JC GEOTECHNICS

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Soukutsu Pty Ltd

Proposed River Gardens Cemetery

GEOTECHNICAL ASSESSMENT REPORT

1290 Greendale Park Road, Wallacia, NSW

JC GEOTECHNICS PTY LTD
Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137

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Document Prepared by:

JC Geotechnical Pty Ltd

Shop 2, 143 – 147 Parramatta Road,
Concord, NSW 2137
T 02 8066 0665
E admin@jcgeotechnics.com.au
W www.jcgeotechnics.com.au

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Author Signature		**Approver Signature**	
Name	David Fisher	**Name**	Joseph Chaghouri
Title	Senior Geotechnical Engineer	**Title**	Principal Geotechnical Engineer

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APPENDICES

1. INTRODUCTION

JC Geotechnics Pty Ltd (JCG) has been commissioned by **Soukutsu Pty Ltd** to carry out a geotechnical assessment for the proposed River Gardens Cemetery at 1290 Greendale Park Road, Wallacia, NSW. The site assessment was carried out over a period of four (4) days and was completed generally in accordance with our Proposal Ref. GP2020-1205 Rev2, dated 9th June 2020.

The purpose of the assessment was to assess the subsurface conditions at critical locations to assist with the planning and design of the proposed development.

This report presents the results of the geotechnical assessment, which is preliminary in nature, interpretation, and assessment of the site's existing geotechnical conditions, as a basis for comments and recommendations regarding site classification, excavation conditions, retention, hydrogeological considerations, foundations, subgrade preparation and engineered fill, slab-on-grade design and pavements.

To assist in reading the report, reference should be made to "About Your Report" attached as **Appendix A**.

2. AVAILABLE INFORMATION

Prior to preparation of this report, the following information was made available to JC Geotechnics:

- Development Application – Stage 1 Earthworks (Project 20971, Drawing Nos. DA-3.01, DA3.02, DA3.03, DA3.04 Revision A dated November 2020), prepared by MKD Architects;
- DA Architectural Plans (Project 20971, Drawing Nos. DA-B1.00^{A} - DA-B1.03^{A} date2020), prepared by MKD Architects;
- DA Architectural Plans (Project 20971, Drawing Nos. DA-B2.00^{A}, DA-B2.01^{A} dated November 2020 and DA-B2.02^{B}-DA-B2.05^{B} dated October 2020), prepared by MKD Architects;
- DA Architectural Plans (Project 20971, DA-B4.00 to DA-B4.06 Revision A dated November 2020), prepared by MKD Architects;
- Landscape Masterplan Concept dated 25 November 2020, prepared by MKD Architects;
- Environmental Preliminary Site Assessment Report (Project No. 99.72 dated 23 July 2020) prepared by Trace Environmental;
- Detailed Site Assessment [DSI] (Ref: E20111-1) dated 12 August 2020, prepared by Geotechnical Consultants Australia (GCA);
- CENVP Review of DSI dated 4 September 2020, prepared by Harwood Environmental Consultants;

- Detail Survey Plan (Ref: 18599/6 Revision A dated 12 December 2018) prepared by C. Robson & Associates Pty Ltd Land and Engineering Surveyors;
- Partial Detail Survey (Ref: 14504-20 DET dated 8/7/2020) prepared by C & A Surveyors NSW P/L (Duncans Creek).

Based on the information provided, we understand that the proposed development comprises balanced cut and fill earthworks to form four level elevated pads (at RL44.8m AHD) with basins (typically at RL33m AHD to RL36m AHD, but as low as RL26m AHD) throughout the central and western portions of the site. 'Pad 1' (north eastern portion of the site) will require filling of the order of 7.5m above existing levels, 'Pad 2' (near the north western corner) will require filling of between about 3m and 7.5m above existing levels, 'Pad 3' (near the south western corner) will require filling between about 0.5m and 5m above existing levels and 'Pad 4' (near the south eastern corner) will require filling up to about 6m above existing levels.

Basins throughout the central portion of the site, at its south eastern and south western corners, will require cut to depths between 4m and 6m below existing levels, while the deepest cut will be at the north western corner of the site, where the depth of proposed cut is approximately 14m. The proposed cut depth at the north western corner of the site appears to be to a similar level as the water level within the adjacent Nepean river.

We understand that an elevated pond with waterfalls either side into adjacent (lower) ponds will be incorporated between 'Pad 2' and 'Pad 3' and that a Mausoleum will be constructed within the elevated pond. We understand that the Mausoleum will be flood proof below RL44.8m AHD.

Three to five circular mausoleums or 'memorials in landscape' are proposed within the central (basin) portion of the site.

A 'loop road' and pedestrian footpath are proposed to extend between the four elevated pads with an internal access road and on grade pedestrian access paths within the central basin area. The elevated portions of the loop road and pedestrian footpath (bridges) will be suspended up to 12m above adjacent surface levels within the central basin.

A chapel, administration buildings, function centre and reception / gatehouse buildings are proposed within the eastern portion (lesser fill height) end of 'Pad 1', near the toe of the existing hillside.

3. SCOPE OF WORK

The fieldwork for the geotechnical site assessment was carried out by a Geotechnical Engineer from **JCG** broadly following the guidelines provided in Australian Standard AS 1726-2017 (Reference 1).

A site walk-over inspection was carried out by a Geotechnical Engineer in order to determine the overall surface conditions and to identify relevant site features.

Prior to commencement of the fieldwork, the proposed borehole locations were electromagnetically scanned by a specialist subcontractor with reference to Dial Before You Dig (DBYD) plans.

Safe work measures and procedures were implemented throughout the fieldwork.

Nineteen (19) boreholes were drilled using spiral auger drilling techniques, to depths between 0.5m (BH10) and 13.5m (BH11) below existing ground surface levels with a 'V bit' and / or Tungsten Carbide ('TC') bit attached to the augers. The strength of the bedrock was assessed by observation of the auger penetration resistance, together with the tactile examination of recovered rock cuttings.

Standard Penetration Test (SPT) were carried out, where possible, in the augered section of the boreholes to assess the fill compaction and strength/relative density of the soils. Hand Penetrometer tests were also carried out, where possible, on the recovered clayey SPT samples.

One of the boreholes (BH11, near the proposed mausoleum or 'memorial in landscape' toward the south eastern corner of the site) was extended using diamond coring techniques with water flush to a depth of 17.4m. The strength of the cored bedrock (from BH11) was assessed with reference to Point Load Strength Index Tests (Is_{50}) completed by Macquarie Geotechnical, a National Association of Testing Authorities (NATA) registered laboratory, on the recovered rock cores.

Groundwater levels were measured in the boreholes during and soon after completion of auger drilling. The introduction of water to the borehole for coring of BH11 precluded further measurements of groundwater levels during drilling. Groundwater monitoring wells (Class 18 PVC standpipes) were installed at selected locations (BH5, BH6, BH11, BH12, BH14 and BH18) for subsequent groundwater measurement. A return trip was made to site on 9th July to measure groundwater levels in the standpipes.

The approximate locations of the nineteen boreholes are shown on "Figure 2 – Borehole Location Plan" attached in **Appendix B**. Reduced Levels (RLs) shown on the borehole logs have been interpolated between contour lines and spot level heights shown on the provided survey plan, and are therefore considered to be approximate.

A geotechnical engineer from JC Geotechnics was present full-time on site to set out the test locations, log the encountered subsurface profile and nominate in-situ testing and sampling, measure the groundwater levels and install the monitoring wells. The borehole logs, together with explanatory notes used are attached in **Appendix C** and **Appendix D**, respectively.

Selected soil samples were submitted to Macquarie Geotechnical for geotechnical laboratory testing [four (4) Atterberg Limits/Linear Shrinkage tests, ten (10) Emerson crumb dispersion tests, four (4) 4-day soaked CBR tests, and eight (8) moisture content tests on selected rock chip samples collected during auger drilling.

Selected soil samples (24) and a water sample recovered from BH11 were submitted to a second NATA accredited laboratory, ALS Environmental, for aggressivity testing. The results of laboratory testing are attached in **Appendix E**.

4. SITE DESCRIPTION

The site is located among undulating topography and generally sloped down to the west, toward the Nepean River, which abuts the western site boundary. The western portion of the site was gently undulating, the central portion of the site was near flat, containing paddocks which

appeared to have been used for agricultural production, and the eastern portion of the site sloped down toward the central portion of the site.

The eastern portion of the site sloped down to the west and north west (away from Greendale Road) at an average slope of about 5 to 10 degrees. A meandering creek (Duncan's Creek) was present within the central portion of the site, which extended from near the middle of the northern site boundary, generally in a south easterly direction, and two reservoirs (dams) were present on the hillside near the north eastern corner of the site.

At the north eastern corner of the site, there was a single storey brick and weatherboard dwelling with tiled roof which appeared to be in good condition, as well as a large metal shed and awning. Medium to large sized trees were present along the western site boundary (riverfront), along the alignment of Duncan's creek, in clusters near the southern boundary and throughout the north eastern corner of the site. The riverbanks in the vicinity of the site were up to about 8m high with slopes up to about 10 degrees.

An unpaved access road was present from near the dwelling at the north eastern corner of the site towards the middle of the site and continued across Duncan's creek between paddock areas toward the east. Near the access road crossing, the banks of the creek were approximately 1.5m to 2m high, and at the time of the assessment the creek contained a limited depth of standing water.

5. ASSESSMENT RESULTS

5.1 Geology

Reference to the Penrith 1:100,000 Geological Series Sheet 9030 Edition 1, dated 1991, by the Geological Survey of New South Wales, Department of Mineral Resources, indicates the site is located within the geological boundary characterized by "Fine-grained sand, silt and clay" (Qal) associated with the Nepean River, and near the boundary of areas characterized by Bringelly Shale (Rwb) of the Middle Triassic age Wianamatta Group . Bringelly Shale is described as "Shale, carbonaceous claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff".

It should be noted that the published geological profile does not consider the residual soils derived from in-situ weathering of the bedrock or the presence of fill that may have been generated from previous earthworks.

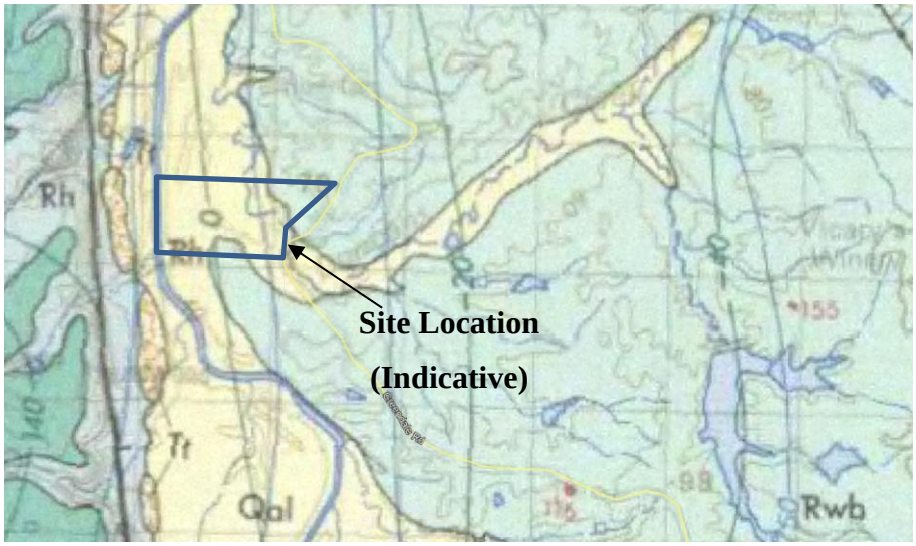


Figure 1. Geological Map Extract

5.2 Subsurface Conditions

The subsurface conditions encountered within the boreholes are summarised below:

Fill

Fill material was encountered in boreholes BH9, BH17, BH18 to depths of 1.2m, 0.4m and 1.0m, respectively. The fill material comprised either fine to medium grained silty sand (BH9 and BH17) or Silty Clay of medium to high plasticity, containing organics such as root fibres.

Natural Soils

Residual silty clay was encountered in all boreholes, either from the existing ground surface or below the fill. The residual silty clay extended to depths between 0.5m (BH10) and 13.5m (BH11). The plasticity of the silty clay was variable, however, was generally low to medium.

Bedrock

Weathered shale bedrock was encountered (or inferred, based on refusal to further penetration of the drilling equipment) at depths between 0.5m and 3.0m at the locations of BH9, BH10, BH11 and BH12 to BH18 (all boreholes toward the eastern end of the site). Based on a gradual transition from the soil profile to the surface of the inferred bedrock, we anticipate that the shale bedrock will be generally extremely weathered to distinctly weathered and of very low to low strength on first contact. Where the bedrock was core drilled (BH11) the shale quickly transitioned into fresh rock of medium to high strength, at a depth of 13.5m below the existing ground surface level.

The remainder of the boreholes (BH1 to BH8 and BH19) were terminated within soil.

5.3 Groundwater

Groundwater was not encountered during auger drilling at any of the borehole locations, nor in standpipes installed at the locations of BH5, BH6, BH12, BH14 or BH18, which were terminated at 6m depth (BH5 and BH6, terminated in soil) 1.8m, 1.7m and 2.7m (BH12, BH14 and BH18, respectively). Groundwater was encountered in one standpipe only (BH11) within a groundwater monitoring well, at a depth of 6.3m below the existing ground surface level, 8 days following drilling. A basic recharge test was undertaken on 9 July 2020 which showed that the groundwater quickly recharged to the observed standing water level. We infer that the extremely weathered shale material between 13m to 13.5m depth at the location of BH11 is likely fractured or may contain high permeability joints.

Note that groundwater levels may be subject to seasonal and daily fluctuations influenced by factors such as rainfall and future development of the surrounding properties.

5.4 Laboratory Testing

5.4.1 Atterberg Limits and Linear Shrinkage

Testing conducted (by Macquarie Geotechnical, a NATA accredited laboratory) on samples from BH5 (1.0m), BH7 (4.5m), BH11 (3.0m) and BH19 (3.0m) indicated that the samples tested were all of low plasticity, with a slight to moderate potential for reactivity to changes in moisture content, which supported our field assessment of the residual silty clays as being generally of low plasticity.

5.4.2 Moisture Content

Testing conducted (by Macquarie Geotechnical) on soil samples from BH5 (1.0m), BH7 (4.5m), BH11 (3.0m), BH19 (3.0m) and BH14 (1.0m) indicated that the samples were of moisture content less than their respective plastic limits as indicated by the results of the Atterberg Limits Testing summarised above.

Testing conducted (by Macquarie Geotechnical) on rock chip samples from the refusal depths of BH9 (3.0m), BH16 (3.0m) and BH17 (0.8m) indicated that the samples tested were of, medium strength (BH16) or high strength (BH9 and BH17). Moisture content of a sample from BH14 (1.0m), confirmed that the sample tested was of ‘soil’ strength. We note that rock strengths assessed in this way are somewhat approximate and variation of at least one strength class should not be unexpected.

5.4.3 Emerson Crumb Dispersion

Testing conducted (by Macquarie Geotechnical) on soil samples from BH5 (1.0m), BH3 (1.5m), BH6 (1.5m), BH7 (2.0m), BH8 (1.0m), BH9 (0.5m) and BH12 (1.5m) indicated the soil samples tested to have a low to very low potential for dispersion when exposed to water. Results of testing on samples from BH11 (3.0m), BH16 (1.4m) and BH19 (0.5m) indicated a moderate to high potential for dispersion.

5.4.4 California Bearing Ratio (Soaked CBR)

Testing conducted (by Macquarie Geotechnical) on samples from BH9, BH12 and BH19 returned soaked CBR values of 1.5 at a penetration of 2.5mm after soak periods of 4 days. The sample tested from BH5 returned a soaked CBR value of 9 at a penetration of 2.5mm after a soak period of 4 days. We consider this result to be an outlier and likely not representative of subgrade performance for the site conditions.

5.4.5 Chemical Aggressivity

Results of testing conducted for chemical aggressivity (by ALS, a NATA accredited laboratory) indicated that the soil samples tested (24 samples in total from BH1, BH4, BH5, BH7, BH11, BH14, BH15, BH16, BH19) returned pH results between 5.8 and 8.6 indicating slightly acidic to slightly alkali conditions. The maximum sulfate concentration from the 24 samplers tested was 100mg/kg and the maximum chloride concentration from the 24 samples tested was 620mg/kg. This combination of results indicates non-aggressive conditions for the design of buried concrete structural elements. Resistivity test results (by ALS) indicated that some soil samples (from BH5, BH11 and BH15) exhibited less than 5000 ohm.cm (but no results were less than 2000 ohm.cm) resulting in 'Non-aggressive' conditions for the design of buried steel elements (screw piles) in low permeability soils.

Testing conducted (by ALS) on one sample of groundwater collected from BH11 indicated a pH of 7.25 (slightly alkali), Electrical conductivity of 5240 micro-siemens per centimetre, 3 mg/L of sulfate as SO4 and 28 mg/L of chloride concentration. This combination of results indicates 'Non-aggressive' conditions to buried concrete elements.

5.4.5 Salinity

Salinity assessment is largely based on the results of electrical conductivity testing. Testing conducted (by ALS) on 23 soil samples indicated EC values ranging from 28 microsiemens per centimetre to 350 microsiemens per centimetre.

