Douglas Partners
Geotechnics / Environment / Groundwater

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Report on
Preliminary Geotechnical Investigation

Proposed Commercial/Industrial Subdivision
106 - 142 Aldington Road, Kemps Creek

Prepared for
Stockland Commercial Property

Project 92345.00
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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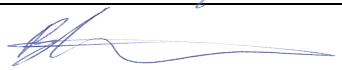
Reviewer		for KS	16 May 2019

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1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed commercial/industrial subdivision at 106 – 142 Adlington Road, Kemps Creek, NSW ('the site'). The investigation was commissioned by Mr Marcus Donnelly of Stockland Commercial Property, developers and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal MAC190088 dated 31 March 2019

It is understood that the development of the site for a commercial/industrial subdivision is proposed and investigation was undertaken for due diligence purposes to provide information on subsurface conditions for preliminary design of earthworks, retaining walls, foundations and pavements.

The investigation comprised a site walkover inspection, test pit excavation, borehole drilling and dynamic cone penetrometer (DCP) testing followed by laboratory testing of selected samples, engineering analysis and reporting. Details of the work undertaken and the results obtained are given in this report, together with comments relating to design and construction practice.

Preliminary concept plans (refer Appendix B) were provided by the client for the investigation. The work was undertaken concurrently with a 'due-diligence' contamination assessment which is report separately (Project 92345.R.001.Rev0).

2. Site Description, Regional Geology and Salinity Potential

The site is an irregular-shaped area of approximately 21 ha, with maximum north-south and east-west dimensions of some 340 m and 540 m respectively. It is bounded to the west by Aldington Road and on the remaining sides by rural properties. Surface levels generally fall in the north-east to easterly direction towards a drainage depression and dam in the eastern section of the site at grades of approximately 1 in 8 to 1 in 20. The overall difference in level is estimated to be approximately 20 m from the highest part of the site (near Bore 5) to the lowest (near Pit 4).

At the time of the investigation, four residences and detached rural structures were located in the western section of the site. The remainder of the site comprised rural land being used for grazing and agistment. Various features observed during the assessment are shown on the colour photoplates in Appendix C.

Reference to the 1:100 000 Penrith Geological Series Sheet (Dept of Minerals and Energy, 1991) indicates that the hillslopes in western portion site are underlain by Bringelly Shale of the Wianamatta Group of Triassic age. The Bringelly Shale typically comprises shale, siltstone, claystone and laminite with coal bands, all of which weather to form clays of medium to high plasticity. The eastern low-lying areas are underlain by quaternary fluvial sediments comprising fine grained sand, silts and clays. The

results of the investigation were generally consistent with the geological mapping with shale encountered in five of the twelve test locations in the west and likely fluvial sediments encountered in the eastern test pits.

Reference to the Map of Salinity Potential in Western Sydney (Ref 3) mapping infers known salinity and high salinity potential around the primary creek/dam line and moderate salinity potential for the remainder of the site. Approximate salinity potential boundaries from the mapping, are shown in Figure 1. The mapping is based on soil type, surface level and general groundwater considerations and, as such are approximate only.

