER LOG2 1-24684 GINT.GPJ <<DrawingFile>> 14/12/2021 09:07 10.01.00.11 Developed by Datgel

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 12

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust
Date: 08/12/2021 Page: 1 OF 1

Easting: 494892 Northing: 6924052 RL: 49.7 m
Logger: JCG Operator: JCG Machine: J 105

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 0 6 12 18 24 30	Samples and Remarks
	0.30		FILL Silty SAND (SM): Loose, fine to medium grained, dark grey mottled light brown, moist		
	0.5		FILL Clayey Silty SAND (SC): Medium dense, fine to medium grained, dark grey mottled light brown, low to medium plasticity clay, moist		
	0.80		NATURAL Silty Sandy CLAY (CH): Very stiff, high plasticity, dark grey mottled light brown, fine to medium grained sand, w=pl		U50 PP=>600 Rec = 92%
	1.0				
	1.30		Hard		
	1.40		Extremely weathered Sandstone (XW) recovered as Clayey SAND (SC): Dense, fine to medium grained, light brown, low plasticity clay, moist		D
	1.5				
	1.80		SANDSTONE (DW): Distinctly weathered, low strength, fine to medium grained, light brown, indistinct moist BOREHOLE BH 12 TERMINATED AT 1.80 m		
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				

Comments:
1. Groundwater not encountered during augering.
2. DCP refusal at 1.44m.
3. TC bit refusal at 1.80m.

Water First Noted Water Steady Level Water Loss

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved:
Date:

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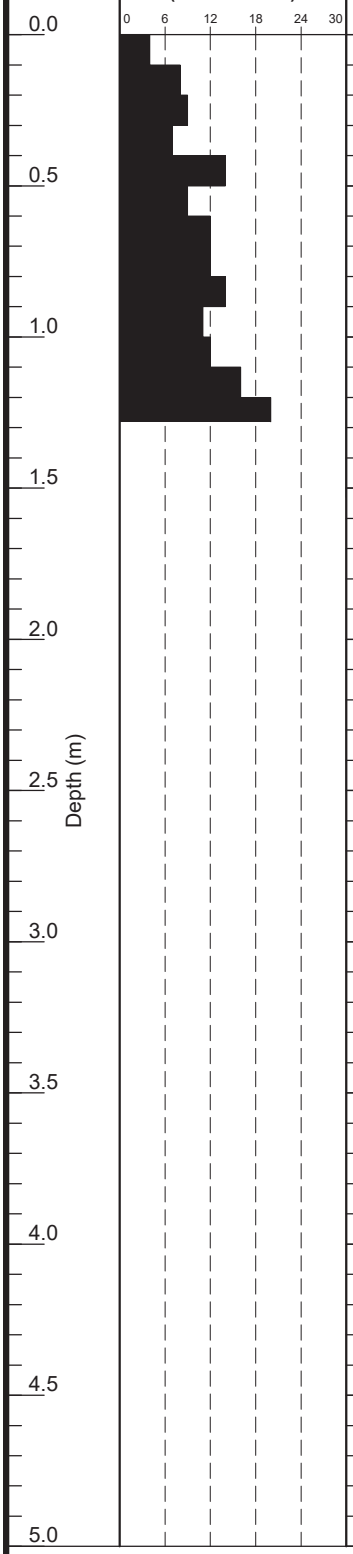
SOIL SURVEYS

DYNAMIC CONE PENETROMETER TESTING

Project Number: 1-24684
Project Name: Storage Facility & Retail Development
Location: 1 Homestead Drive, Jimboomba
Client: Centre Stores Properties Trust