5.4.6 Point Load Strength Index

The point load strength index test results on selected samples of the bedrock (from BH11 only) showed good correlation with our field assessment of rock strength. The estimated Unconfined Compressive Strength (UCS) of the rock cores ranged from 16.6 MPa to 30.8 MPa.

6. COMMENTS AND RECOMMENDATIONS

6.1 Site Classification

Much of the site is underlain by silty clays of low to medium plasticity and slight to moderate reactivity to changes in moisture, as indicated by information presented in our boreholes and confirmed by the laboratory testing (Atterberg Limits and Linear shrinkage tests). Accordingly, we recommend that the proposed structures be designed for Class M site conditions, where

residual clays are present, and where structures or trees are not required to be removed within the footprint of, or in close proximity to the proposed structures.

Where existing fill greater than 0.4m in depth is present, or where existing structures or trees require removal near proposed structures, the site classification should be considered to be Class P, due to the likely abnormal moisture condition that will be present following their removal. Where shale bedrock is present uniformly throughout the footprint of a proposed structure, the structure may be designed for Class A conditions.

6.2 Excavation Conditions

Prior to any excavation commencing, we recommend that reference be made to the WorkCover Excavation Work Code of Practice current at the time of the works.

Based on the borehole logs, proposed excavations may extend through fill and residual clay, but possibly also shale bedrock the upper profile of which may be extremely weathered. Where the excavations are not able to be appropriately benched or battered, an engineered retention system must be installed for support of the soil profile and any shale of less than low strength prior to excavation commencing. Where temporary battering of the sides of excavations is preferred, fill materials should be battered at 1 Vertical (V) to 1.5 Horizontal (H), while residual clays and weathered rock may be battered at maximum slopes of 1V:1H, for temporary stability.

The soil and weathered shale bedrock of less than low strength could be excavated using buckets of conventional large earthmoving hydraulic excavators, particularly if fitted with 'Tiger Teeth' with some ripping.

Ripping of low strength shale (or stronger) bedrock will present hard ripping or "hard rock" excavation conditions and therefore excavation productivity will be slow and higher than normal 'wear and tear' of excavation attachments is to be expected. The presence of defects will help facilitate excavation, but only marginally. Therefore, ripping would require a high capacity and heavy bulldozer such as a Caterpillar D10 or similar. The use of a smaller size bulldozer will result in lower productivity. Perimeter and grid sawing techniques with ripping (for basement excavations in bedrock, if required) will also facilitate neat excavation.

Groundwater seepage monitoring should be carried out during bulk excavation prior to finalising the design of any required pump out facility, with the exception to the mausoleum where the portion below the flood level should be designed as tanked. Outlets into the stormwater system will require Council approval.

6.3 Retention

Retention may be required, where the required ground contours cannot be supported by batters or where proposed subfloor levels are recessed into the hillside to depths greater than 1.5m.

The following parameters may be used for static design of temporary and permanent retaining walls at the subject site:

For progressively anchored or propped walls where minor movements can be tolerated (provided there are no buried movement sensitive services), we recommend the use of a

trapezoidal earth pressure distribution of 4HkPa for fill materials, soil and shale of less than low strength, where H is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system, tapering to nil at top and bottom.

For progressively anchored or propped walls which support areas that are highly sensitive to movement (such as areas where movement sensitive structures or infrastructures or buried services are located in close proximity) we recommend the use of a trapezoidal earth pressure distribution of 8HkPa for fill materials, soil and weathered shale bedrock of less than low strength, where 'H' is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system, tapering to nil at top and bottom;

Where some deformation of the ground behind cantilevered retaining walls is tolerable, the walls may be designed using a coefficient of active earth pressure, K_a, of 0.33 and a passive coefficient of earth pressure, K_p, of 3. Where it is preferable to limit subsidence behind cantilevered retaining walls, an 'at rest' coefficient of earth pressure, K_o, of 0.55 should be used, with a factor of safety of 2 to limit deflections.

All surcharge loading affecting the walls (temporary batters, construction equipment, construction loads, adjacent high-level footings, etc.) should be also be incorporated in the retaining wall design.

The retaining walls should be designed as drained and measures are to be taken to provide complete and permanent drainage from behind the walls. Strip drains protected with a non-woven geotextile fabric should be used behind shotcrete infill panels for soldier pile walls or inserted between gaps in contiguous piles. Alternatively, for contiguous pile walls, weepholes comprising 20mm diameter PVC pipes grouted into holes or gaps between adjacent piles at 1.2m centres (horizontal and vertical), may be used. The embedded end of the pipes must be wrapped with a non-woven geotextile fabric (such as Bidim A34) to act as a filter against subsoil erosion.

For piles embedded into medium to high strength shale bedrock and below bulk excavation level, an allowable lateral toe resistance value of 100kPa may be adopted. This value assumes excavation is not carried out within the zone of influence of the wall toe and the rock does not contain adverse defects etc. The upper 0.3m depth of the socket should not be taken into account in the design, to allow for tolerance and disturbance effects during excavation.

Any required anchors should have their bond length within low strength shale or better. For the design of anchors bonded into medium to high strength shale or better, an allowable bond stress value of 100kPa may be used, subject to the following conditions:

- Anchor bond lengths of at least 3m behind the 'active' zone of the excavation (taken as a 45-degree zone above the base of the excavation) is provided;
- Overall stability, including anchor group interaction, is satisfied;
- All anchors should be proof loaded to at least 1.33 times the design working load before being locked off at working load. Such proof loading is to be witnessed by an engineer independent of the anchoring contractor. We recommend that only experienced contractors be considered for anchor installation with appropriate insurances;
- If permanent anchors are to be used, these must have appropriate corrosion provisions for longevity.

6.4 Hydrogeological Considerations

Groundwater was encountered in only one of the boreholes (BH11) at a depth of 6.3m below existing levels. Note that groundwater levels may be subject to seasonal and daily fluctuations influenced by factors such as rainfall and future development of neighbouring properties.

Due to the expected low permeability of the clay soils present on site, groundwater inflows into excavations less than 6m deep are expected to be minor. We expect groundwater inflows into excavations along the soil/rock interface and through any defects within the bedrock (such as jointing, and bending planes, etc.) particularly following periods of heavy rain. The initial flows into excavations may be locally high where they intersect poor quality rock at depths shallower than 6m (potentially at the location of the proposed chapel, administration building, function rooms, reception / gatehouse building and crematorium) but would be expected to decrease with time as the bedding seams/joints or any perched groundwater are drained. We recommend that monitoring of seepage be implemented during excavation works to confirm that the capacity of any required drainage system is adequate.

We expect that any seepage which does occur should be able to be controlled by a conventional sump and pump system in flat areas (proposed 'memorials in landscape') or by gravity drainage from hillside cuts. We anticipate that a sump-and-pump system may be necessary during construction at the location(s) of the proposed mausoleum(s), which will be designed as fully tanked and flood-proof / waterproof below the maximum anticipated flood height (RL44.8m).

The design of drainage and pump systems should take the above issues into account along with careful ongoing inspections and maintenance programs.

6.5 Foundation Design

It is expected that shale of at least low strength will potentially be present within a couple of metres below the existing surface levels at the location of the proposed chapel, administration building, function rooms, reception / gatehouse and crematorium buildings. It is recommended that all footings for the buildings be founded within shale bedrock of at least low strength to provide uniform support and reduce the potential for differential settlements.

Pad footings, strip footings or piles founded within shale of at least low strength may be designed for an allowable bearing capacity of 1000kPa, based on serviceability. In addition, an allowable shaft adhesion of 100kPa may be used for rock sockets in low strength (or stronger) shale provided the socket is satisfactorily cleaned and roughened. All footings must be visually inspected by the geotechnical engineer.

A Higher Bearing Pressure (of the order of 1500kPa to 3500kPa) may be suitable for the design of footings that are founded in medium to high strength shale bedrock, however identifying such strata would require proving the strength and continuity of the bedrock by drilling further cored boreholes (minimum of 2 cored boreholes per proposed structure) prior to the detailed design being undertaken. Based on the rock core recovered at the location of BH11 we anticipate that 3500kPa bearing pressures are likely to be feasible, however in the absence of additional borehole information, we recommend that preliminary designs be based on an assumed allowable bearing pressure of 1000kPa for all structures.

We anticipate that loads from the proposed elevated roads and pedestrian walkways (bridges) will be high, and as such will likely need to be transferred to the bedrock via piled footings. If the entire loop road is not proposed to be supported on piles, then the provision for settlement of on-grade pavements (on the fill platforms) should be incorporated at the interfaces between elevated sections (bridges) and on-grade pavements.

Footings for the proposed 'memorials in landscape' within the central portion of the site, may be designed for an allowable bearing pressure of 200kPa on silty clays of at least very stiff strength.

Where water retaining structures (dams or 'flood walls') are proposed, we consider that design advice may be required from a dam engineer.

The allowable bearing pressures given above are based on serviceability criteria of settlements at the footing base of less than or equal to 1% of the minimum footing dimension (or pile diameter).

Inspection of foundations should be carried out by a geotechnical engineer to determine that the required socket and founding material has been achieved and determine any variations that may occur between the boreholes and inspected locations.

6.6 Subgrade Preparation

At the location of proposed pavements and structures, any surface soils containing organic matter (grass, roots etc) should be stripped and stockpiled separately for reuse in landscaping areas. Material containing organics is not considered suitable for reuse as engineered fill.

Following stripping and excavation to achieve the desired levels, the residual soil subgrade should be subjected to proof rolling using a 12 tonne (or heavier) smooth drum roller in non-vibratory mode for at least 6 passes. The final pass should be carried out in the presence of an experienced geotechnical engineer or representative from the Geotechnical Inspection and Testing Authority (GITA) to identify any unstable (soft or heaving) areas, which may occur where the subgrade has been allowed to become saturated. The heaving material should be locally excavated and replaced with engineered fill as detailed below.

If the clay subgrade shows signs of cracking during proof rolling, then the subgrade should be lightly moistened and rolled until the cracking disappears.

6.7 Engineered Fill

Due to the scale of the earthworks, we recommend that all filling be placed under Level 1 earthworks control, as defined in AS3798-2007. Due to a potential conflict of interests, the GITA should be engaged directly by the developer and not by the earthwork's contractor or subcontractor. The GITA should provide daily site reports on a fortnightly basis for review by the Project Superintendent or Geotechnical Engineer.

Excavated residual soils are expected to be suitable for reuse as engineered fill. In the case of additional fill materials needing to be imported to site, crushed sandstone with a maximum particle size of 150mm would be preferred. We recommend that any imported fill materials must have a minimum soaked CBR value of 2.5%.

Engineered fill should be compacted in maximum 200mm thick layers (when the material is loose) using a large pad foot roller (minimum 12 tonnes) to a density ratio between 98% and 102% of the Standard Maximum Dry Density (SMDD) for the material within ±2% of the Standard Optimum Moisture Content (SOMC).

6.8 Edge Compaction of Engineered Fill

Where fill platforms supported by sloping embankments are proposed, the outer edge of each fill layer should extend at least one metre horizontally beyond the design geometry. The roller must be operated past the edge of each fill layer to achieve compaction of the downslope batter surfaces, and the edge fill should be trimmed back to the well compacted material within the design geometry following completion of filling.

For landscape design purposes, we recommend that downslope batters on engineered fill platforms be formed at maximum slopes of 1V:3H and provided with fast-establishing low height vegetation to reduce the likelihood of erosion on the batters and resulting maintenance requirements. Surface runoff should be directed away from the fill slopes where possible, and any piped drainage should discharge beyond the toe of the slopes if it cannot be piped to the stormwater system for controlled disposal. The long-term performance of proposed pavements and structures on fill platforms depends on the satisfactory completion of earthworks, and thoughtful design of landscaping and maintenance programs.

6.9 Retention of Fill Platforms

We anticipate that the most economical retention system for the edges of fill platforms may be Gabion baskets or similar gravity retaining structures. If these are considered suitable, then the retaining walls will likely need to incorporate steps and / or inclined wall faces. Geofabric wrapped free draining material (durable, single sized gravel such as ‘blue metal’) would be required behind the walls to facilitate drainage and to limit loss of soil through erosion into the retaining structure. We anticipate that sequential wall construction and filling behind the walls may be feasible during platform construction; however we note that visually significant geometric alignment issues can arise with respect to long walls constructed in this manner.

Permanent embankments (fill batters) if required, must be cut back at no steeper than 1V:3H with erosion controls. Flatter slopes may be preferred for ease of maintenance.

Where the fill platform edges are to be supported by vertical or sub-vertical cast-in-situ retaining walls in the long term the edges of the fill platforms must be built up with embankment slopes no steeper than 1H:1V (i.e. 45°). This will require the initial layers of fill to extend approximately H+1m laterally beyond the proposed geometry, where H is the height of the proposed fill platform above existing levels. Due to the height of the batters, we recommend that a horizontal bench at least 1.5m wide be provided (during platform construction) at 0.5H (mid slope). Once filling is completed, the permanent retention system would need to be installed prior to the removal of the over-filled embankment slopes.

6.10 Backfilling of Service Trenches

Service trenches must be backfilled using engineered fill to the above specification, to reduce ongoing settlement of the trench material. In service trenches, the loose layer thickness should be reduced to 150mm to reflect the reduced energy output of trench rollers, excavator compaction attachments or hand operated compaction equipment that will need to be used in the trench. For trench backfill, the maximum particle size for the fill materials should also be reduced to 80mm.

Density testing of engineered fill must be carried out in accordance with AS3798-2007 (i.e. one test per layer per 2500m^2 or 3 tests per lot, whichever requires more tests) and the frequency of density tests in trench backfill should be at least one test per two (150mm loose thickness) layers per 40 lineal metres.

6.11 Salinity

Salinity is a phenomenon which can be influenced by many factors and can affect many aspects of site use. On a basic level, it is a measure of the soluble salt concentration in the soil (or groundwater) which is generally detrimental to the agricultural productivity of the land, as well as to structures and aesthetics at surface level. The effects of a salinity 'outbreak' can be compounding and can affect the amenity of landscapes and structures. The salinity condition of a property can also be radically affected by changes in land use and earthworks.

Soluble salts are transported by the movement of water. They can also be introduced by irrigation and by effluent disposal systems, as well as being leeched from soils and weathering rock, and deposited by rainfall or wind spray. Changes in salinity conditions generally occur as a result of the deposition of salts following periods of soil saturation or flooding due to inadequate drainage, especially following earthworks or disruption to drainage conditions further uphill.

The effects of saline conditions include dying-off of vegetation in areas where the salts are concentrated, and the dying-off of vegetation often contributes to erosion of soils. Erosion of soils can exacerbate conditions of poor drainage and contribute to further accumulation or concentrations of salts following dispersion of the soils.

Surface runoff can also accumulate around manmade structures, if specific attention is not paid to design of drainage against such problems. A saline environment can reduce the life of steel and concrete structures through several mechanisms and is a driving factor in procedure development regarding the management of dryland salinity.

Reference should be made to 'Phase 4: Management and Evaluation' of 'Site Investigations for Urban Salinity' (Local Government Salinity Initiative) published by the Department of Land and Water Conservation (2002) and Industry Guide T56 (2018) published by Cement and Concrete Association of Australia (CCAA) for further advice on management strategies.

Key factors in limiting the potential for dryland salinity include effective drainage to reduce infiltration of surface runoff, matching irrigation supply to the needs of the vegetation present and treating affected areas to prevent compounding of the problem.

Management of saline soils generally takes the form of landscape design and maintenance, and design against sulfate attack such as minimum concrete cover and strength requirements, as well as the incorporation of damp-proof membranes. Reference should be made to the appropriate Australian Standards for the design of concrete elements in saline environments.

The Salinity potential in Western Sydney 2002 map indicates that the site is located within an area of moderate potential for saline soils. No indicators of salinity (salt tolerant vegetation, salt on existing buildings, corroded metal pipes, distressed brick, mortar or concrete, or scalding / bare patches of surface soils) were noted during our site walkover assessment.

Salinity under existing site use conditions is primarily assessed based upon the results of Electrical Conductivity Testing. The results of laboratory Electrical Conductivity testing (EC) for this site are multiplied by an 'ECe conversion factor' of 9 (for low plasticity clays as defined in the Department of Natural Resources (DNR) publication "Site Investigations for Urban Salinity" – 2002) to determine the Electrical Conductivity of Saturated Extracts, ECe. The resultant ECe values for site soils tested ranged between 0.252dS/m and 3.15dS/m indicating non-saline to moderately-saline conditions in accordance with 'Dryland Salinity (1993)' or slightly saline conditions in accordance with the 'Environmental Planning & Assessment Regulation 1994'.

We note that the 'higher' EC laboratory results were obtained from BH5 (between 0.5m depth and 2.0m depth), BH11 (between 0.5m depth and 9.5m depth, all samples tested) BH14 and BH15 (near surface) and BH19 (1.5m depth to 3.5m depth).

The geographical spread of these borehole locations indicates that the entire site has the potential for a developing salinity condition. Furthermore, given the proposed land use (cemetery, with artificial water bodies), the inherent difficulties in preventing localised conditions of poor drainage following the backfilling of individual burial plots, and the likelihood of ongoing irrigation to maintain the aesthetics of the site, we recommend that all structures in contact with the ground (footings, slabs etc) be designed for at least 'moderately saline' conditions.

'Moderately saline' conditions require the use of minimum Grade N25 concrete, minimum concrete cover (to reinforcement) of 30mm where a damp-proof membrane is incorporated or 45mm where it may not be feasible to fully incorporate a damp-proof membrane (for example piles, pad and strip footings).