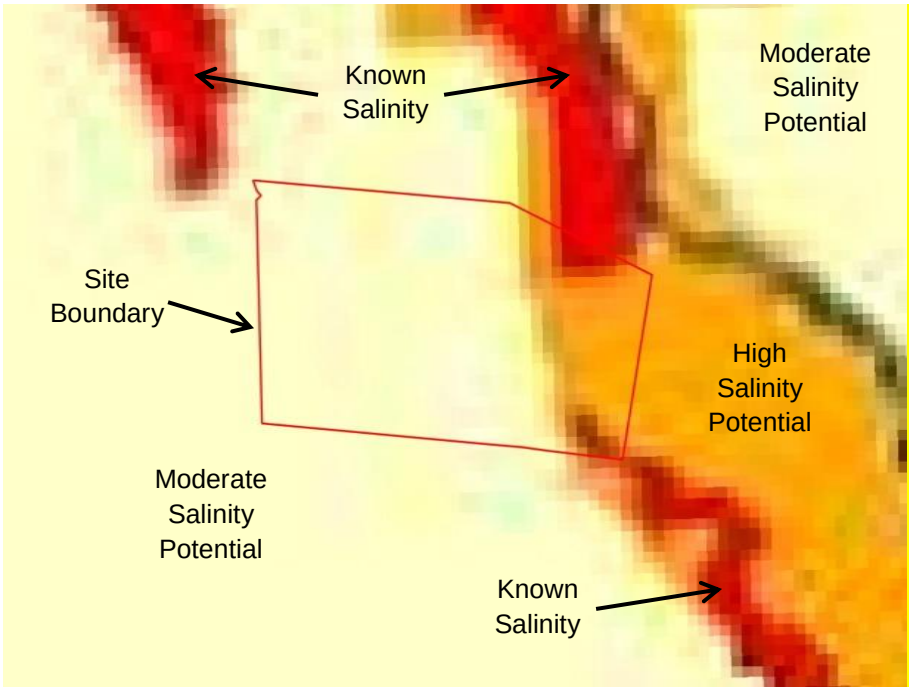


Figure 1: Map of Salinity Potential

3. Field Work

3.1 Methods

The field work comprised a site walkover inspection by an engineering geologist, the excavation of ten test pits (Pits 1 – 4, 6 and 9 – 12) and the drilling of two boreholes (Bores 5 and 8).

The test pits were excavated to depths of 3 m using a John Deer 315SE backhoe fitted with a 400 mm wide bucket. The test pits were logged on site by a geotechnical engineer who collected disturbed and 'undisturbed' (in 50 mm diameter thin-walled tubes) for laboratory testing and to assist in strata identification. Following logging, testing and sampling, all test pits were backfilled and the ground surface reinstated to its previous level. Dynamic cone penetrometer (DCP) tests (AS 1289 6.3.2) were carried out adjacent to the test pit locations to depths of up to 1.2 m to assess the penetration resistance of the near-surface soils.

The boreholes were drilled with a Hanjin DB8 tracked mounted drilling rig to depths of 5.9 m and 7.4 m. The boreholes were advanced through the overburden soils with 150 mm solid flight augers to refusal of the TC-bit at depths of 4.3 m and 2.6 m and were continued into the rock using NMLC (50 mm diameter) diamond coring equipment to the termination depths of 5.9 m and 7.4 m. Standard penetration tests (SPT) were carried out at regular depth intervals to assist in strata identification and for possible laboratory testing. Details of the SPT procedure are given on the accompanying notes in Appendix A, with the penetration 'N' values shown on the borehole logs.

The test pit and borehole locations were nominated by DP and located on site prior to the investigation. The approximate test pit locations are shown on Drawing 1 in Appendix B. The surface levels to Australian Height Datum (AHD) and coordinates to Map Grid of Australia (MGA) were obtained using a differential GPS for which an accuracy of 20 mm is typical.

3.2 Results

3.2.1 Site Inspection

Specific observations at various Map Reference Points (MRP) within the site are included in Appendix B, the locations of which are shown on Drawing 2 and summarised below:

- The Aldington Road embankment was approximately 6 m in height with batter slopes of up to 40°. A 600 mm culvert drains into the site from the base of the embankment (MRP 4 and Photo 1);
- Fill mounds and stockpiles comprising clay, gravel and cobbles were scattered across the site. Fill in places had been levelled and in others was heaped (MRP 1, 5, 15 and 16 and Photo 10);
- The eastern portion of the site was occupied by four dwellings and outbuildings. Planting fields occupied the portion of the site behind the north eastern dwellings (MRP 3);
- A portion of the low-lying ground around the watercourses and dams appears to be prone to waterlogging but was dry at the time of the investigation (MRP 9 and 10 and Photo 5);
- In the southeast portion of the site there is a large farm dam (approximately 2.4 Ha of which approximately 1 Ha was within the site boundary). The dam embankment was approximately 2 m in height with downstream batters of 2(H):1(V) to near vertical. There was no obvious spillway however the embankment freeboard was approximately 0.4 m (MRP 11 – 14 and Photos 4 and 6);
- A smaller dam (approximately 2000 m^2) was immediately downstream of the large dam. The dam walls were north of the site boundary (MRP 7 and Photo 7);
- No signs of salt efflorescence or scalding were noted during the field investigation.

3.2.2 Subsurface Investigation

The test pit and borehole logs are included in Appendix C and should be read in conjunction with the accompanying standard notes that define classification methods and descriptive terms.

Relatively uniform conditions were encountered underlying the site with the general succession of strata broadly summarised as follows:

- TOPSOIL FILL – silty clay topsoil and topsoil fill to depths of 0.1 – 0.3 m;
- FILL – silty clay with some anthropogenics to depths of 0.2 – 0.5 m in Pits 1, 9 and Bore 5 only;
- SILTY CLAY – variably stiff to hard silty clay to depths of 1.4 – 2.8 m in Pits 1, 6 and 10 and Bores 5 and 8, and to the termination depths of 3 m in Pits 2 – 4, 7, 9, 11 and 12; and
- BEDROCK – initially extremely low to very low strength shale at first contact at depths of 1.4 – 2.8 m and continuing to the termination depths of 3 m in Pits 1, 6 and 10. In Bore 5 the core was very low strength shale to the termination depth of 5.9 m. In Bore 8, medium strength shale was intersected at 5.3 m and then medium strength sandstone from 6.1 m to the termination depth of 7.4 m.