DCP 01

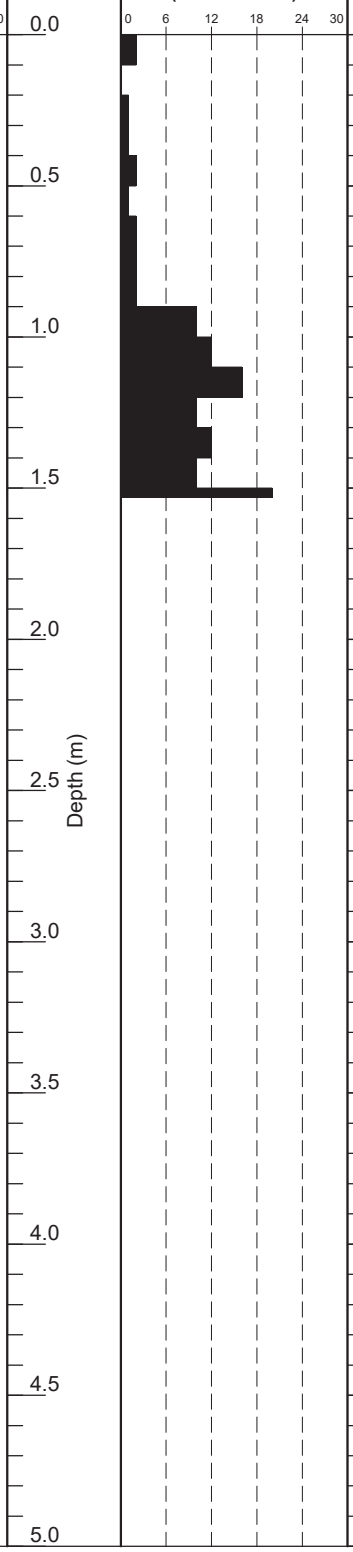
Easting: 494961 Northing: 6924080 RL 50.2



Notes
1. Operator : JCG
2. Date: 08/12/2021
3. DCP refusal at 1.28m.

DCP 02

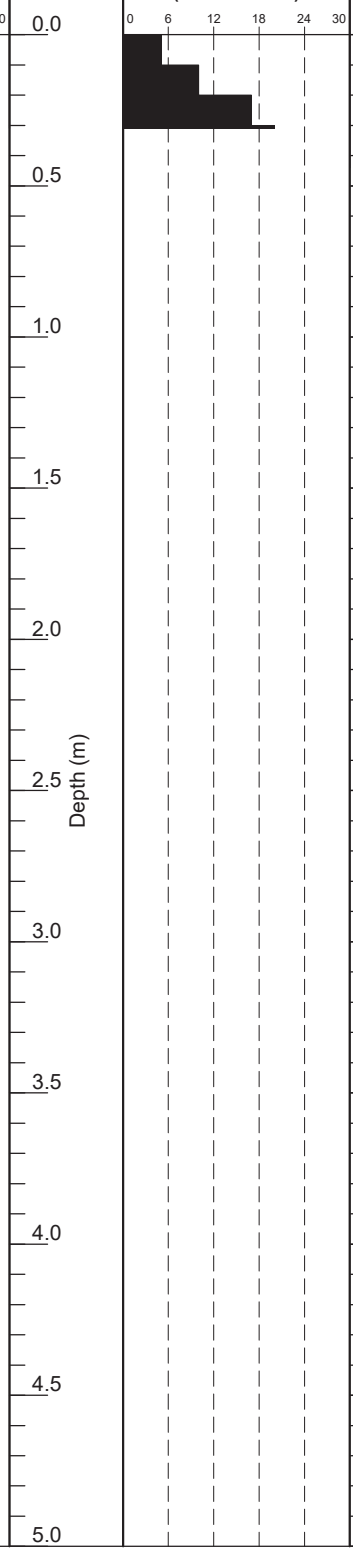
Easting: 494930 Northing: 6924084 RL 51.7



Notes
1. Operator : JCG
2. Date: 08/12/2021
3. DCP refusal at 1.53m.

DCP 03

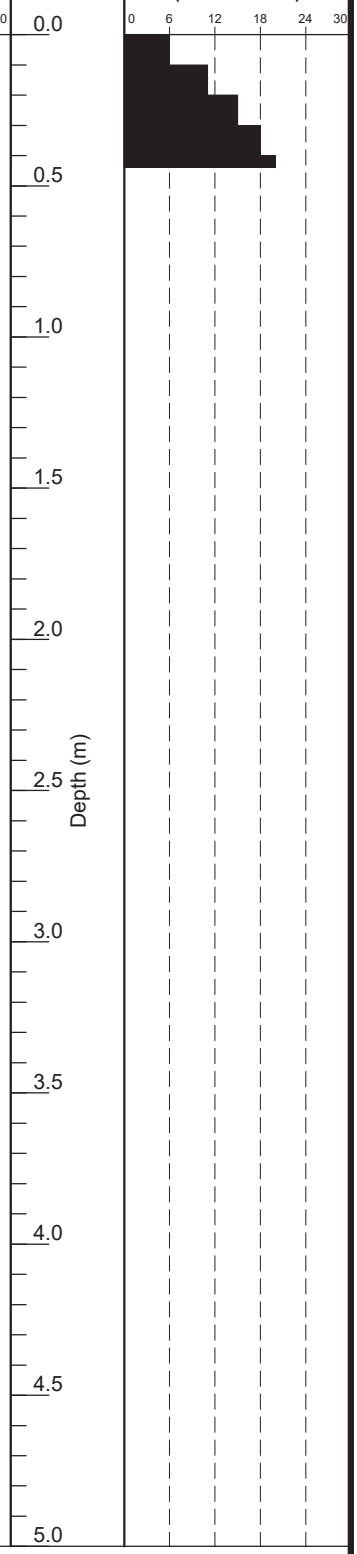
Easting: 494899 Northing: 6924091 RL 52.7



Notes
1. Operator : JCG
2. Date: 08/12/2021
3. DCP refusal at 0.31m.