6.12 Pavements

We anticipate that on-grade sections of the proposed loop road, the internal access road and any car parks will be constructed using flexible pavements. We anticipate that elevated sections of the loop road and pedestrian access path (bridges) will be constructed from reinforced concrete or composite pavements. Based on the laboratory test results, we recommend that the proposed on-grade pavements are designed using a CBR value of 1.5% for the existing clay subgrade.

Provision of a select fill layer immediately below design subgrade level would reduce shrink swell effects and provide a more favourable working platform during construction in the event of wet weather. A select fill layer would comprise (100mm minus) crushed sandstone with a

soaked CBR value of at least 15%. The crushed sandstone layer would be compacted as engineered fill per the above specification. CBR testing on the crushed sandstone should incorporate the RMS Specification T102 method to allow for potential break-down of the material during compaction.

Lime stabilisation of the clay subgrade may also be considered, to improve the performance of flexible pavements. If this methodology is preferred, then we recommend that lime demand tests and additional soaked CBR tests be carried out to determine the optimum lime dosage rate. As a guide, the addition of 4% lime by dry weight of clay might achieve a soaked CBR of 20% for the stabilised layer, which would require thorough mixing to 300mm depth and compaction to the above engineered fill specification with density testing as per AS3798-2007.

Subbase layers should comprise DGS20 or DGS40 strictly compacted in 150mm thick layers to between 98% and 102% SMDD at SOMC +/- 2%. The basecourse should comprise DGB20 compacted in 150mm thick layers to the same specification.

For flexible pavement design, a computer-based design package (such as 'Circly') should be used to model the subgrade and engineered fill.

Subsoil drains should be provided below pavement edges, with invert levels at least 200mm below the design subgrade level. The subgrade should be graded to promote flow into the drains, which should have a uniform longitudinal fall and discharge to piped drainage.

7. LIMITATIONS

The geotechnical assessment of the subsurface profile and geotechnical conditions within the proposed development area and the conclusions and recommendations presented in this report have been based on available information obtained during the work carried out by JC Geotechnics and in the provided documents listed in Section 2 of this report. Inferences about the nature and continuity of ground conditions away from and beyond the locations of field exploratory tests are made but cannot be guaranteed.

It is recommended that should ground conditions including subsurface and groundwater conditions, encountered during construction and excavation vary substantially from those presented within this report, JC Geotechnics Pty Ltd be contacted immediately for further advice and any necessary review of recommendations. JC Geotechnics does not accept any liability for site conditions not observed or accessible during the time of the inspection.

This report and associated documentation and the information herein have been prepared solely for the use of **Soukutsu Pty Ltd** and any reliance assumed by third parties on this report shall be at such parties' own risk. Any ensuing liability resulting from use of the report by third parties cannot be transferred to JC Geotechnics Pty Ltd, directors or employees.

The conclusions and recommendations of this report should be read in conjunction with the entire report.

For and on behalf of

JC Geotechnics Pty Ltd

David Fisher
Senior Geotechnical Engineer

Reviewed By

Joseph Chaghouri

BSc (Civil), MEngSc (PM), MEngSc (Geotech), MIEAust
Principal Geotechnical Engineer

APPENDIX A

About Your Report

JC GEOTECHNICS

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical- related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include the general nature of the structure involved, its size and configuration, the location of the structure on the site and its orientation, physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program.
To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.
Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should NOT be used:*

- when the nature of the proposed structure is changed: for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an un-refrigerated one,
- when the size or configuration of the proposed structure is altered.
- when the location or orientation of the proposed structure is modified.
- when there is a change of ownership, or for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project. The report may not be relevant for other phases of the project, or where project details change.

The advice herein relates only to this project and the scope of works provided by the Client.

Soil and Rock Descriptions are based on AS1726- 1993, using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out. Refer to the attached terms and symbols sheets for definitions.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact. For this reason, most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems that encountered on site.

SUB SURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions, and thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

Subsurface conditions can change with time and can vary between test locations. Construction activities at or adjacent to the site and natural events such as flood, earthquake or groundwater fluctuations can also affect the subsurface conditions.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems.

No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professional develop their plans based on mis-interpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

The interpretation of the discussion and recommendations contained in this report are based on extrapolation/ interpretation from data obtained at discrete locations. Actual conditions in areas not sampled or investigated may differ from those predicted.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access in the complete geotechnical engineering report prepared or authorized for their use. Those who do not provide such access may proceed under mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are not exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

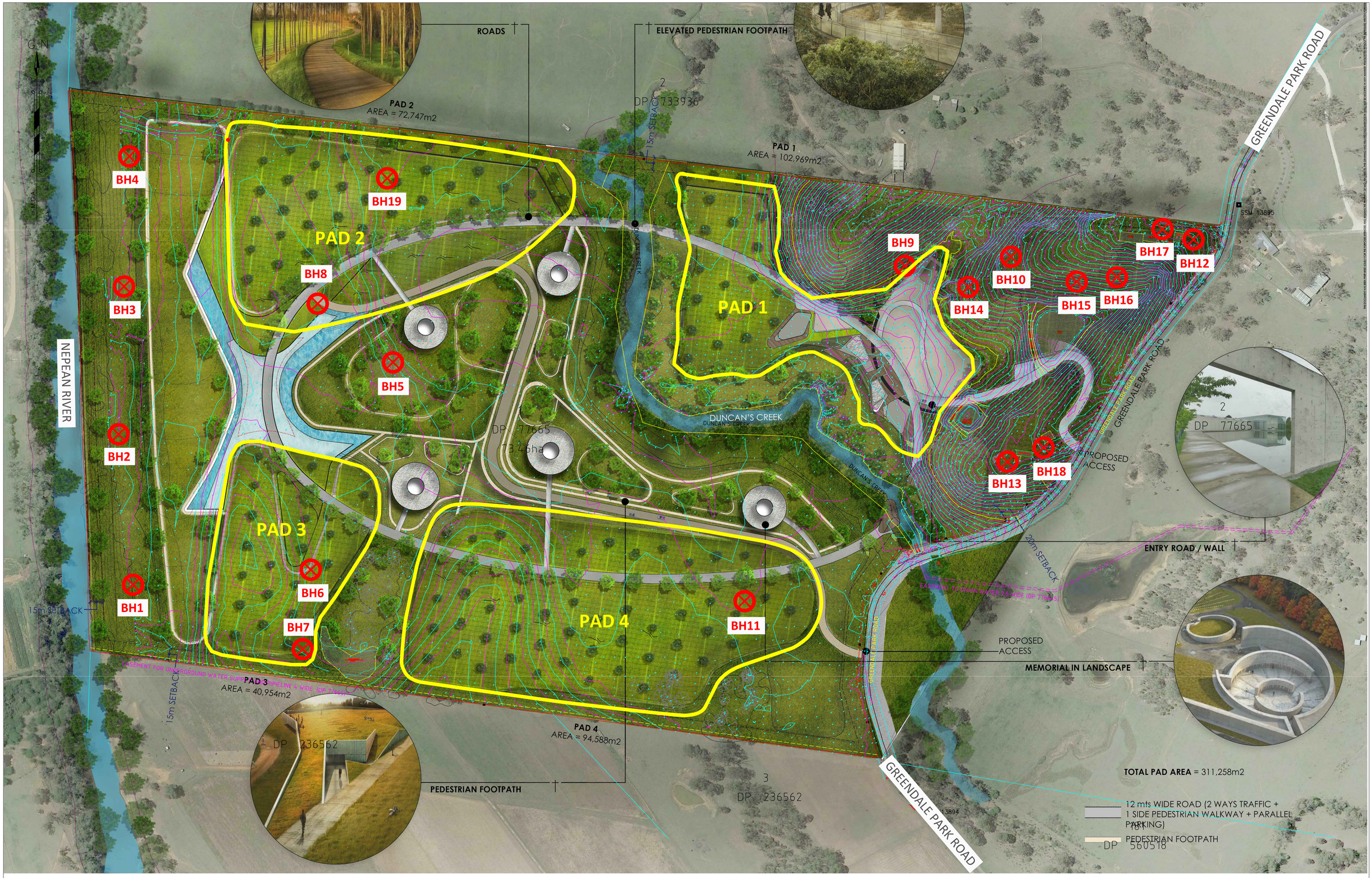
Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publication's directory.

FURTHER GENERAL NOTES

Groundwater levels indicated on the logs are taken at the time of measurement and may not reflect the actual groundwater levels at those specific locations. It should be noted that groundwater levels can fluctuate due to seasonal and tidal activities.

APPENDIX B

Borehole Location Plan



Drawn	KX	CLIENT: **MKD Architects Pty Ltd**	0 4 8 12 16 20m 1 : 2000 A1 1 : 4000 A3	Geotechnics	Figure No.	1
Checked	DF				Datum	AHD
Date	1/10/2020	PROJECT: **Proposed Cemetery**			Job No.	GR1137.1J
Scale	AS SHOWN					

LOCATION:
1290 GREENDALE PARK ROAD, WALLACIA
LOT 1 DP 776645

DRAWING TITLE:
BOREHOLE LOCATION PLAN

APPENDIX C

Engineering Borehole Logs with Core Photographs

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH1

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈39.4m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 24/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 24/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low-medium plasticity, brown, trace of rootlets.	MC<=PL	St		0.5m/450mm 4,5,6 N=11 480kPa	Residual
		1		CL	Silty CLAY: low to medium plasticity, brown.	MC<=PL	H		1.5m/450mm 14,14,16 N=30 >600kPa	
		2								
		3							3.0m/450mm 16,16,14 N=30 >600kPa	
					EOH @ 3.45m.					
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH2

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈40.0m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 24/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 24/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low-medium plasticity, brown, trace of rootlets.	MC<=PL	St		0.5m/450mm 2,2,2 N=4 150kPa	Residual
		1		CL	Silty CLAY: low to medium plasticity, orange-brown.	MC<=PL	VSt		1.5m/450mm 3,5,7 N=12 280kPa	
		2								
		3					H		3.0m/450mm 16,18,18 N=36 >600kPa	
					EOH @ 3.45m.					
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH3

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈40.5m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 24/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 24/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low-medium plasticity, brown, trace of rootlets.	MC<=PL	St			Residual
		1					VSt		0.5m/450mm 3,3,4 N=7 300kPa	
				CL	Silty CLAY: low to medium plasticity, brown.	MC<=PL	VSt		1.5m/450mm 4,3,6 N=9 250kPa	
		2		CH	Silty CLAY: medium to high plasticity, brown.	MC<PL	VSt			
		3							3.0m/450mm 6,5,6 N=11 230kPa	
					EOH @ 3.45m.					
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH4

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈41.0m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 24/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 24/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low to medium plasticity, brown, trace of rootlets.	MC<=PL	St			Residual
		1					VSt		0.5m/450mm 3,3,3 N=6 320kPa	
		2							1.5m/450mm 4,4,5 N=9 200kPa	
		3		CL	Silty CLAY: low to medium plasticity, brown.	MC<=PL	St		3.0m/450mm 4,3,4 N=7 150kPa	
		4								
		5		CL	Silty CLAY: low plasticity, orange-brown.	MC<PL	Vst		4.5m/450mm 9,9,9 N=18 300kPa	
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH4

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈41.0m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 24/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 24/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		11								
		12								
					EOH @ 12.50m.					
		13								
		14								
		15								
		16								
		17								
		18								
		19								
		20								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH5

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW		Elevation: ≈38.8m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd		Date Drilled: 23/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig		Date Completed: 23/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low plasticity, brown, trace of rootlets.	MC<PL	St			Residual
		1					H		0.5m/450mm 5,7,8 N=15 420kPa	
		2					H		1.5m/450mm 5,11,13 N=24 560kPa	
		3					H		3.0m/450mm 6,7,13 N=20 520kPa	
		4		CH	Silty CLAY: medium-high plasticity, brown.	MC<PL	Vst			
		5							4.5m/450mm 5,4,6 N=10 210kPa	
		6			EOH @ 6.0m.					
		7								
		8								
		9								
		10								

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH6

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈40.8m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 23/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed:	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low to medium plasticity, brown.	MC<=PL	St			Residual
		1					St-Vst		0.5m/450mm 6,7,9 N=16 390kPa	
		2							1.5m/450mm 5,10,14 N=24	
		3					H		3.0m/450mm 8,13,15 N=28 460kPa	
		4		CH	Silty CLAY: medium to high plasticity, brown.	MC<PL	H			
		5							4.5m/450mm 8,11,17 N=28	
		6			EOH @ 6.0m.					
		7								
		8								
		9								
		10								

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH7

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈40.7m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 23/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed:	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low plasticity, orange- brown, traces of rootlets.	MC<=PL	St			Residual
		1			Silty CLAY: low plasticity, orange-brown.	MC<=PL	H		0.5m/450mm 3,5,6 N=11 560kPa	
		2					Vst		1.5m/450mm 4,6,8 N=14 280kPa	
		3							3.0m/450mm 7,11,14 N=25 330kPa	
		4								
		5					H		4.5m/450mm 9,13,15 N=28 590kPa	
		6			EOH @ 6.0m.					
		7								
		8								
		9								
		10								

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH8

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈41.2m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 23/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed:	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CH	Silty CLAY: medium-high plasticity, brown, traces of rootlets.	MC<=PL	St			Residual
		1		CH	Silty CLAY: medium-high plasticity, orange mottled brown, traces of rootlets.	MC<=PL	St		0.5m/450mm 3,3,3 N=6 110kPa	
							H		1.5m/450mm 4,5,5 N=10 470kPa	
		2			EOH @ 2.0m.					
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH9

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW		Elevation: ≈48.5m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd		Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig		Date Completed:	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		FILL	FILL: silty sand, fine-medium grained, orange mottled dark brown, traces of rootlets.	M	MD			
						M	D		0.5m/450mm 3,3,4 N=7 330kPa	
		1			Colour changed to orange brown.					
				CL	Silty CLAY: low-medium plasticity, light brown, grading into highly weathered shale.	MC<PL	H			Residual V-bit refusal
		2								
		3			EOH @ 3.0m.					TC-bit refusal
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH10

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈54.5m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed:	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low-medium plasticity, brown, traces of rootlets.	MC<=PL	St			Residual
				CL	Silty CLAY: low-medium plasticity, brown, grading into highly weathered shale.	MC<PL	H			TC-bit refusal
		1			EOH @ 0.5m.					
		2								
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH11

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈38.3m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 1/7/2020	Logged By: KX
Drill Rig: Truck Mounted Rig	Date Completed: 1/7/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		0		CL	Silty CLAY: low plasticity, brown, traces of rootlets.	MC<PL	St			Residual
		1							0.5m/450mm 3,2,4 N=6 110kPa 140kPa 150kPa	
				CL	Silty CLAY: brown, low plasticity.	MC<PL	VSt-H			
		2							1.5m/450mm 9,17,23 N=40 >600kPa	
		3							3.0m/450mm 7,14,22 N=36 390kPa >600kPa	
		4							4.5m/450mm 8,9,15 N=24 310kPa 310kPa 350kPa	
▼		5								
		6							6.0m/450mm 9,15,22 N=37 280kPa 400kPa >600kPa	
		7							7.5m/450mm 10,16,27 N=43 480kPa 530kPa >600kPa	
		8								
		9							9.0m/450mm 7,8,13 N=21 320kPa	
		10								

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH11

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈38.3m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 1/7/2020	Logged By: KX
Drill Rig: Truck Mounted Rig	Date Completed: 1/7/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
		11								
		12							12.0m/450mm 8,10,15 N=25 150kPa	
		13								V-bit refusal
					Refer to cored borehole log.					TC-bit refusal
		14								
		15								
		16								
		17								
		18								
		19								
		20								

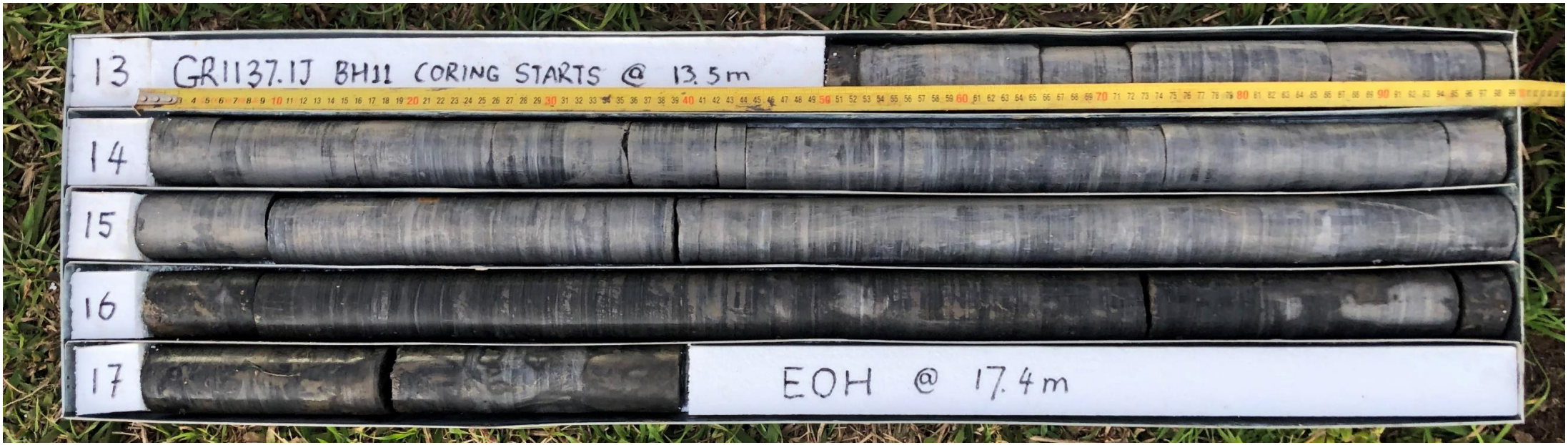
CORING LOG OF BOREHOLE NO. BH11

Client: MKD Architects Pty Ltd	**Project No.: GR1137.1J**
Project: Proposed Cemetery	**Logged By: KX**
Location: 1290 Greendale Road, Wallacia NSW	**Checked By:**
Drilling Equipment/Method: NMLC Coring	**Elevation: ≈38.3m**
Date Drilled: 1/7/2020 **Completed: 1/7/2020**	**Datum: AHD**
Depth To Water: N/A	**TOTAL DEPTH: 17.4 ft**