Groundwater was observed at depths of 2.5 m (RL59.1 AHD) in Pit 4 and 3 m (RL61 AHD) in Pit 11 during excavation. No free groundwater was observed in the remaining pits for the short time that they were left open or in Bores 5 and 8 whilst auger drilling. The use of water as a drilling fluid precluded groundwater observations whilst core drilling. It is also noted that the pits and boreholes were immediately backfilled following excavation which precluded longer term monitoring of groundwater levels. Groundwater levels are affected by factors such as soil permeability and weather conditions, and can therefore vary with time.

4. Laboratory Testing

Four bulk samples were tested in the laboratory for measurement of field moisture content, compaction properties and California bearing ratio (CBR). The CBR tests were carried out on samples compacted to approximately 100% dry density ratio relative to Standard compaction at standard optimum moisture content. The samples were then soaked for four days under surcharge loadings of 4.5 kg. The detailed laboratory test report sheets are given in Appendix D, with the results summarised in Table 1.

Table 1: Results of CBR Testing

Pit No	Depth (m)	W_F (%)	OMC (%)	MDD (t/m^3)	Swell (%)	CBR (%)	Material
2	1.0	17.3	16.0	1.83	2.0	1.5	Silty Clay
7	0.5	25.1	21.0	1.63	1.5	1.0	Silty Clay
9	0.5	23.6	21.0	1.67	0.5	0.5	Silty Clay
11	1.0	17.1	17.0	1.82	0.5	4.0	Silty Clay

Where FMC = Field moisture content OMC = Optimum moisture content
MDD = Maximum dry density

The results of the field moisture content tests (at the time of the sampling) listed in Table 1 indicate the soils ranged between approximately 0.1 – 4.1% wet of standard optimum moisture content (SOMC).

Disturbed samples were tested for measurement of plasticity, moisture content and dispersion. The detailed laboratory test report sheets are given in Appendix D, with the results summarised in Table 2.

Table 2: Results of Plasticity and Dispersion Testing

Pit No	Depth (m)	W_L (%)	W_P (%)	PI (%)	LS (%)	ECN	Material
4	0.5	-	-	-	-	1	Silty Clay
5	1.0	45	19	26	13.5	-	Silty Clay
6	1.0	-	-	-	-	2	Silty Clay
10	0.5	70	19	51	17.0	-	Silty Clay

Where W_L = Liquid limit, W_P = Plastic limit, PI = Plasticity Index, LS = Linear shrinkage, ECN = Emerson Class number

The test results indicate that the natural clays are of medium to high plasticity and as such, would be susceptible to shrinking and swelling with changes in soil moisture content. The results of the Emerson crumb tests indicate that the soils tested are dispersive.

'Undisturbed' samples were recovered for measurement of field moisture content and Shrink-swell Index. The detailed laboratory test report sheets are given in Appendix D, with the results summarised in Table 3.

Table 3: Results of Shrink Swell Testing

Pit No	Depth (m)	W_F (%)	I_{ss} (%/ΔpF)	Material
1	0.8 -1.1	20.7	2.6	Silty Clay
4	0.5 – 0.9	23.3	2.8	Silty Clay
7	0.5 – 0.9	23.5	1.8	Silty Clay

Where I_{ss} = Shrink-swell Index, W_f = Field moisture content

The Shrink-swell Index (I_{ss}) test results also indicate that the natural clays are of moderate shrink-swell potential and are consistent with the results of the plasticity index testing.

4.1 Salinity, Aggressivity and Sodicity

Samples from the test pits were also tested in the laboratory for determination of aggressivity to concrete and steel, sodicity, textural classification and salinity.

The detailed laboratory test report sheets and a summary table presenting the results of laboratory tests, calculated salinity ECe and salinity classification inferred from ECe values using the method of Richards (Ref 4) are given in Appendix D.

The summary table presents aggressivities and salinities for each pit location, based on minimum pH, minimum electrical resistivity and maximum ECe values within the investigated depth zone.

The number of samples tested for each parameter and the range of test results obtained are summarised in Table 4.