DCP 03 A

Easting: 494899 Northing: 6924091 RL 52.7



Notes
1. Operator : JCG
2. Date: 08/12/2021
3. DCP refusal at 0.44m.

APPENDIX C

LABORATORY TEST CERTIFICATES

SOIL SURVEYS

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SHRINK SWELL INDEX REPORT

Client :	**Centre Stores Property Trust**	Report No:	WHL21-1124-S1-S3
Client Address :	**C/O 2/19 Finchley Street, Milton, QLD, 4064**	Report Date:	16/12/2021
Project Number :	**1-24684**	Issue Number:	1
Project :	**Storage Facility**	Page 1 of 1	
Location :	**Jimboomba**		

SAMPLE DETAILS:					
Sample ID:	WHL21-1124-S1	WHL21-1124-S2	WHL21-1124-S3		
Date Sampled:	8/12/2021	8/12/2021	8/12/2021		
Date Tested:	10/12/2021	10/12/2021	10/12/2021		
Soil Description:	Silty Clay (CH) Grey Brown, Trace of Sand	Silty Sandy Clay (CH) Grey / Brown	Silty Clay (CH) Grey, Red Brown Mottled		
Sampling Method:	As Supplied	As Supplied	As Supplied		
Sampled by:	SSE	SSE	SSE		
Sample Location:	**BH05**	**BH06**	**BH11**		
Depth (m):	**1.5**	**0.60**	**0.7**		
Source:	Borehole	Borehole	Borehole		
Material:	Unknown	Unknown	Unknown		
TEST RESULTS:					
Swell Test (AS1289.7.1.1)					
Swell on Saturation(%)	**0.9**	**1.1**	**1.7**		
Moisture Content Before(%)	18.0	12.8	25.9		
Moisture Content After(%)	21.9	14.9	31.8		
Shrink Test (AS1289.7.1.1)					
Shrink on Drying(%)	**2.6**	**2.5**	**5.9**		
Shrinkage Moisture Content(%)	19.8	14.0	30.2		
Est. Inert Material(%)	0	0	0		
Crumbling	None	None	None		
Cracking	Slight	Slight	Slight		
Results:					
Shrink Swell Index - Iss (%):	**1.7**	**1.7**	**3.8**		
Swell Pressure (kPa)		50	90		
Unit Weight (t/m^3):	2.09	2.17	1.92		

Remarks :

NATA
WORLD RECOGNISED ACCREDITATION

APPROVED SIGNATORY
C.Ferguson-Hannah

Nata Accreditation number: 15301

END OF DOCUMENT

SOIL SURVEYS

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SHRINK SWELL INDEX REPORT

Client :	**Centre Stores Properties Trust**	Report No:	WHL21-1094-S3-S4
Client Address :	**C/O 2/19 Finchley Street, Milton, QLD, 4064**	Report Date:	9/12/2021
Project Number :	**1-24684**	Issue Number:	1
Project :	**Storage Facility**	Page 1 of 1	
Location :	**Jimboomba**		

SAMPLE DETAILS:					
Sample ID:	WHL21-1094-S3	WHL21-1094-S4			
Date Sampled:	26/11/2021	26/11/2021			
Date Tested:	2/12/2021	2/12/2021			
Soil Description:	Silty Sandy Clay (CI) Grey Brown	Silty Sandy Clay (CI) Grey Brown			
Sampling Method:	As Supplied	As Supplied			
Sampled by:	SSE	SSE			
Sample Location:	**BH03**	**BH04**			
Depth (m):	**1.0**	**0.8**			
Source:	Borehole	Borehole			
Material:	Unknown	Unknown			
TEST RESULTS:					
Swell Test (AS1289.7.1.1)					
Swell on Saturation(%)	**1.0**	**0.5**			
Moisture Content Before(%)	10.9	11.2			
Moisture Content After(%)	14.0	14.4			
Shrink Test (AS1289.7.1.1)					
Shrink on Drying(%)	**1.0**	**1.8**			
Shrinkage Moisture Content(%)	13.2	14.8			
Est. Inert Material(%)	0	0			
Crumbling	None	None			
Cracking	Slight	Slight			
Results:					
Shrink Swell Index - Iss (%):	**0.8**	**1.1**			
Swell Pressure (kPa)	60	N/A			
Unit Weight (t/m^3):	2.13	2.10			