Well Description	Depth (m)	Graphic Log	Material Descrption	Weathering Condition	Strength	DEFECT DESCRIPTION	Defect Spacing mm (30, 100, 300, 1000, 3000)	Point Load(a) (0.04, 0.1, 0.3, 1, 2, 3, 5, 8)
	14	>	Shale: grey, distinctly bedded at 0-5°.	FR	M-H	14.36m,BP,0-5°,PL,SM,CN.		
	15					15.39m,BP,0-5°,PL,SM,CN.		
	16					16.73m,BP,0-5°,PL,SM,CN.		
	17					17.18m,BP,0-5°,PL,SM,CN.		
	18		BH11 terminated at 17.40m.					
	19							
	20							
	21							
	22							

EL<0.03 VL0.03-0.1 L 0.1-0.3 M 0.3-1.0 H 1.0-3.0 VH3.0-10.0 EH>10.0

JC Geotechnics Pty Ltd


13
GR1137.1J BH11 CORING STARTS @ 13.5m
14
15
16
17
EOH @ 17.4m

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH12

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈71.5m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 22/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CH	Silty CLAY: medium-high plasticity, orange mottled brown, traces of rootlets.	MC<=PL	St		0.5m/450mm 2,3,3 N=5	Residual
		1					H		1.5m/200mm 6,6/50mm N>6	
		2			EOH @ 1.8m.					TC-bit refusal
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH13

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈57.6m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 22/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CH	Sandy CLAY: medium-high plasticity, dark brown, traces of rootlets.	MC<PL	St		0.5m/450mm 1,2,2 N=4	Residual
		1					H		1.5m/245mm 5,9/95mm N>9/R	
		2			EOH @ 1.8m.					TC-bit refusal
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH14

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈48.9m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 22/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CH	Silty CLAY: medium-high plasticity, orange-dark brown, traces of rootlets.	MC<=PL	St		0.5m/450mm 3,5,10 N=15	Residual
		1		CL	Silty CLAY: low-medium plasticity, light grey, grading into extremely weathered shale.	MC<PL	VSt-H			
		2			EOH @ 1.70m.					TC-bit refusal
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH15

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈60.6m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 23/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 23/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CH	Silty CLAY: medium-high platicity, orange-brown. Grading into extremely weathered shale.	MC<=PL	St		0.5m/450mm 5,9,14 N=23	Residual
		1		CL	Silty CLAY: low-medium plasticity, light brown, grading into extremely weathered shale.	MC<PL	VSt-H			
		2			EOH @ 2.0m.					TC-bit refusal
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH16

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈63.8m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 23/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 23/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low-medium plasticity, dark brown.	MC<=PL	St		0.5m/450mm 3,3,4 N=7	Residual
		1		CL	Silty CLAY: low-medium plasticity, orange-light grey, grading into extremely weathered shale.	MC<PL	VSt-H			
		2		CL	Silty CLAY: low-medium plasticity, light grey, grading into extremely weathered shale.	MC<PL	VSt-H			
		3			EOH @ 3.0m.					TC-bit refusal
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH17

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈72.4m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 22/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		SM	FILL: silty sand, fine-medium grained, dark brown, traces of rootlets.	M	L			
				CL	Silty CLAY: low-medium plasticity, orange-brown, grading into highly weathered shale.	MC<=PL	St			TC-bit refusal.
		1			EOH @ 0.8m.					
		2								
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH18

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW	Elevation: ≈58.6m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd	Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig	Date Completed: 22/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		FILL	FILL: sandy clay, medium-high plasticity, dark brown, traces of rootlets.	MC<=PL	St			
		1		CL	Silty CLAY: low-medium plasticity, light brown, grading into highly weathered shale.	MC<=PL	St			Residual
		2		CL	Silty CLAY: low-medium plasticity, dark brown, grading into highly weathered shale.	MC<=PL	St			TC-bit refusal
		3			EOH @ 2.7m.					
		4								
		5								
		6								
		7								
		8								
		9								
		10								

Client: MKD Architects

Project: Proposed Cemetery

Borehole No: BH19

Project No: GR1137.1J

Location: 1290 Greendale Road, Wallacia NSW		Elevation: ≈38.0m	Datum: AHD
Drilling Contractor: Fico Group Pty Ltd		Date Drilled: 22/6/2020	Logged By: KX
Drill Rig: Ute Mounted Rig		Date Completed: 22/6/2020	Checked By: DF

Ground Water Observation	Well Description	Depth	Graphic log	USCS Classification	Description	Field moisture content	Consistency	Field Sample(DS)	Field Tests	Remarks
Dry upon Completion		0		CL	Silty CLAY: low plasticity, brown, traces of rootlets.	MC<=PL	St-VSt			Residual
		1							0.5m/450mm 3,3,4 N=7 260kPa	
		2							1.5m/450mm 4,5,8 N=13 280kPa	
		3							3.0m/450mm 7,11,14 N=25	
		4								
		5							4.5m/450mm 7,6,8 N=14 340kPa	
		6			EOH @ 6.0m.					
		7								
		8								
		9								
		10								

APPENDIX D

Laboratory Testing Results

MOISTURE CONTENT TEST REPORT

Client:	JC Geotechnics Pty Ltd	**Job No:**	S20293-2
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Report No:**	S61626-MC
Project:	Proposed Residential Development (GR1137 1J)		

Test Procedure:

- ☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	24/06/2020
Preparation:	Prepared in accordance with the test method		

Sample No.	Source	Sample Description	Moisture Content %
S61626	BH5 1.0-m	Silty CLAY	**15.4**
S61627	BH7 4.5-m	Silty CLAY	**15.7**
S61628	BH11 3.0-m	Silty CLAY	**15.0**
S61629	BH19 3.0-m	Silty CLAY	**17.3**

Notes:

NATA

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

10/07/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

MOISTURE CONTENT TEST REPORT

Client:	JC Geotechnics Pty Ltd	**Job No:**	S20293-2
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Report No:**	S61640-MC
Project:	Proposed Residential Development (GR1137 1J)		

Test Procedure:

- ☐ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☑ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	24/06/2020
Preparation:	Prepared in accordance with the test method		

Sample No.	Source	Sample Description	Moisture Content %
S61640	BH14 1.0-m	Rock Chips	**13.5**
S61641	BH16 3.0-m	Rock Chips	**6.6**
S61642	BH17 0.8-m	Rock Chips	**4.7**
S61643	BH9 3-m	Rock Chips	**4.7**

Notes:

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Authorised Signatory:

Chris Lloyd

27/07/2020

Date:

MACQUARIE GEOTECH

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Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH5 1.0-m
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61626-PI
Job No	S20293-2	**Lab No**	S61626

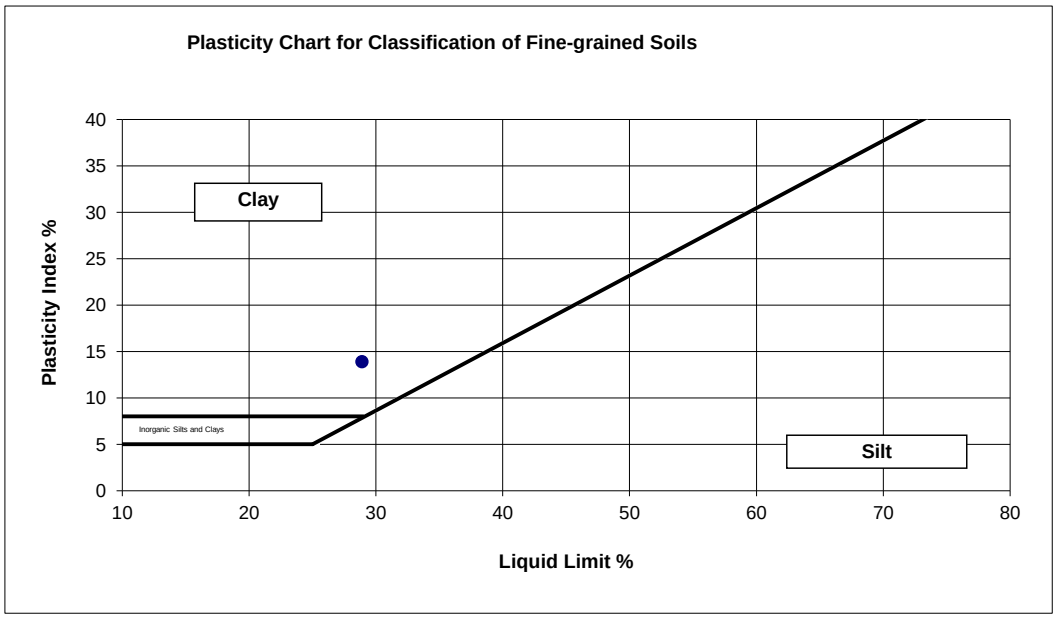
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	29	**Linear Shrinkage (%)**	8.0
Plastic Limit (%)	15	**Plasticity Index**	14



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

Notes

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SOIL CLASSIFICATION REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH7 4.5-m
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61627-PI
Job No	S20293-2	**Lab No**	S61627

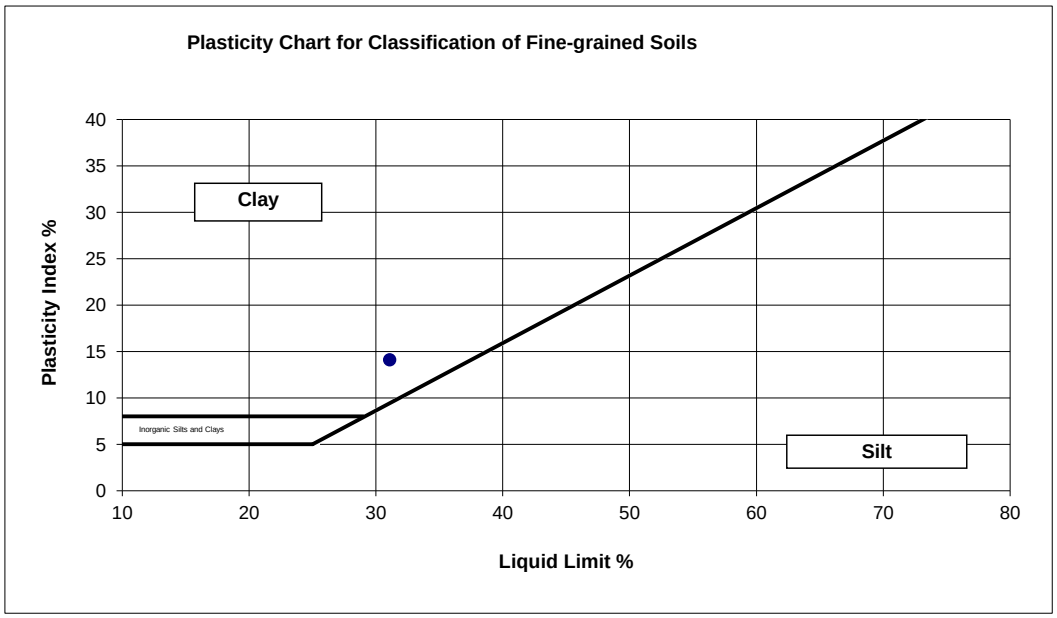
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	31	**Linear Shrinkage (%)**	8.5
Plastic Limit (%)	17	**Plasticity Index**	14



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

Notes

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17/07/2020

Date:

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SOIL CLASSIFICATION REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH11 3.0-m
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61628-PI
Job No	S20293-2	**Lab No**	S61628

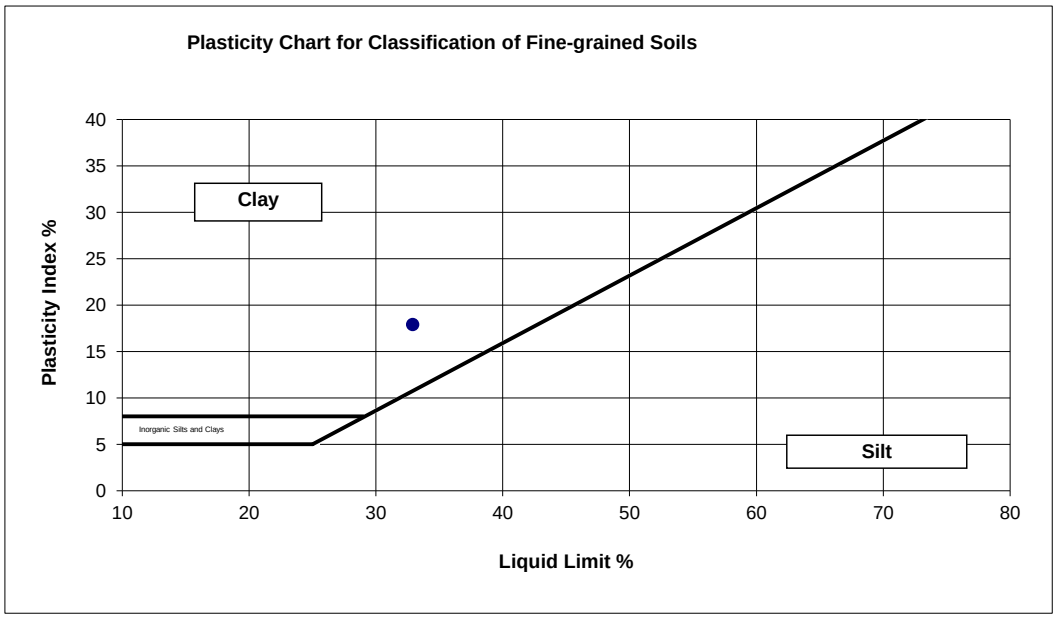
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	33	**Linear Shrinkage (%)**	9.0
Plastic Limit (%)	15	**Plasticity Index**	18



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: N/A

Notes

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17/07/2020

Date:

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SOIL CLASSIFICATION REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH19 3.0-m
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61629-PI
Job No	S20293-2	**Lab No**	S61629

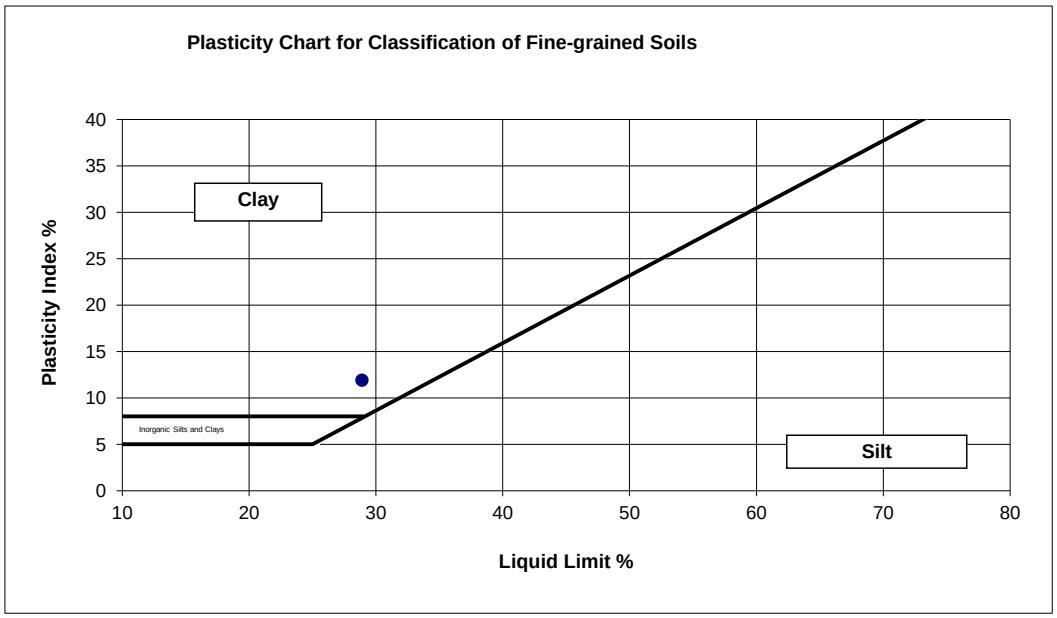
Test Procedure:

- ☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- ☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
- ☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
- ☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- ☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
- ☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	29	**Linear Shrinkage (%)**	7.5
Plastic Limit (%)	17	**Plasticity Index**	12



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

Notes

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17/07/2020

Date:

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Alexandria NSW 2015

POINT LOAD STRENGTH INDEX REPORT

Client:	JC Geotechnics Pty Ltd	**Moisture Content Condition:**	As received
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Storage History:**	Core boxes
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61644-PL
Job No:	S20293-2	**Date Tested:**	7/07/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 1/07/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S61644	BH11 13.6-13.7m	Shale		-					
			Axial	50.9	34.0	2.81	1.28	1.24	1
S61645	BH11 14.5-14.6m	Shale		-					
			Axial	49.6	42.0	2.16	0.81	0.83	1
S61646	BH11 15.4-15.5m	Shale		-					
			Axial	51.3	41.0	3.94	1.47	1.49	1
S61647	BH11 16.6-16.7m	Shale		-					
			Axial	51.6	40.0	3.47	1.32	1.34	1
S61648	BH11 17.25-17.35m	Shale		-					
			Axial	51.8	37.0	3.78	1.55	1.54	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Authorised Signatory:

Chris Lloyd

22/07/2020

Date

MACQUARIE GEOTECH

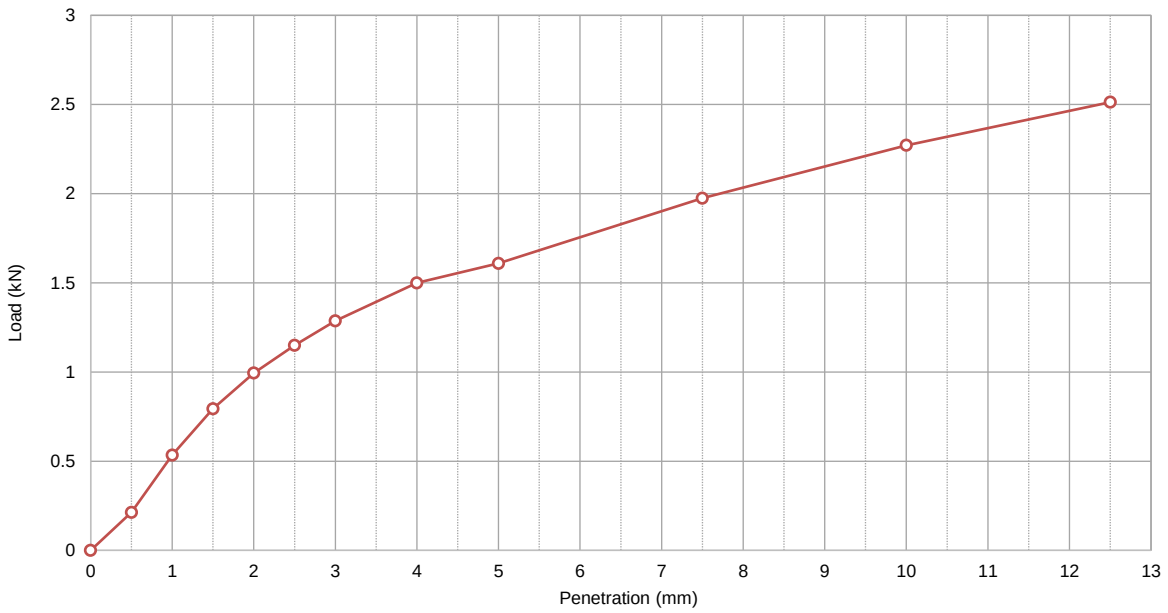
Macquarie Geotechn
U7/8 10 Bradford Street
Alexandria NSW

CALIFORNIA BEARING RATIO REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH5
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY with Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No.**	S61279-CBR
Job No.	S20293-1	**Sample No.**	S61279

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	98.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	98.5	98.0
Sample Curing Time (hrs)	73 hrs	Dry Density - At Compaction (t/m³)	1.72	1.71
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.71	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.9	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	17.6	
Maximum Dry Density - MDD (t/m³)	1.75	Moisture Content - Top 30mm (%)	22.3	
Optimum Moisture Content - OMC (%)	18.0	Moisture Content - Remainder (%)	19.1	

Material CBR Value (%): **9** **at a penetration of** **2.5** **mm**

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

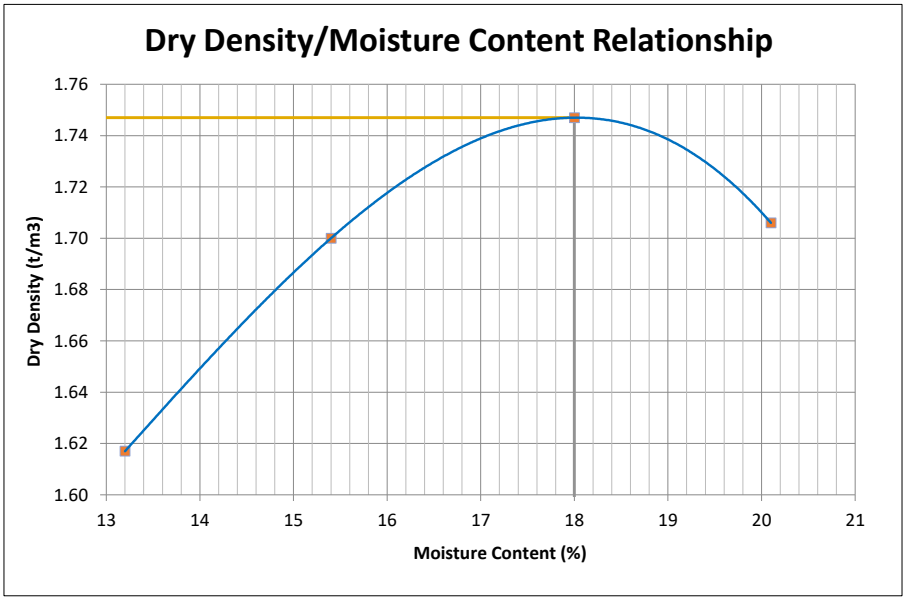
Client	JC Geotechnics Pty Ltd	**Source**	BH5
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY with Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61279-MDD
Job No	S20293-1	**Sample No**	S61279

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.747
Optimum Moisture Content (%)	18.0
Oversize Retained on 19mm sieve (%)	0.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	96 hrs
Liquid Limit Determination	Technician Assessment

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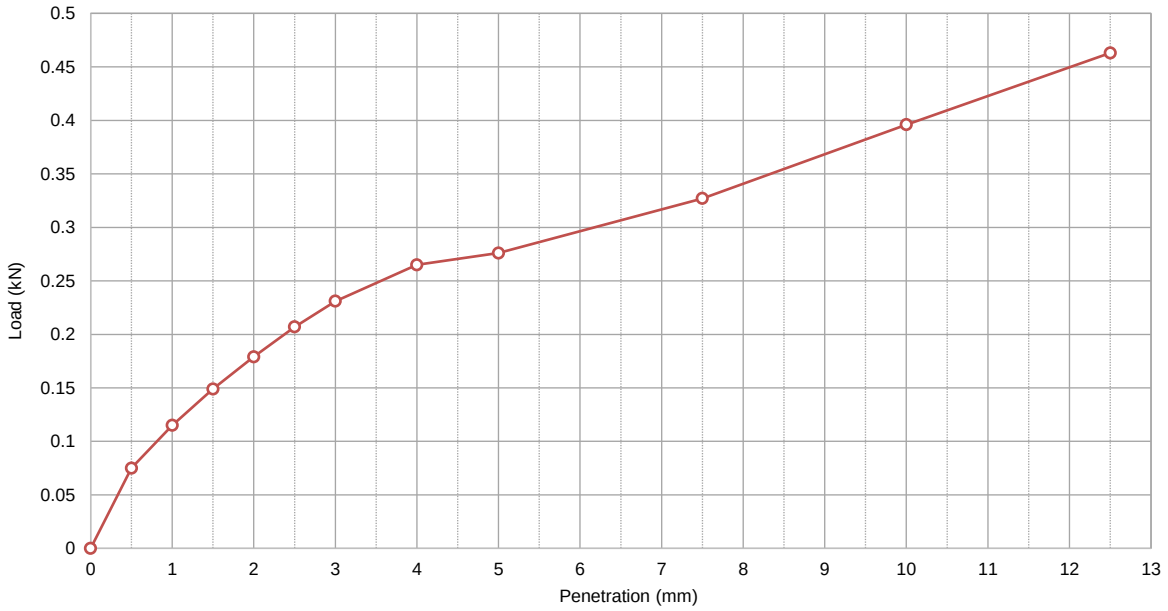
CALIFORNIA BEARING RATIO REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH9
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY with Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No.**	S61281-CBR
Job No.	S20293-1	**Sample No.**	S61281

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	100.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	98.0	98.0
Sample Curing Time (hrs)	78 hrs	Dry Density - At Compaction (t/m³)	1.77	1.77
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.67	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	6.3	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	14.5	
Maximum Dry Density - MDD (t/m³)	1.81	Moisture Content - Top 30mm (%)	25.5	
Optimum Moisture Content - OMC (%)	14.5	Moisture Content - Remainder (%)	19.1	

Material CBR Value (%): **1.5** **at a penetration of** **2.5** **mm**

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

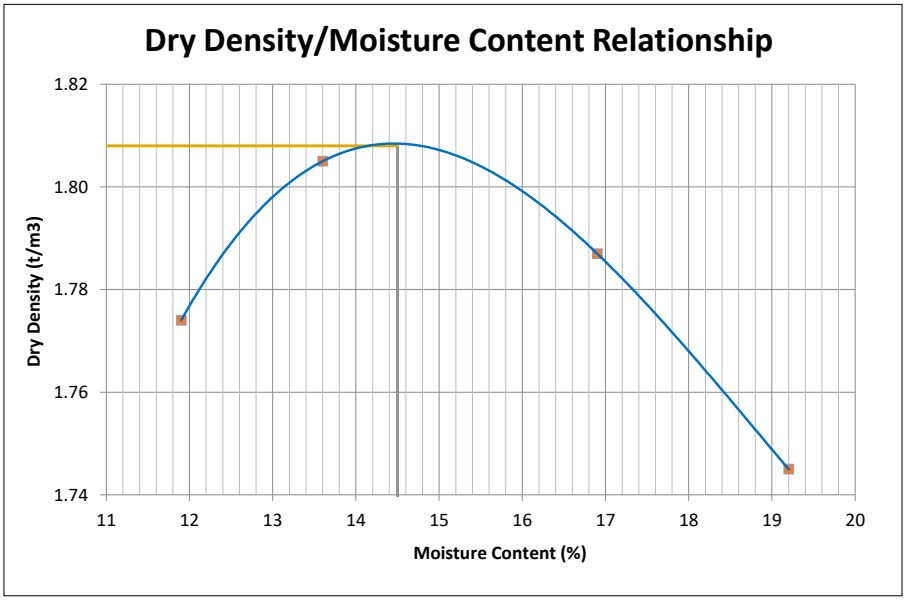
Client	JC Geotechnics Pty Ltd	**Source**	BH9
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY with Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61281-MDD
Job No	S20293-1	**Sample No**	S61281

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.808
Optimum Moisture Content (%)	14.5
Oversize Retained on 19mm sieve (%)	0.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	97 hrs
Liquid Limit Determination	Technician Assessment

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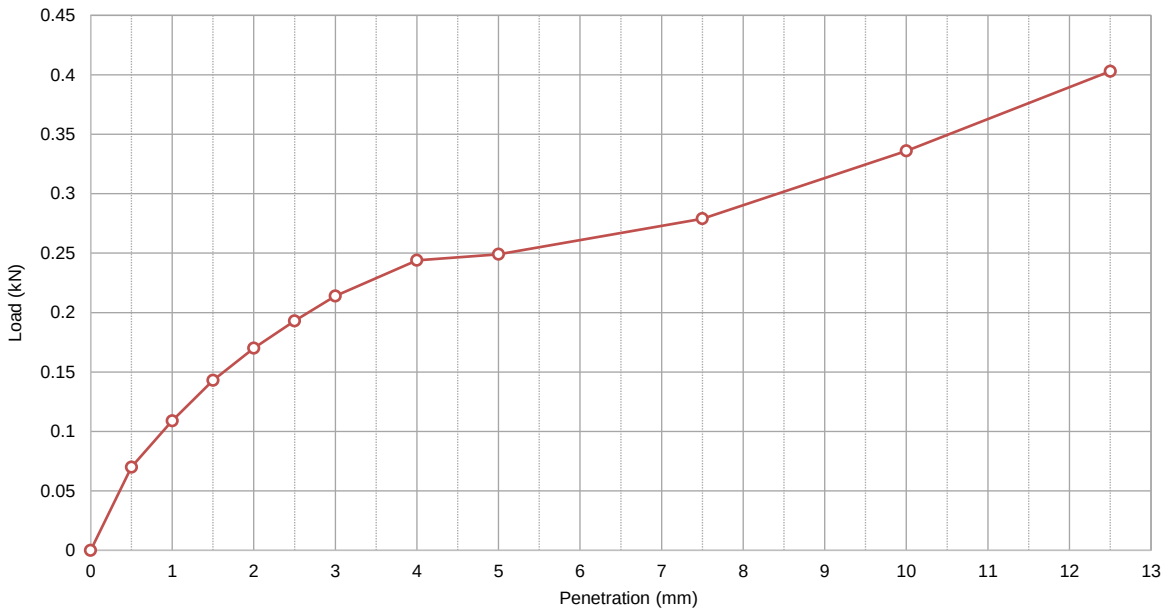
CALIFORNIA BEARING RATIO REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH12
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY trace of Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No.**	S61282-CBR
Job No.	S20293-1	**Sample No.**	S61282

Test Procedure:				
	☑	AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑	AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐	AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑	AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		**Density & Moisture**	**Achieved**	**Target**
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	102.5	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	97.5	98.0
Sample Curing Time (hrs)	96 hrs	Dry Density - At Compaction (t/m³)	1.72	1.73
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.65	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	4.2	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	17.6	
Maximum Dry Density - MDD (t/m³)	1.77	Moisture Content - Top 30mm (%)	29.8	
Optimum Moisture Content - OMC (%)	17.2	Moisture Content - Remainder (%)	19.8	

Material CBR Value (%): **1.5** **at a penetration of** **2.5** **mm**

Notes:

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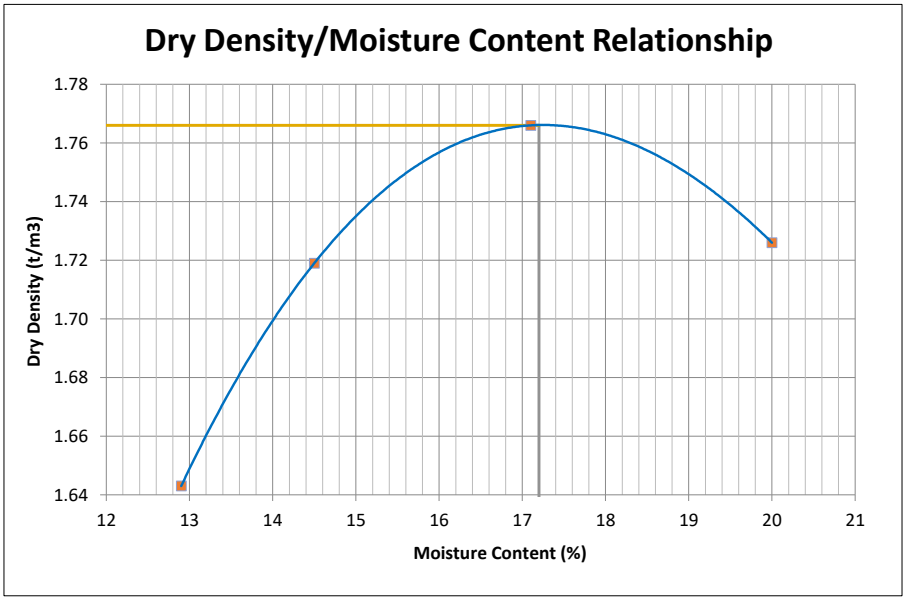
DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH12
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY trace of Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61282-MDD
Job No	S20293-1	**Sample No**	S61282

Test Procedure:
- ☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction
- ☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 22-23/06/2020

Preparation: Prepared in accordance with the test method



Maximum Dry Density (t/m^3)	1.766
Optimum Moisture Content (%)	17.2
Oversize Retained on 19mm sieve (%)	0.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	48 hrs
Liquid Limit Determination	Technician Assessment