Table 4: Results of Laboratory Testing - Chemical

Parameter		Units	Number of Tests	Range of Results
pH		pH units	53	4.8 – 9.5
Chlorides		(mg/kg)	13	>10 – 1400
Sulphates		(mg/kg)	13	>10 - 360
Aggressivity [AS 2159, Ref 7]	to Concrete	-	54	non-aggressive – mildly aggressive
	to Steel	-	54	non-aggressive – moderately aggressive
Exchangeable Sodium (Na)		(meq/100g)	5	0.2 – 2.0
CEC (cation exchange capacity)		(meq/100g)	5	6.2 – 21.0
Sodicity [Na/CEC]		(ESP%)	5	0.7 – 32.3
Sodicity Class		[after DLWC]	5	Non-sodic – Highly Sodic
EC1:5 [Lab.]		(mS/cm)	53	30 – 1300
Resistivity		Ω.cm	53	770 - 33333
ECe [M x EC1:5] [1]		(dS/m)	53	0.2 – 11.1
Salinity Class [after Richards, Ref 10]		-	53	Non-Saline – Very Saline

Note: 1 M is soil textural factor

4.1.1 Aggressivity

Test results showing the aggressivity assessed by pH, resistivity, sulphate concentrations, and chloride concentration criteria (of AS 2159) at the test pit locations, together with the aggressivity class ranges indicated in Australian Standard AS 2159 (Ref 5) are given in Appendix D. The absence of free groundwater in the test pits or the inferred very low permeability of the sampled clay-rich soils indicate that soils at all test pits are in Condition "B" as defined by AS 2159 (Ref 5).

The results indicate that of the 54 samples tested for aggressivity:

- 24 samples were mildly aggressive to concrete and 30 were non aggressive to concrete; and
- Two samples were moderately aggressive to steel, 23 were mildly aggressive to steel and 29 were non-aggressive to steel.

4.1.2 Salinity

Test results showing the salinity classifications based on the electrical conductivity (ECe) and the methods of Richards (Ref 4) are given in Appendix D.

The results indicate that of the 53 samples tested for salinity:

- 19 samples were non-saline;
- 14 samples were slightly saline;
- 19 samples were moderately saline; and
- 1 sample was very saline.

4.1.3 Sodicity and Dispersibility

The sodicity tests show non-sodic up to highly sodic soils, indicating a potential for erosion of exposed soils.

5. Proposed Development

It is understood that the site will be developed for commercial and light industrial purposes. Preliminary concept plans (refer Appendix B) indicate that the proposed development will likely include five warehouse structures constructed on near-level building platforms. Based on the information provided, excavation and filling to maximum depths of 4.5 m and 8 m respectively will required to create a series of near-level benches ranging from RL65 to RL80. Although detailed design is yet to be undertaken, similar developments have required advice regarding earthworks, foundations, retaining walls and pavements.

6. Comments

6.1 General

The following comments are based on the surface and subsurface profiles encountered in the test locations. Comments are provided in the following sections on development constraints related to geotechnical and geological factors to assist in the conceptual planning and design of the proposed commercial and light industrial subdivision. Notwithstanding this, further investigation, analysis and reporting will be required as conceptual planning and development of the subdivision and specific proposal on each allotment progresses.

6.2 Geotechnical Model

Based on the results of the investigation, the inferred subsurface geotechnical model underlying the site comprises:

- A surficial layer of topsoil, topsoil fill and uncontrolled fill to depths of up to 0.5 m;
- A residual clay profile, typically of stiff to hard consistency, to depths ranging from 1.5 – 3.0 m in the western (elevated) section of the site and a fluvial clay profile to undetermined depth in the eastern (lower) section of the site;
- Shale bedrock initially extremely low to very low strength becoming low to medium strength below a depth of 5.3 m in Bore 8;
- Groundwater within the fluvial clay was at depths of 2.5 m (Pit 4) and 3 m (Pit 11) during excavation possibly being controlled by the adjacent watercourse.

6.3 Earthworks

6.3.1 Site Preparation

To prepare the general area of the site (other than farm dams) for the proposed commercial/industrial lots and pavements, the following procedures should be considered:

- Strip vegetation and organic topsoil and uncontrolled fill (including existing dwelling platforms). The organic topsoil could be separately stockpiled for use in landscaping or removed off site. Clay fill free of deleterious material would be re-used subject to geotechnical inspection and environmental protocols;
- Compact the exposed surface with at least 6 passes of a 12 tonne (minimum dead weight) roller, followed by test rolling in the presence of a geotechnical engineer;
- Soft or unstable areas that are identified during test rolling may need to be treated by excavation to a stiff stratum and replaced with engineered fill (refer Section 6.3.5). If this exceeds 500 mm, a bridging layer over very weak material may be required; and
- Site drainage should be maintained at all times by adopting appropriate cross-falls within the site. Surface drainage should be installed as soon as is practicable in order to capture and remove surface flows to prevent erosion and softening of the exposed soils and weathered bedrock.