Remarks :

NATA
WORLD RECOGNISED ACCREDITATION

APPROVED SIGNATORY
Mark Rutten

Nata Accreditation number: 15301

END OF DOCUMENT

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CALIFORNIA BEARING RATIO REPORT

Client :	**Centre Stores Properties Trust**	Report No:	WHL21-1094-S1-S2
Client Address :	**C/O 2/19 Finchley Street, Milton QLD 4064**	Report Date:	9/12/2021
Project Number :	**1-24684**	Issue Number:	1
Project :	**Storage Facility**	Page 1 of 1	
Location :	**Jimboomba**		

SAMPLE DETAILS:					
Sample ID:	WHL21-1094-S1	WHL21-1094-S2			
Field Sample ID:	-	-			
Date Sampled:	26/11/2021	26/11/2021			
Soil Description:	Clayey Sand (SC) Grey, with Trace of Gravel	Silty Sandy Clay (CI) Grey/Brown			
Sampling Method:	As Supplied	As Supplied			
Sampled by:	SSE	SSE			
Sample Location:	**BH 1**	**BH 2**			
Depth (m):	**0.1-0.6m**	**0.3-0.7m**			
Source:	Borehole	Borehole			
Material:	Unknown	Unknown			
Specification:	100% STD	100% STD			
TEST RESULTS:					
Moisture Content (AS1289.2.1.1)					
Moisture Content (%)	11.3	19.2			
Date Tested:	29/11/2021	29/11/2021			
Maximum Dry Density - Standard (AS1289.5.1.1):					
Standard Maximum Dry Density (t/m3):	1.96	1.85			
Standard Optimum Moisture Content (%):	11.3	14.2			
Oversize Sieve (mm):	19	19			
Oversize Material (%):	4	0			
Date Tested:	30/11/2021	2/12/2021			
California Bearing Ratio (AS1289.6.1.1):					
CBR Value (%):	**13**	**2.0**			
CBR Penetration :	**5.0mm**	**2.5mm**			
Maximum Dry Density (t/m^3):	1.96	1.85			
Optimum Moisture Content (%):	11.3	14.2			
Dry Density Before Soaking (t/m^3):	1.96	1.85			
Density Ratio Before Soaking (%):	100.0	100.0			
Moisture Content before Soaking (%):	11.3	14.2			
Moisture Ratio before Soaking (%):	100.0	100.5			
Dry Density after Soaking (t/m^3):	1.96	1.79			
Density Ratio after Soaking (%):	100.0	97.0			
Swell (%):	0.0	3.0			
Moisture Content of Top 30mm (%):	12.6	19.0			
Moisture Content of Remaining Depth (%):	11.9	14.8			
Compactive Effort:	Standard	Standard			
Surcharge Mass (kg):	4.5	4.5			
Period of Soaking (Days):	4	4			
Oversize Material:	Excluded	N/A			
Oversize Material (%):	4	0			
Date Tested:	7/12/2021	7/12/2021			
CBR Total Curing Time (hr):	98	98			
Plasticity Determination:	Tactile Assessment	Tactile Assessment			

Remarks :

NATA
WORLD RECOGNISED ACCREDITATION

APPROVED SIGNATORY
Rodney Lucas

NATA Accred No:15301

END OF DOCUMENT

APPENDIX D

SITE PLAN

LEGEND

Borehole Locations

Approx. Lot Boundary

Image from Nearmap.com (14/11/2021)

SCALE: 1:750 @ A4			DRAWING TITLE: **Bore Hole Locations**
REFERENCE: V:\Milton\Milton 1-24001 - 1-25000\1-24601 - 1-24800\1-24684 Jimboomba\Graphics			
A4	DRW. NO: 1-24684-01	DATE: 01/12/2021	CHECKED: NTP
CLIENT: Centre Stores Properties Trust			Soil Surveys SOIL SURVEYS ENGINEERING PTY.LIMITED Specialists in Applied Geotechnics
LOCATION: 1 Homestead Drive Jimboomba			