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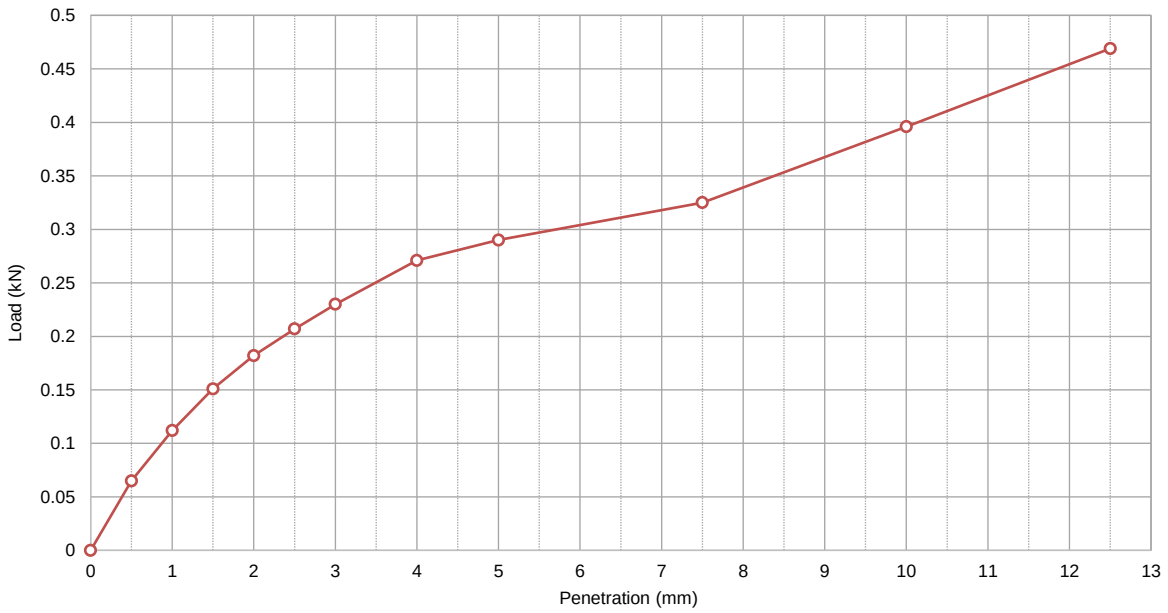
CALIFORNIA BEARING RATIO REPORT

Client	JC Geotechnics Pty Ltd	**Source**	BH19
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY trace of Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No.**	S61280-CBR
Job No.	S20293-1	**Sample No.**	S61280

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	97.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	97.5	98.0
Sample Curing Time (hrs)	103 hrs	Dry Density - At Compaction (t/m³)	1.71	1.72
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.68	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	2.2	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	17.2	
Maximum Dry Density - MDD (t/m³)	1.75	Moisture Content - Top 30mm (%)	27.3	
Optimum Moisture Content - OMC (%)	17.7	Moisture Content - Remainder (%)	19.1	

Material CBR Value (%): **1.5** **at a penetration of** **2.5** **mm**

Notes:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

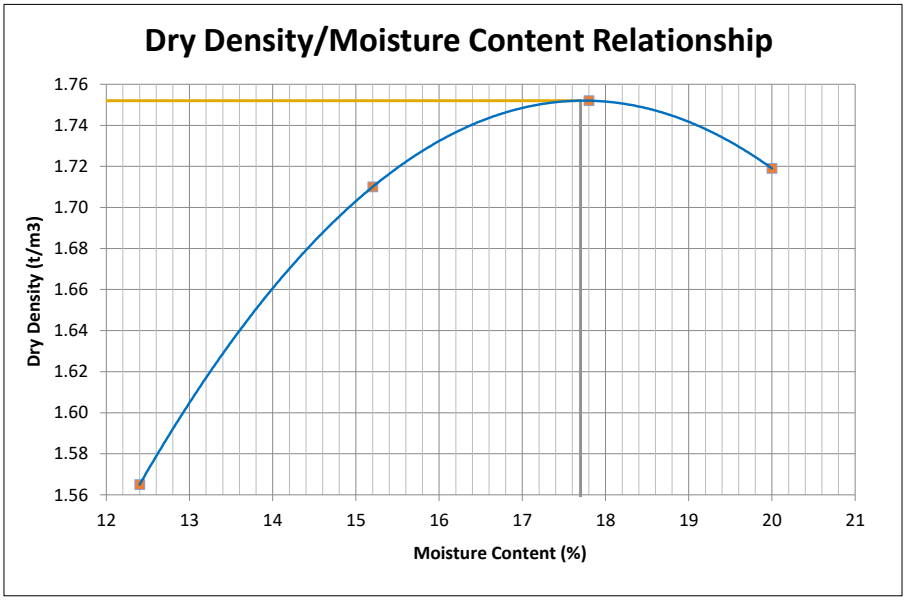
Client	JC Geotechnics Pty Ltd	**Source**	BH19
Address	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description**	Silty CLAY trace of Sand.
Project	Proposed Residential Development (GR1137 1J)	**Report No**	S61280-MDD
Job No	S20293-1	**Sample No**	S61280

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	22-23/06/2020
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.752
Optimum Moisture Content (%)	17.7
Oversize Retained on 19mm sieve (%)	0.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	48 hrs
Liquid Limit Determination	Technician Assessment

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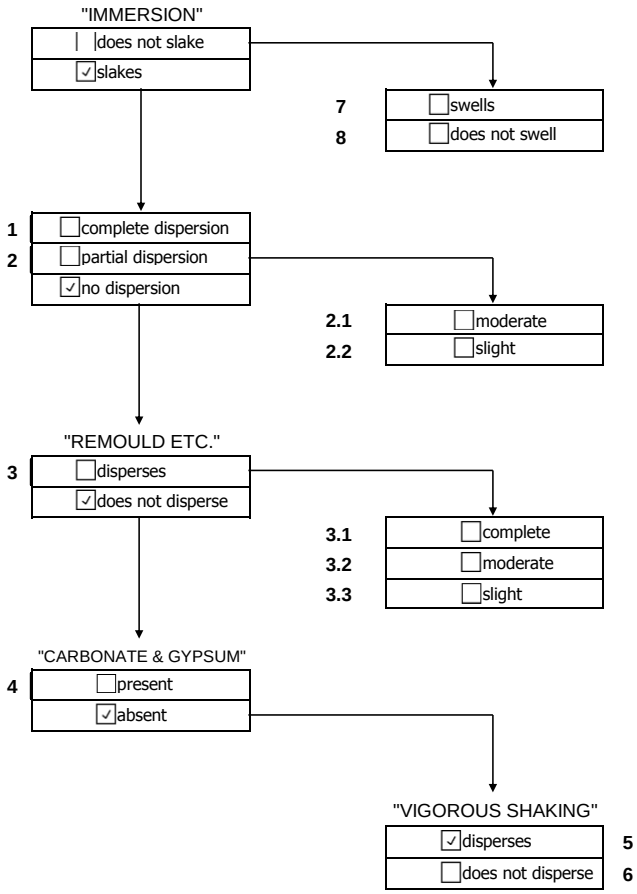
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH3 1.5-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Sandy Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61630-ECT
Job No:	S20293-2	**Lab No:**	S61630

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**18**

RESULT:

Emerson Class No. **5**

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Alexandria NSW 2015

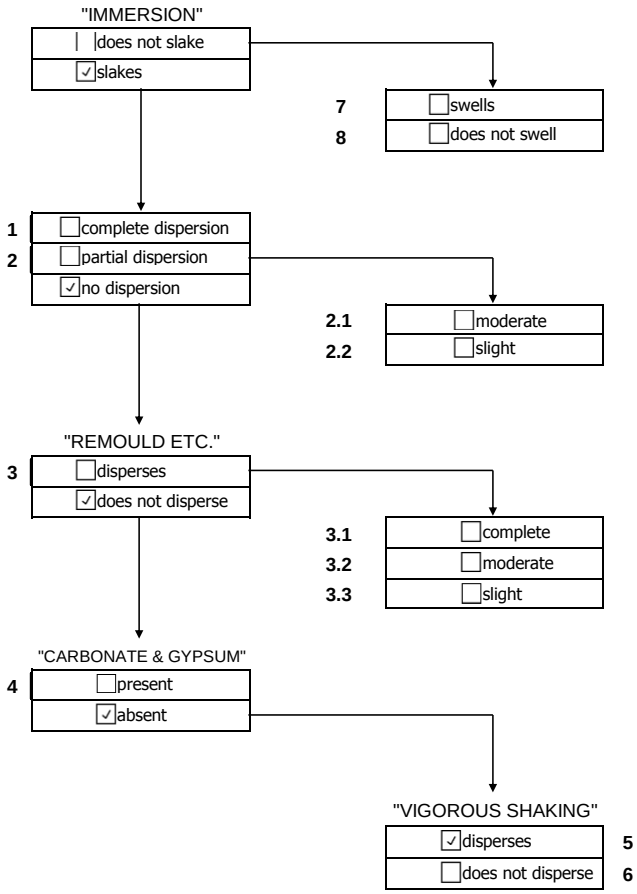
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH5 1.0-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61626-ECT
Job No:	S20293-2	**Lab No:**	S61626

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**17**

RESULT:

Emerson Class No. **5**

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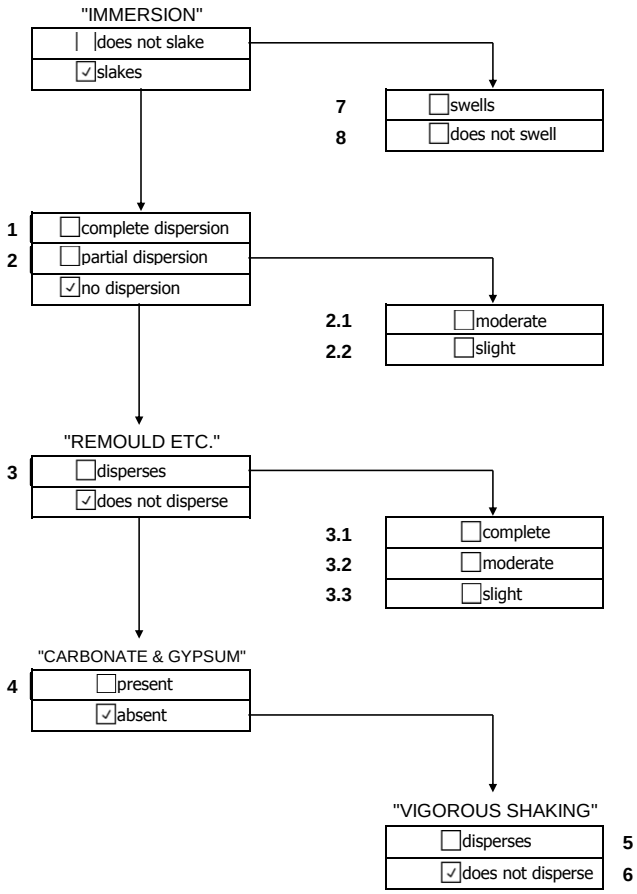
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH6 1.5-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61632-ECT
Job No:	S20293-2	**Lab No:**	S61632

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**17**

RESULT:

Emerson Class No. **6**

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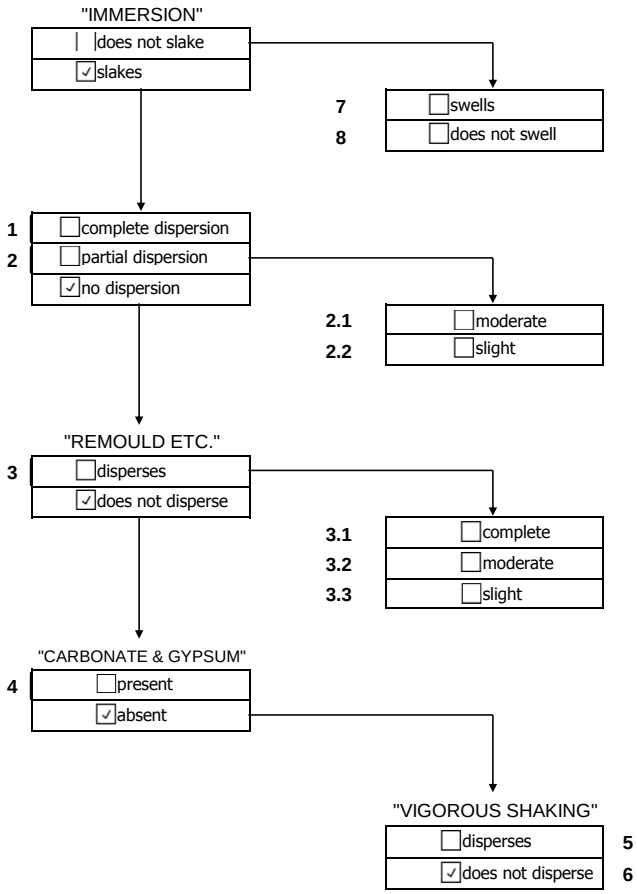
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH7 2.0-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61633-ECT
Job No:	S20293-1	**Lab No:**	S61633

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**16**

RESULT:

Emerson Class No. **6**

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Date:

MACQUARIE GEOTECH

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Alexandria NSW 2015

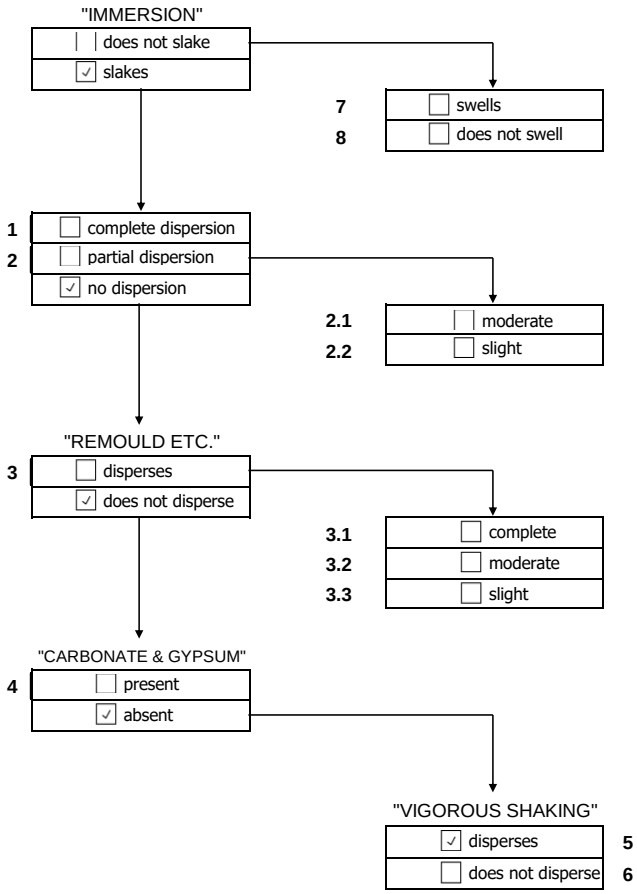
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH8 1.0-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61637-ECT
Job No:	S20293-2	**Lab No:**	S61637

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**16**

RESULT:

Emerson Class No.	**5**

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

27/07/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

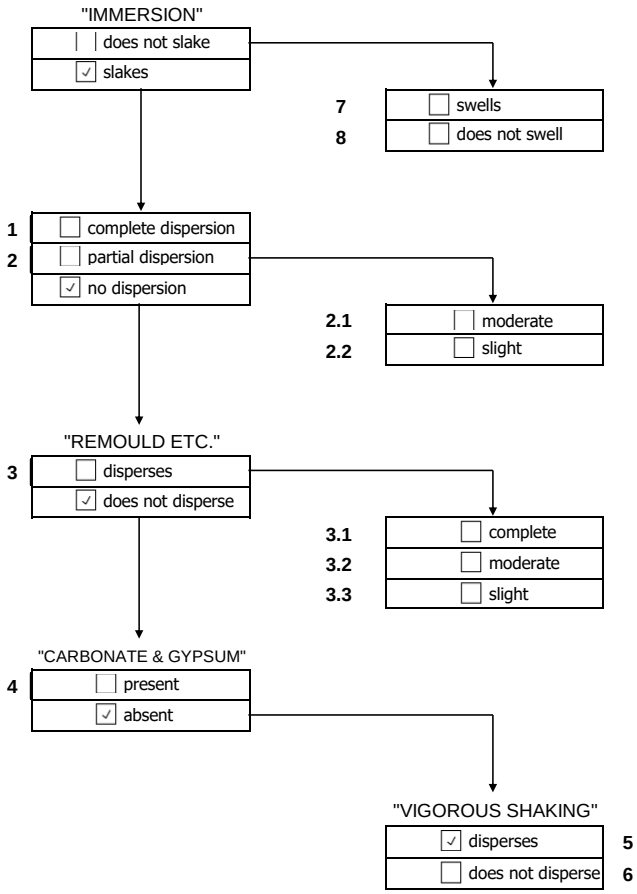
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH9 0.5-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61638-ECT
Job No:	S20293-2	**Lab No:**	S61638

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**16**

RESULT:

Emerson Class No. **5**

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Authorised Signatory:

Chris Lloyd

27/07/2020

Date:

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Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

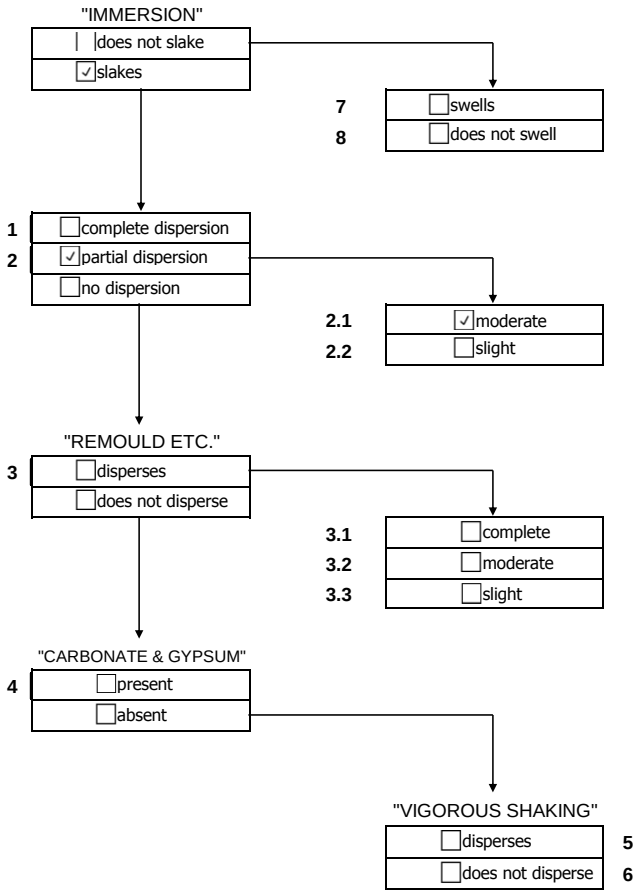
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH11 3.0-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61628-ECT
Job No:	S20293-2	**Lab No:**	S61628