Any fill delivered to site must be approved by the geotechnical and environmental consultant before use.

Site observations have indicated low lying areas susceptible to water logging and subsurface material predominantly consists of silty clays which could potentially be affected by inclement weather and result in difficult trafficability conditions. As a result, surface drainage that directs runoff away from work areas should be installed prior to construction, possibly in conjunction with the designation of construction equipment haul routes to minimise trafficking of stripped areas.

Conventional sediment and erosion control measures should be implemented during the earthworks operation, with final surfaces to be topsoiled and vegetated as soon as practicable following the completion of earthworks.

6.3.2 Desilting of Dams

The existing farm dams will need to be drained and filled to design level. The following general procedure is provided however as the main dam is only partially within the site, a detailed plan will be required on how to manage this part of the works:

- Pump out existing water pondage across land at a minimum distance of 50 m from any existing waterways;
- Strip all vegetation and other deleterious material (such as saturated silt and clay) to expose the underlying stiff clay/weathered rock;
- Excavate the existing uncontrolled fill from the dam wall;
- Bench the exposed surface to facilitate near-horizontal fill placement;
- Test roll the surface to receive fill with six passes of a 12 tonne dead weight roller operating in static mode, with final pass undertaken in the presence of a geotechnical engineer in order to identify areas requiring remedial work;
- Place and compact approved fill as per Section 6.3.5;
- Saturated *'organic*' soils from the dam base can be spread out and dried. Once dried the material can be blended with stockpiled topsoils and spread across the finished surface of lots;
- Any saturated *'non-organic'* soils can be spread out and dried. Once moisture conditioned the materials can be reused as engineered fill (refer Section 6.3.5) subject to inspection and approval.

Prior to discharging, an assessment of the dam water should be undertaken to confirm the adequacy of the above disposal method. The assessment should include (as a minimum) pH and turbidity testing to in accordance with Penrith City Council requirements.

6.3.3 Excavation

All topsoil, uncontrolled fill, natural soils and bedrock up to very low to low strength should be readily removed using an elevating scraper or a conventional medium sized excavator with a toothed bucket with some light ripping, or a D6 or equivalent dozer.

Medium strength rock as is expected in the areas of deepest cut in the western section of the site, will require, as a minimum a D9 or equivalent dozer with some medium to heavy ripping. However, larger plant may provide greater excavation efficiency. Hydraulic rock hammers will be required for detailed excavation (such as footings and service trenches).

Anticipated plant required for rock removal is given as a guide only as excavatability depends on the size of the plant and the skills of the operator, as well as the rock strength and the degree of jointing.

Vibration issues may become a concern where excavation is undertaken within 20 m of neighbouring structures, such as along the western, southern and northern boundaries. However, this will need to be determined once the details of the proposed excavations and equipment are known.

Reference must be made to the individual logs which are included in Appendix C. The contractor must make its own assessment of excavation conditions as the information given on the test pit logs are preliminary only. Additional investigation may be required as the design of the subdivision progress.

6.3.4 Batter Slopes

While cut slopes within the stiff clays may often stand vertically unsupported (provided no nearby structures are present) for short periods of time, they will rapidly lose strength upon exposure to weather. A maximum batter slope of 2(H):1(V) is recommended for permanent slopes in stiff clays and temporary slopes (with no surcharge) in fill, provided that the slopes are no more than 4 m in height and they are protected against surface erosion and local slumping.

Where the slopes are to be vegetated and maintained to prevent erosion, a maximum batter slope of 3(H):1(V) is recommended. It should be noted, however, that Council may require slopes of the order of 4(H):1(V).

If batters greater than 4 m in height are required, the inclusion of a 3 m wide intermediate bench every 4 m in vertical height is recommended to reduce the effects of scour and erosion. Detailed stability analysis will be required.

Where fill batters are formed, similar parameters to those recommended for cut slopes can be adopted. However, it is recommended that whilst the slope is being constructed, the batters should be over-filled in near-horizontal lifts and cut back to the design grades.

All other excavations and fill is to be supported by engineer-designed retaining walls.

6.3.5 Reuse of Excavated Materials

Generally, the majority of natural soils and clayey fill encountered during the investigation will be suitable for reuse as engineered fill within the site provided that any pre–treatment (moisture conditioning, removal of oversize and deleterious material etc), is carried out prior to fill placement. The material should not contain any particles greater than 150 mm in size as these may restrict compaction. It is expected that bedrock of very low strength or less should breakdown to a suitable size beneath the construction plant used for placement. Low strength and higher strength rock will require the use of a crushing plant to create a homogeneous material appropriate for compaction.

Consideration should be given to the high dispersion potential of the clay soils. Care should be exercised to ensure dispersive soils are covered with a layer of topsoil.

Regarding reuse of existing fill, reference should be made to DP's preliminary site investigation for contamination (Project 92345.00.R.001.Rev0) carried out in conjunction with this preliminary geotechnical investigation.

6.3.6 Engineered Fill

Controlled fill should be placed at a minimum dry density ratio of 98% relative to standard maximum dry density (SMDD) placed in loose 250 mm thick, near-horizontal layers. Placement moisture content of the fill should be maintained within the range of -2% to +2% of optimum moisture content (OMC) as measured in the Standard compaction test.

Inspection and density testing would be required to confirm the placement of fill to the required standard. The general limits are shown in AS 3798:2007 *'Guidelines on Earthworks for Commercial and Residential Developments'* (Standards Australia, 2007) as detailed below.

Where fill is required to achieve design subgrade levels along road alignments, the upper 0.5 m thickness (ie: to subgrade level) must be compacted to achieve a dry density ratio of at least 100% relative to SMDD, with placement moisture contents within the range of -2% to +2% of OMC in order to minimise the potential for post compaction volume change due to moisture content variations. Any soft or weak areas detected during proof rolling should be excavated and replaced by select fill, compacted as recommended above.

During inclement weather or if the site is to be left unattended for an extended period, the upper surfaces of fill should be crowned and if possible blinded by smooth wheeled plant. Any stockpiles should be blinded to allow water to run off.

Where building construction is delayed following completion of earthworks, the allotments will need to be revegetated promptly to minimise the effects of erosion and to prevent drying of the site soils. A minimum topsoil thickness of 100 mm is suggested. Alternatively, the subgrades are to be tyned, moisture conditioned and re-compacted immediately before building construction. The allotments must also be graded to a minimum of 1% to prevent ponding.

6.3.7 Geotechnical Inspections and Testing

It is recommended that the site be inspected by a geotechnical engineer following stripping of vegetation, topsoils and uncontrolled fill and during the test rolling undertaken prior to the placement of fill. Geotechnical testing should be carried out in accordance with AS 3798:2007 (Standards Australia, 2007). As a minimum, placement of fill on future lots must be to a Level 1 standard as described in AS 3798 whilst Level 2 standard is considered appropriate for pavement construction and backfilling of service trenches, unless otherwise specified by the designer. It is also recommended that the Geotechnical Inspection and Testing Authority (GITA) should be engaged directly on behalf of the Principal and not by the earthworks contractor.

6.4 Retaining Walls

Where engineer-designed retaining walls are proposed, the following measures should be incorporated into the design:

- Backfilling of the void between the wall and the slope using imported, free draining granular material connected into a drainage pipe at the base of the wall;
- Capping of the backfill (where exposed) with compacted clay or concrete to prevent surface runoff entering the backfill;
- Provision of an open drain to collect and divert surface runoff from ponding above the wall;
- For horizontal backfill or retained soils, design based on an average bulk unit weight for retained material of 20 kN/m^3 and on a triangular earth pressure distribution based on an active earth pressure coefficient of (K_a) 0.3 for compacted fill and natural clay where no movement sensitive structures are located within a horizontal distance of 2H (where H is the vertical height of the retained zone) of the rear of the wall; and
- Where there are movement sensitive structures located within the abovementioned critical zone, an at rest pressure coefficient (K_0) of 0.6 should be adopted.

If a drainage medium is not provided behind the retaining wall, then hydrostatic pressures must be incorporated within the design and soil densities must be reduced to the buoyant values.

6.5 Site Classification

Classification of individual allotments within the site (if required) should comply with the requirements of AS 2870 : 2011 *"Residential Slabs and Footings"* (Standards Australia, 2011). Based on the subsurface conditions encountered and previous experience in similar geological settings, the site would currently be classified as Class P due to the presence of uncontrolled fill.

Class P sites can be reclassified if all the uncontrolled fill and other deleterious material is removed and replaced with controlled fill (Level 1 inspection and testing). If controlled fill is placed, subsurface profiles would most likely range from Class M (moderately reactive) to H1 (highly reactive), with the final classifications dependent on fill quality, fill depth, soil reactivity, soil strength and rock depth.