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**17**

RESULT:

Emerson Class No. **2**

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Authorised Signatory:

Chris Lloyd

20/07/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

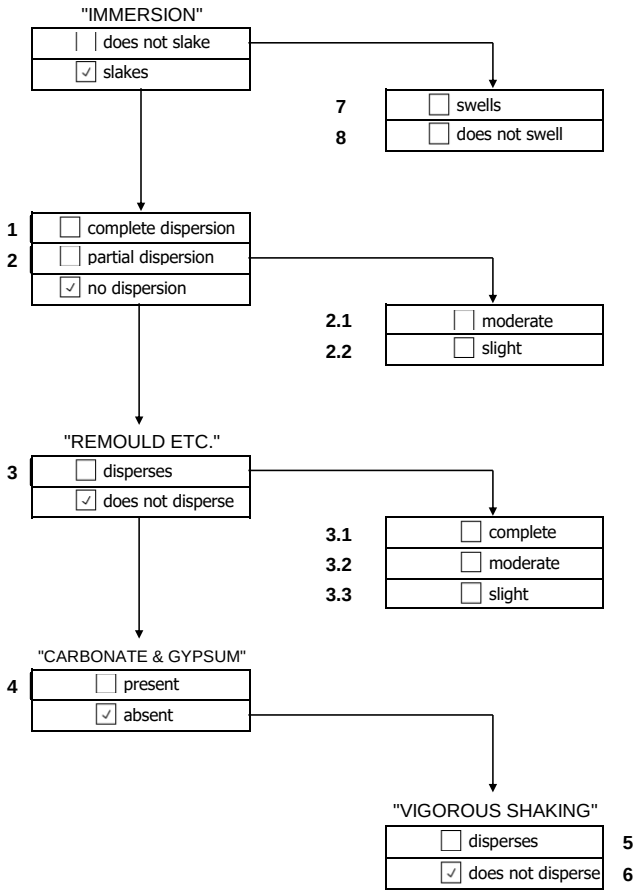
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH12 1.5-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61639-ECT
Job No:	S20293-2	**Lab No:**	S61639

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**16**

RESULT:

Emerson Class No. **6**

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Authorised Signatory:

Chris Lloyd

27/07/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

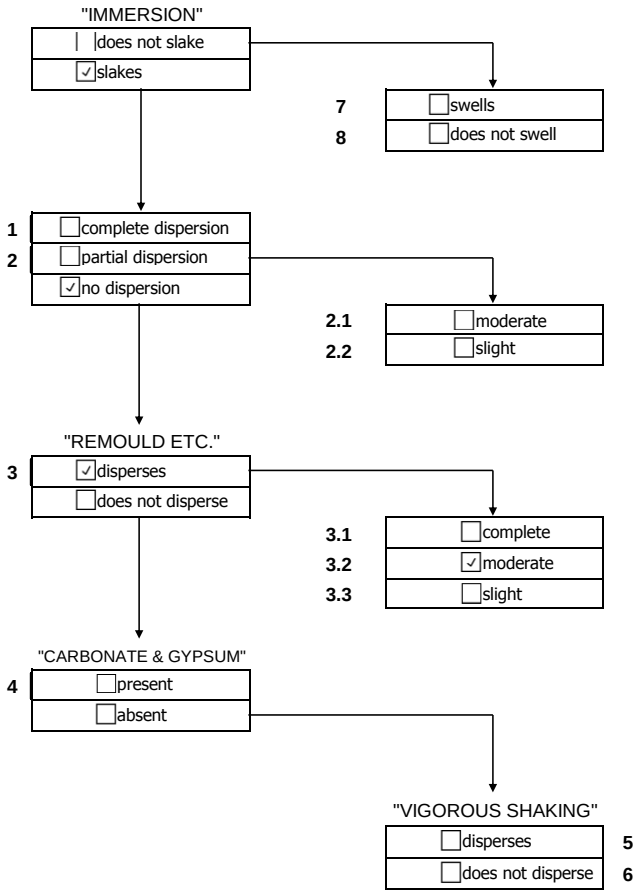
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH16 1.4-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61635-ECT
Job No:	S20293-2	**Lab No:**	S61635

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**18**

RESULT:

Emerson Class No. **3**

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

20/07/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

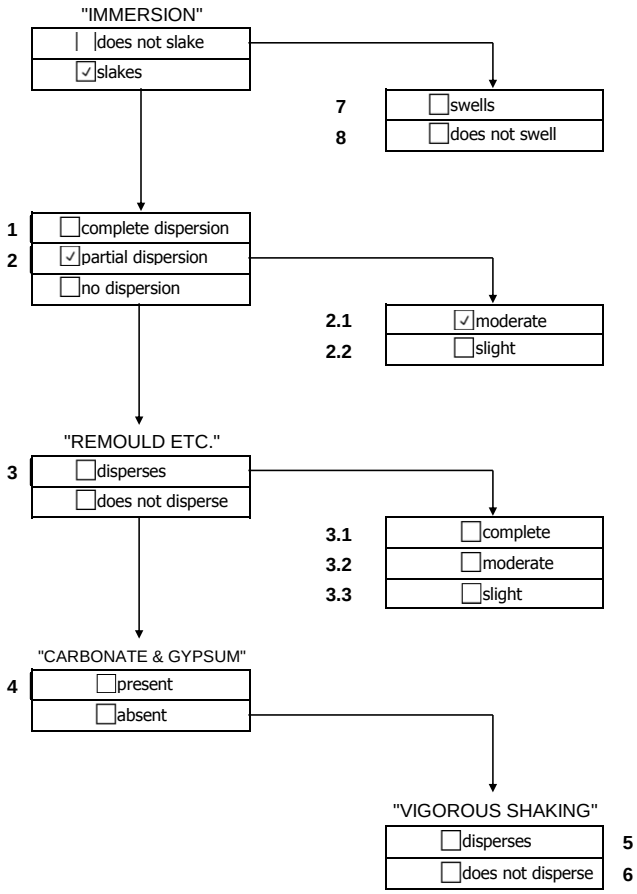
EMERSON CLASS REPORT

Client:	JC Geotechnics Pty Ltd	**Source:**	BH19 0.5-m
Address:	Shop 2-4, 143-147 Parramatta Road, Concord, NSW 2137	**Sample Description:**	Silty CLAY
Project:	Proposed Residential Development (GR1137 1J)	**Report No:**	S61636-ECT
Job No:	S20293-2	**Lab No:**	S61636

Test Procedure: ☑ AS1289 3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 24/06/2020

Preparation: Prepared in accordance with the test method



Water Type	**Distilled**
Water Source	**Laboratory**
Water Temperature (°c)	**18**

RESULT:

Emerson Class No. **2**

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

20/07/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2023802**	Page	: 1 of 7
Client	: **JC Geotechnics**	Laboratory	: Environmental Division Sydney
Contact	: Joseph Chaghouri	Contact	: Customer Services ES
Address	: Shop 2-4 143-146 Parramatta Road Concord 2137	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: GR1137.1J WALLACIA	Date Samples Received	: 10-Jul-2020 12:43
Order number	: ----	Date Analysis Commenced	: 13-Jul-2020
C-O-C number	: ----	Issue Date	: 15-Jul-2020 17:24
Sampler	: JITHENDHAR M		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 33		
No. of samples analysed	: 24		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Senior Chemist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED045G: LOR raised for Chloride on sample 23 due to sample matrix.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH1 (0-0.5M)	BH1 SPT AT 1.5M	BH1 SPT AT 3.0M	BH4 (0-0.5M)	BH4 SPT AT 1.5M
			Client sampling date / time	21-Apr-2020 11:00	24-Jun-2020 00:00	24-Jun-2020 00:00	24-Jun-2020 00:00	24-Jun-2020 00:00
Compound	CAS Number	LOR	Unit	ES2023802-001	ES2023802-002	ES2023802-003	ES2023802-004	ES2023802-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.9	6.1	6.3	5.8	6.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	28	68	30	71	34
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	13.5	8.5	9.0	13.7	12.0
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	35700	14700	33300	14100	29400
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	3.7	1.4	1.7	3.9	1.9
Exchangeable Magnesium	----	0.1	meq/100g	2.0	2.2	2.8	1.5	2.3
Exchangeable Potassium	----	0.1	meq/100g	0.2	<0.1	0.2	0.2	0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.3	0.2	0.1	0.4
Cation Exchange Capacity	----	0.1	meq/100g	5.9	3.9	4.8	5.7	4.7
Exchangeable Sodium Percent	----	0.1	%	0.4	7.8	3.8	2.3	8.0
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	<10	<10	30	30
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	10	100	40	60	10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH4 SPT AT 3.0M	BH5 (0-0.5M)	BH5 SPT AT 0.5M	BH5 SPT AT 1.5M	BH7 SPT AT 0.5M
			Client sampling date / time	24-Jun-2020 00:00	23-Jun-2020 00:00	23-Jun-2020 00:00	23-Jun-2020 00:00	23-Jun-2020 00:00
Compound	CAS Number	LOR	Unit	ES2023802-006	ES2023802-007	ES2023802-008	ES2023802-009	ES2023802-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.0	7.2	7.4	7.0	6.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	48	64	116	206	44
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	11.9	13.8	13.2	16.4	16.1
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	20800	15600	8620	4850	22700
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	----	----	2.7	----	----
Exchangeable Magnesium	----	0.2	meq/100g	----	----	3.0	----	----
Exchangeable Potassium	----	0.2	meq/100g	----	----	0.2	----	----
Exchangeable Sodium	----	0.2	meq/100g	----	----	0.8	----	----
Cation Exchange Capacity	----	0.2	meq/100g	----	----	6.7	----	----
Exchangeable Sodium Percent	----	0.2	%	----	----	11.6	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.7	4.5	----	2.8	3.7
Exchangeable Magnesium	----	0.1	meq/100g	2.2	2.7	----	5.5	4.1
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.9	----	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g	0.4	<0.1	----	1.6	0.4
Cation Exchange Capacity	----	0.1	meq/100g	4.5	8.2	----	10.1	8.4
Exchangeable Sodium Percent	----	0.1	%	8.9	1.0	----	16.2	5.0
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	30	100	40	60
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	70	10	50	190	<10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH11 SPT AT 0.5M	BH11 SPT AT 1.5M	BH11 SPT AT 4.5M	BH11 SPT AT 6.0M	BH11 SPT AT 7.5M
			Client sampling date / time	01-Jul-2020 00:00	01-Jul-2020 00:00	01-Jul-2020 00:00	01-Jul-2020 00:00	01-Jul-2020 00:00
Compound	CAS Number	LOR	Unit	ES2023802-013	ES2023802-014	ES2023802-016	ES2023802-017	ES2023802-018
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.9	6.6	7.9	8.1	8.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	141	350	224	184	207
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	21.9	16.0	14.7	14.4	14.9
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	7090	2860	4460	5430	4830
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	----	----	2.9	3.9	4.9
Exchangeable Magnesium	----	0.2	meq/100g	----	----	3.8	6.1	6.8
Exchangeable Potassium	----	0.2	meq/100g	----	----	<0.2	0.2	<0.2
Exchangeable Sodium	----	0.2	meq/100g	----	----	1.3	1.9	2.2
Cation Exchange Capacity	----	0.2	meq/100g	----	----	8.1	12.2	14.1
Exchangeable Sodium Percent	----	0.2	%	----	----	16.5	15.8	15.8
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.7	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	8.7	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	1.7	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	15.3	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	10.9	----	----	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	2.9	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	7.3	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	0.1	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	2.0	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	----	12.4	----	----	----
Exchangeable Sodium Percent	----	0.1	%	----	16.5	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	100	10	30	20	20
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	140	620	230	200	220

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH11 SPT AT 9M	BH14 (0-0.5M)	BH16 (0-0.5M)	BH16 SPT AT 0.5M	BH15 (0M)
			Client sampling date / time	01-Jul-2020 00:00	22-Jun-2020 00:00	23-Jun-2020 00:00	23-Jun-2020 00:00	23-Jun-2020 00:00
Compound	CAS Number	LOR	Unit	ES2023802-019	ES2023802-020	ES2023802-022	ES2023802-023	ES2023802-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.0	7.2	7.6	7.6	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	261	199	52	63	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	18.4	14.9	18.9	14.6	----
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	3830	5020	19200	15900	----
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	4.0	----	6.0	3.1	----
Exchangeable Magnesium	----	0.2	meq/100g	5.9	----	1.0	5.5	----
Exchangeable Potassium	----	0.2	meq/100g	<0.2	----	0.6	1.3	----
Exchangeable Sodium	----	0.2	meq/100g	1.7	----	<0.2	1.0	----
Cation Exchange Capacity	----	0.2	meq/100g	11.7	----	7.6	10.9	----
Exchangeable Sodium Percent	----	0.2	%	14.6	----	<0.2	8.7	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	9.2	----	----	13.6
Exchangeable Magnesium	----	0.1	meq/100g	----	6.6	----	----	8.8
Exchangeable Potassium	----	0.1	meq/100g	----	0.9	----	----	0.6
Exchangeable Sodium	----	0.1	meq/100g	----	0.7	----	----	0.7
Cation Exchange Capacity	----	0.1	meq/100g	----	17.3	----	----	23.7
Exchangeable Sodium Percent	----	0.1	%	----	3.8	----	----	3.0
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	40	150	10	20	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	290	40	20	<100	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH15 SPT AT 0.5M	BH4 SPT AT 0.5M	BH19 SPT AT 1.5M	BH19 SPT AT 3.0M	----
				Client sampling date / time	23-Jun-2020 00:00	24-Jun-2020 00:00	22-Jun-2020 00:00	22-Jun-2020 00:00	----
Compound	CAS Number	LOR	Unit		ES2023802-030	ES2023802-031	ES2023802-032	ES2023802-033	--------
					Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		8.6	6.9	6.9	7.8	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		202	22	178	135	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		9.2	11.1	16.0	12.3	----
EA080: Resistivity									
Resistivity at 25°C	----	1	ohm cm		4950	45400	5620	7410	----
ED006: Exchangeable Cations on Alkaline Soils									
Exchangeable Calcium	----	0.2	meq/100g		6.0	----	----	2.4	----
Exchangeable Magnesium	----	0.2	meq/100g		5.5	----	----	3.6	----
Exchangeable Potassium	----	0.2	meq/100g		0.2	----	----	<0.2	----
Exchangeable Sodium	----	0.2	meq/100g		1.5	----	----	2.9	----
Cation Exchange Capacity	----	0.2	meq/100g		13.3	----	----	9.0	----
Exchangeable Sodium Percent	----	0.2	%		11.6	----	----	32.6	----
ED007: Exchangeable Cations									
Exchangeable Calcium	----	0.1	meq/100g		----	4.0	3.5	----	----
Exchangeable Magnesium	----	0.1	meq/100g		----	1.5	8.1	----	----
Exchangeable Potassium	----	0.1	meq/100g		----	0.1	0.2	----	----
Exchangeable Sodium	----	0.1	meq/100g		----	0.2	4.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g		----	5.9	16.0	----	----
Exchangeable Sodium Percent	----	0.1	%		----	3.6	25.9	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		40	10	20	10	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		70	<10	460	280	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2023985**	Page	: 1 of 2
Client	: **JC Geotechnics**	Laboratory	: Environmental Division Sydney
Contact	: Joseph Chaghouri	Contact	: Customer Services ES
Address	: Shop 2-4 143-146 Parramatta Road Concord 2137	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: GR1137.2J WALLACIA	Date Samples Received	: 13-Jul-2020 15:15
Order number	: ----	Date Analysis Commenced	: 13-Jul-2020
C-O-C number	: ----	Issue Date	: 14-Jul-2020 13:50
Sampler	: Kail		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 1		
No. of samples analysed	: 1		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Senior Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