It is noted however, that the classification is appropriate for the undeveloped site and is independent of proposed development. Furthermore, reference to Clause 3.1.1 of the Code indicates that the footing details given are not appropriate for buildings longer than 25 m and as such the classifications above are indicative only and may not be appropriate for use in design of the proposed commercial/light industrial development.

6.6 Footings

Design of footings for proposed structures can only be undertaken once detailed investigation has been undertaken. As a guide however and based on the results of the subsurface investigation and the range of soils encountered, preliminary footing design could be based on the parameters presented in Table 5.

Table 5: Preliminary Footing Design Parameters

Material	Allowable Base Bearing Pressures (kPa)
Stiff clay or controlled fill	150
Very stiff to hard clays or stronger	200 – 250
Very low strength rock	500
Low to medium strength rock	1200

Footings on fill over clay will likely only be feasible for column loads up to, say, 400 kN. As a guide, settlements under column loads of 400 kPa would be in the range 15 – 25 mm. Notwithstanding this, due to large footprints of the proposed warehouses and the variable subgrade conditions that will occur following site works (that could include weathered rock through residual clays and controlled fill), consideration must be given to differential movements that would result. In this regard, differential settlements could approach the total estimated settlements.

If estimated settlements are beyond tolerable limits or higher loads are proposed, footings-to-rock systems would be required. The principal advantage of footings-to-rock systems would be that settlements (both total and differential).

6.7 Pavements

6.7.1 Preliminary Pavement Thicknesses

Based on the results of laboratory testing and previous experience in the area, it is expected that most of the clay subgrades will generally comprise clays with CBR values in the range of 0.5 – 4%. A CBR value of 7% could be adopted for rock subgrades.

Where weak clay subgrades with a CBR below 2% (such as near Pits 2, 7 and 9), subgrade improvement in the form of lime stabilisation or replacement with a select material such as crushed rock (CBR of at least 15%) will be required. As an example, where material with CBR of 0.5% is encountered at subgrade level, an effective design CBR of 2% could be achieve by liming or subgrade replacement to a depth of 300 mm. In addition to localised subgrade improvement required where weak subgrades are encountered, overall pavement thickness design may be optimized by the inclusion of a select subgrade following detailed subgrade investigation.

It may also be feasible to selectively remove and replace the weak subgrade materials with select fill (such as excavated rock won from site) within the road alignments during bulk earthworks so that pavement thicknesses can be optimised.

The preliminary flexible pavement thickness designs given in Table 6 are based on the design traffic loading requirements of Penrith City Council, Austroads – 2018 and a range of likely CBR values. Additional investigations, sampling and laboratory testing will need to be undertaken at the appropriate time to provide a final pavement thickness design.

Table 6: Preliminary Flexible Pavement Thickness Design

Road	Traffic Loading (ESA) (1)	Design CBR (2) (%)	Total Granular Pavement Thickness (mm) (3)
Industrial	5×10^6	2	745
		4	520
		7	380
Heavy Industrial	1×10^7	2	790
		4	555
		7	405

Notes: (1) To be confirmed by Council prior to construction;
(2) Indicative CBR values, need to be confirmed by further investigation at the completion of earthworks;
(3) Excluding wearing course thickness

Notwithstanding the above, detailed subgrade investigation should be undertaken prior to pavement construction to provide optimised subgrade strength and design parameters.

6.7.2 Materials and Compaction

Suggested material quality and compaction requirements are given in Table 7 (following page). Whilst the use of lesser quality pavement materials may be feasible, some compromise in either performance and/or pavement life must be anticipated and accepted.

The pavements should be placed and compacted in layers no thicker than 150 mm, with control exercised over placement moisture contents. If layer thicknesses greater than 150 mm are proposed, it may be necessary to test the top and bottom of the layer to ensure that the minimum level of compaction has been achieved through the layer.