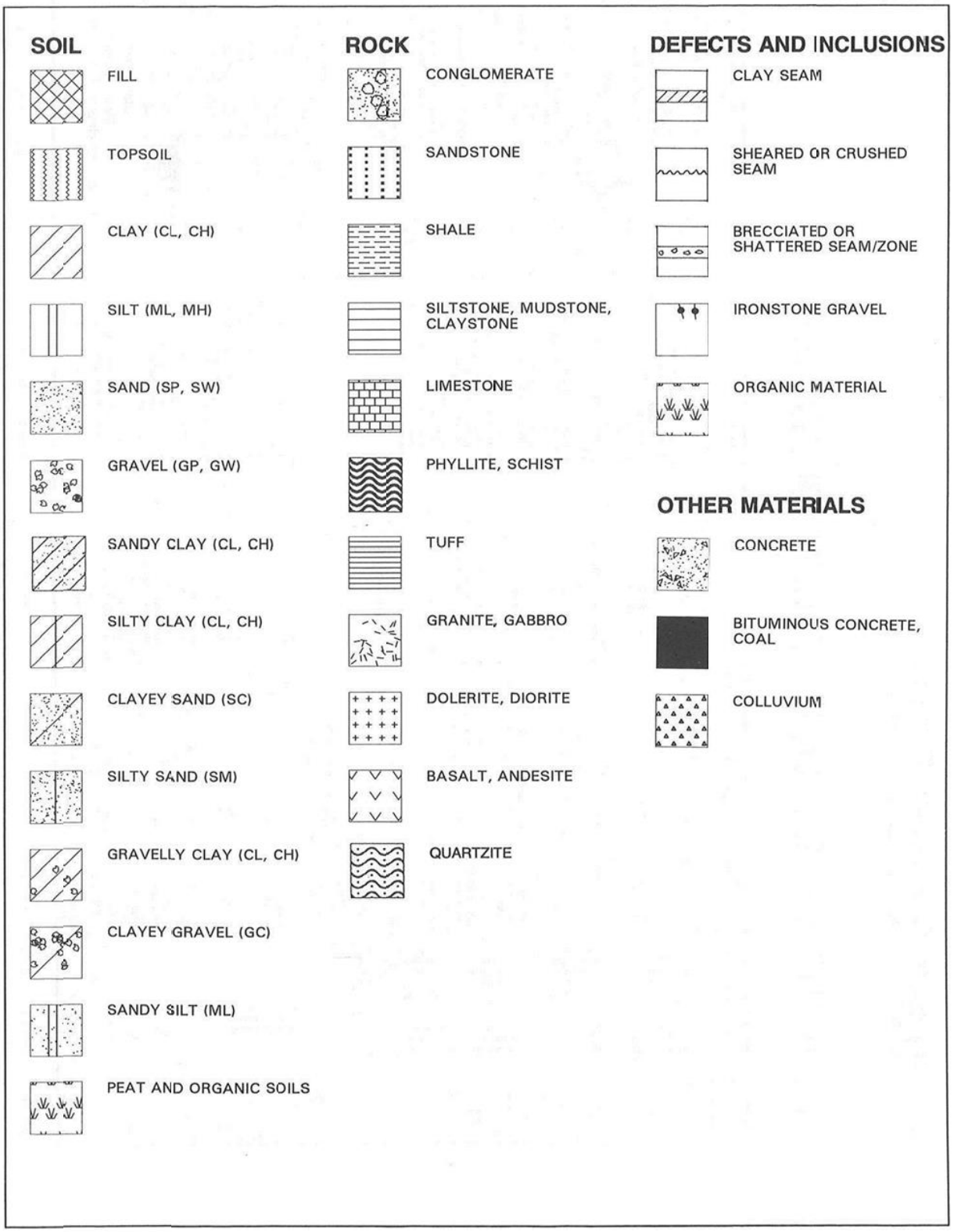
Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**BH11**	----	----	----	----
				Client sampling date / time	09-Jul-2020 15:10	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**ES2023985-001**	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.25**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**5240**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**3**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**28**	----	----	----	----

APPENDIX E

Explanatory Notes

JC GEOTECHNICS

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS



The following information is intended to assist in the interpretation of terms and symbols used in geotechnical borehole logs, test pit logs and reports issued by or for the JC Geotechnics Pty Ltd. More detailed information relating to specific test methods is available in the relevant Australian Standards AS1726-2017.

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Soil Descriptions

Description and Classification of Soils for Geotechnical Purposes: Refer to AS1726-2017 (Clause 6.1.6)

The following chart (adapted from AS1726-2017, Clause 6.1.6, Table A1) is based on the Unified Soil Classification System (USCS). Table 1

Major Divisions		Particle size mm	USCS Group Symbol	Typical Names	Field classification of sand and gravel	Laboratory Classification				
						% < 0.075 mm	Plasticity of fine fraction	$C_u = \frac{D_{60}}{D_{10}}$	$C_u = \frac{(D_{30})^2}{(D_{10})(D_{60})}$	NOTES
COARSE GRAINED SOILS (more than 65% of soil excluding oversize fraction is greater than 0.075 mm)	BOULDERS	200								
	COBBLES	63								
	GRAVELS (more than half of coarse fraction is larger than 2.36 mm)	coarse 20	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	Use the gradation curve of material passing 63 mm for classification of fractions: ≤ 5% fines	—	>4	Between 1 and 3	(1) Identify fines by the method given for fine-grained soils. (2) Borderline classifications occur when the percentage of fines (fraction smaller than 0.075 mm size) is greater than 5% and less than 12%. Borderline classifications require the use of SP-SM, GW-GC.
			GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	—	Fails to comply with above		
			GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Below 'A' line or PI<4	—	Fines behave as silt	
			GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Above 'A' line and PI>7	—	Fines behave as clay	
		medium 6	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	—	>6	Between 1 and 3	
			SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	—	Fails to comply with above		
			SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Below 'A' line or PI<4	—	—	
			SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Above 'A' line and PI>7		—	

Classification of fine-grained soils

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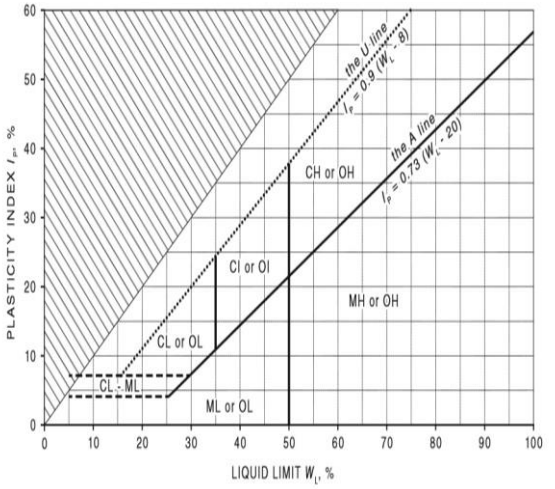
Major Divisions		USCS Group Symbol	Typical Names	Field classification of sand and gravel			Laboratory classification
				Dry Strength	Dilatancy	Toughness	% < 0.075 mm
FINE GRAINED SOILS (more than 35% of soil excluding oversize fractions is less than 0.075 mm)	SILT and CLAY (low to medium plasticity, %) (Liquid Limit ≤50%)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silts and clays of low plasticity	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity) (Liquid Limit >50%)	MH	Inorganic silts, mic- aceous or diato-maceous fine sands or silts, elastic silts	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clays of high plasticity, fat clays	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils	-	-	-	-



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Soil Colour: Is described in the moist condition using black, white, grey, red, brown, orange, yellow, green or blue. Borderline cases can be described as a combination of two colours, with the weaker followed by the stronger. Modifiers such as pale, dark or mottled, can be used as necessary. Where colour consists of a primary colour with secondary mottling, it should be described as follows: (Primary) mottled (Secondary). Refer to AS 1726-2017, Clause 6.1.5

Soil Moisture Condition: Is based on the appearance and feel of soil. Refer to AS 1726-2017, Clause 6.1.7

Term	Description
Dry (D)	Cohesive soils; hard and friable or powdery, well dry of plastic limit. Granular soils; cohesionless and free-running.
Moist	Soil feels cool, darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	Soil feels cool, darkened in colour. Cohesive soils usually weakened and free water forms on hands when handling. Granular soils tend to cohere and free water forms on hands when handling.

Consistency of Cohesive Soils: May be estimated using simple field tests, or described in terms of a strength scale. In the field, the undrained shear strength (s_u) can be assessed using a simple field tool appropriate for cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-2017, Table 11.

Consistency - Essentially Cohesive Soils					
Term	**Field Guide**	**Symbol**	**SPT "N" Value**	**Undrained Shear Strength s_u (kPa)**	**Unconfined Compressive Strength q_u (kPa)**
Very soft	Exudes between the fingers when squeezed in hand	VS	0-2	<12	<25
Soft	Can be moulded by light finger pressure	S	2-4	12-25	25-50
Firm	Can be moulded by strong finger pressure	F	4-8	25-50	50-100
Stiff	Cannot be moulded by fingers	St	8-15	50-100	100-200
Very stiff	Can be indented by thumb nail	VSt	15-30	100-200	200-400
Hard	Can be indented with difficulty by thumb nail.	H	>30	>200	>400
Friable (Fr)	Can be easily crumbled or broken into small pieces by hand	Fr	-	-	-

Soil Particle Sizes	
Term	**Size Range**
BOULDERS	>200 mm
COBBLES	63-200 mm
Coarse GRAVEL	20-63 mm
Medium GRAVEL	6-20 mm
Fine GRAVEL	2.36-6 mm
Coarse SAND	0.6-2.36 mm
Medium SAND	0.2-0.6 mm
Fine SAND	0.075-0.2 mm
SILT	0.002-0.075 mm
CLAY	<0.002 mm

Note: SPT - N to q_u correlation from Terzaghi and Peck, 1967. (General guide only).

Consistency of Non-Cohesive Soils: Is described in terms of the density index, as defined in AS 1289.0-2014. This can be assessed using a field tool appropriate for non-cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-2017, Table 12

Consistency - Essentially Non-Cohesive Soils				
Term	**Symbol**	**SPT N Value**	**Field Guide**	**Density Index (%)**
Very loose	VL	0-4	Foot imprints readily	0-15
Loose	L	4-10	Shovels Easily	15-35
Medium dense	MD	10-30	Shoveling difficult	35-65
Dense	D	30-50	Pick required	65-85
Very dense	VD	>50	Picking difficult	85-100

Standard Penetration Test (SPT): Refer to. AS 1289.6.3.1-2004 (R2016). Example report formats for SPT results are shown below:

Test Report	Penetration Resistance (N)	Explanation / Comment
4, 7, 11	N=18	Full penetration; N is reported on engineering borehole log
18, 27, 32	N=59	Full penetration; N is reported on engineering borehole log
4, 18, 30/15 mm	N is not reported	30 blows causes less than 100 mm penetration (3rd interval) – test discontinued
30/80 mm	N is not reported	30 blows causes less than 100 mm penetration (1st interval) – test discontinued
rw	N<1	Rod weight only causes full penetration
hw	N<1	Hammer and rod weight only causes full penetration

hb	N is not reported	Hammer bouncing for 5 consecutive blows with no measurable penetration – test discontinued

Rock Descriptions

Refer to AS 1726-2017 Clause 6.2.3 for the description and classification of rock material composition, including:

(a) Rock name (Table 15, 16, 17, 18)
(b) Grain size
(c) Texture and fabric
(d) Colour (describe as per soil)
(e) Features, inclusion and minor components.
(f) Moisture content
(g) Durability

The condition of a rock material refers to its weathering characteristics, strength characteristics and rock mass properties. Refer to AS 1726- 2 0 1 7 (Clause 6.2.4 Tables 19, 20 and 21).

Weathering Condition (Degree of Weathering):

The degree of weathering is a continuum from fresh rock to soil. Boundaries between weathering grades may be abrupt or gradational.

Rock Material Weathering Classification				
Weathering Grade		**Symbol**		**Definition**
Residual Soil (Note 1)		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported
Extremely Weathered Rock (Note 2)		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly Weathered Rock (Note 2)	Distinctly Weathered (Note 2)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering
Moderately Weathered Rock (Note 2)		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock.
Slightly Weathered Rock		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock
Fresh Rock		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

Notes:

1. Minor variations within broader weathering grade zones will be noted on the engineering borehole logs.
2. Extremely weathered rock is described in terms of soil engineering properties.
3. Weathering may be pervasive throughout the rock mass, or may penetrate inwards from discontinuities to some extent.
4. Where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock the term 'Distinctly Weathered' may be used. 'Distinctly Weathered' is defined as follows: 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. There is some change in rock strength.

Strength Condition (Intact Rock Strength):

Strength of Rock Material

(Based on Point Load Strength Index, corrected to 50 mm diameter – $I_{s(50)}$. Field guide used if no tests available. Refer to AS 4133.4.1-2007 (R2016).

Term	**Sym**	**Point Load Index (MPa) $I_{s(50)}$**	**Field Guide to Strength**
Extremely Low	EL	≤0.03	Easily remoulded by hand to a material with soil properties.
Very Low	VL	>0.0 ≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3 cm thick can be broken by finger pressure.

Low	L	>0.1 ≤0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	>0.3 ≤1.0	Readily scored with a knife; broken by hand with difficult a piece of core 150 mm long by 50 mm diameter can be y.
High	H	>1 ≤3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	>3 ≤10	pick after more than one blow; rock rings under hammer.
Extremely High	EH	>10	Specimen requires many blow rock ring with geological pick to break through intact material; under hammer

Notes:

1. These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.
2. Anisotropy of rock material samples may affect the field assessment of strength.

Discontinuity Description: Refer to AS 1726-2017, Table 22.

Anisotropic Fabric	
BED	Bedding
FOL	Foliation
LIN	Mineral lineation
Defect Type	
LP	Lamination Parting
BP	Bedding Parting
FP	Cleavage / Foliation Parting
J, Js	Joint, Joints
SZ	Sheared Zone
CZ	Crushed Zone
BZ	Broken Zone
HFZ	Highly Fractured Zone
AZ	Alteration Zone
VN	Vein

Roughness (e.g. Planar, Smooth is abbreviated Pl / Sm)		Class
Stepped (Stp)	Rough or irregular (Ro)	I
	Smooth (Sm)	II
	Slickensided (Sl)	III
Undulating (Un)	Rough (Ro)	IV
	Smooth (Sm)	V
	Slickensided (Sl)	VI
Planar (Pl)	Rough (Ro)	VII
	Smooth (Sm)	VIII
	Slickensided (Sl)	IX

Aperture		**Infilling**		
Closed	CD	No visible coating or infill	Clean	Cn
Open	OP	Surfaces discoloured by mineral/s	Stain	St
Filled	FL	Visible mineral or soil infill <1mm	Veneer	Vr
Tight	TI	Visible mineral or soil infill >1mm	Coating	Ct

Other	
Cly	Clay
Fe	Iron
Co	Coal
Carb	Carbonaceous
Sinf	Soil Infill Zone
Qz	Quartz
CA	Calcite
Chl	Chlorite
Py	Pyrite
Int	Intersecting
Inc	Incipient
DI	Drilling Induced
H	Horizontal
V	Vertical

Note: Describe 'Zones' and 'Coatings' in terms of composition and thickness (mm).

Discontinuity Spacing: On the geotechnical borehole log, a graphical representation of defect spacing vs depth is shown. This representation takes into account all the natural rock defects occurring within a given depth interval, excluding breaks induced by the drilling / handling of core. Refer to AS 1726-2017, BS5930-2015.

Defect Spacing			**Bedding Thickness (Sedimentary Rock**	
Spacing/Width (mm)	**Descriptor**	**Symbol**	**Descriptor**	**Spacing/Width (mm)**
			Thinly Laminated	< 6
<20	Extremely Close	EC	Thickly Laminated	6 – 20
20 – 60	Very Close	VC	Very Thinly Bedded	20 – 60
60 – 200	Close	C	Thinly Bedded	60 – 200
200 – 600	Medium	M	Medium Bedded	200 – 600
600 – 2000	Wide	W	Thickly Bedded	600 – 2000
2000 – 6000	Very Wide	VW	Very Thickly Bedded	> 2000
>6000	Extremely Wide	EW		

Defect Spacing in 3D	
Term	**Description**
Blocky	Equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Defect Persistence (areal extent)
Trace length of defect given in metres

Symbols

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The list below provides an explanation of terms and symbols used on the geotechnical borehole, test pit and penetrometer logs.

Test Results			
PI	Plasticity Index	c'	Effective Cohesion
LL	Liquid Limit	c_u	Undrained Cohesion
LI	Liquidity Index	c'_R	Residual Cohesion
DD	Dry Density	ϕ'	Effective Angle of Internal Friction
WD	Wet Density	ϕ_u	Undrained Angle of Internal Friction
LS	Linear Shrinkage	ϕ'_R	Residual Angle of Internal Friction
MC	Moisture Content	c_v	Coefficient of Consolidation
OC	Organic Content	m_v	Coefficient of Volume Compressibility
WPI	Weighted Plasticity Index	$c_{\alpha\varepsilon}$	Coefficient of Secondary Compression

Test Symbols	
DCP	Dynamic Cone Penetrometer
SPT	Standard Penetration Test
CPTu	Cone Penetrometer (Piezocone) Test
PANDA	Variable Energy DCP
PP	Pocket Penetrometer Test
U50	Undisturbed Sample 50 mm (nominal diameter)
U100	Undisturbed Sample 100mm (nominal diameter)
UCS	Uniaxial Compressive Strength
Pm	Pressuremeter

Test Results			
WLS	Weighted Linear Shrinkage	e	Voids Ratio
DoS	Degree of Saturation	ϕ'_{cv}	Constant Volume Friction Angle
APD	Apparent Particle Density	q_t / q_c	Piezocone Tip Resistance (corrected / uncorrected)
s_u	Undrained Shear Strength	q_d	PANDA Cone Resistance
q_u	Unconfined Compressive Strength	$I_{s(50)}$	Point Load Strength Index
R	Total Core Recovery	*RQD*	Rock Quality Designation

Test Symbols	
FSV	Field Shear Vane
DST	Direct Shear Test
PR	Penetration Rate
A	Point Load Test (axial)
D	Point Load Test (diametral)
L	Point Load Test (irregular lump)

28/11/13 Groundwater level on the date shown	Water Inflow	Water Outflow

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