Table 7: Pavement Material Quality and Compaction

Layer	Material Quality	Minimum Compaction
Wearing Course	To conform to Austroads requirements	To conform to Austroads requirements
Base Course	To conform to Austroads requirements Soaked CBR ≥ 80%, PI ≤ 6%	Minimum dry density ratio of 98% Modified (AS 1289 Test 5.2.1)
Sub-base Course	To conform to APRG requirements Soaked CBR ≥ 50%, PI ≤ 12%	Minimum dry density ratio of 95% Modified (AS 1289 Test 5.2.1)
Subgrade Replacement	Soaked CBR ≥ 15%	Minimum dry density ratio of 100% Standard (AS 1289 Test 5.1.1)
Subgrade		Minimum dry density ratio of 100% Standard (AS 1289 Test 5.1.1)

Where: PI = Plasticity Index
CBR = California bearing ratio

6.7.3 Pavement Drainage

Surface and subsurface drainage should be provided to prevent moisture ingress into the pavement materials. It is suggested that subsurface drains, constructed with an invert level at least 0.5 m below subgrade level. As a minimum, subsurface drainage should be incorporated along the cut sides of all roads, on both sides of roads with minimal grade and around both sides of all intersections. This aspect and the need for additional subsurface drainage should be reviewed on site during construction and should take into consideration the significance of other engineered drainage work proposed for the project. Guidelines on the arrangements of subsurface drainage are given on Page 20 of ARRB – SR41 (ARRB, 1989). It should be noted that if the sub-base is of lower permeability relative to the base layer, then the subsurface drain should intersect all pavement layers as shown in ARRB – SR41.

Additional subsurface drainage may also be required within development lots in footslope locations abutting where water logging forms a constraint to development. Within these areas, fill and/or deep drainage is likely to be required to permit trafficability during construction and subsequent lot development.

Erosion and sedimentation control measures should be installed maintained for the duration of the construction. Furthermore, adequate drainage of all working areas shall be maintained throughout the period of construction to ensure run-off of water without ponding except where ponding forms part of a planned erosion and sedimentation control system.

7. Salinity Effects on the Proposed Development

Mild to moderate aggressivity to concrete and steel, the presence of slightly saline to very saline material and sodic soils are naturally occurring features of the local landscape and are not considered to be significant impediments to the proposed development, provided that appropriate remediation or management techniques are employed.

Salinity and aggressivity affect the durability of concrete and steel by causing premature breakdown of concrete and corrosion of steel. This affects the longevity of structures in contact with these materials. Therefore, additional salinity investigation and preparation of a salinity management plan is recommended to delineate saline areas and provide appropriate recommendations during the development process.

Sodic soils have low permeability due to infilling of interstices with fine clay particles during the weathering process, restricting infiltration of surface water and potentially creating perched water tables, seepage in cut faces or ponding of water in flat open area. In addition, sodic soils tend to erode when exposed. Management of sodic soils is therefore required to prevent these potentially adverse effects.

8. Summary

The geotechnical investigation undertaken has indicated that most of the site will be suitable for commercial/industrial development, with comments given on geotechnical limitations, development guidelines, likely site classification, stability considerations and indicative pavement thicknesses. Comments on conceptual design and construction aspects are also given in the report.

Detailed geotechnical investigation and assessment will be required as the design of the development proceeds. Specific geotechnical investigation would include (but not necessarily be limited to):

- Detailed salinity investigation and management plan;
- Planning for filling of the large dam which extends over the site boundary;
- Detailed geotechnical investigations for determination of pavement thickness design and individual building construction.
- Routine inspections and earthworks monitoring during construction.

9. References

AS 3798:2007 *Guidelines on Earthworks for Commercial and Residential Developments* (Standards Australia, 2007).

AS 2870:2011 *Residential Slabs and Footings* (Standards Australia, 2007).

Australian Road Research *Board (1989), A Structural Design Guide for Flexible Residential Street Pavements*, Special Report No 41.

AUSTROADS (2018), *"Guide to Pavement Technology – Part 2: Pavement Structural Design"*..

NSW Department of Minerals and Energy (1991), Geology of 1:100 000 Penrith Geological Series Sheet 9030 (Edition 1)

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 106 - 142 Aldington Road, Kemps Creek in accordance with DP's proposal dated 31 March 2019 and acceptance from Mr Marcus Donnelly of Stockland Commercial Property. The work was carried out under Stockland's Short Form Consultancy Term Agreement. This report is provided for the exclusive use of Stockland Commercial Property for this project only and for the purposes as described in the report. It should not be used for other projects or purposes or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations.

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

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction of all works (not just geotechnical components) and the controls required to mitigate risk. This report does, however, identify hazards associated with the geotechnical aspects of development and presents the results of risk assessment associated with the management of these hazards. It is suggested that the developer's principal design company may wish to include the geotechnical hazards and risk assessment information contained in this report, in their own Safety Report. If the principal design company, in the preparation of its project Design Report, wishes to undertake such inclusion by use of specific extracts from this subject DP report, rather than by appending the complete report, then such inclusion of extracts should only be undertaken with DP's express agreement, following DP's review of how any such extracts are to be utilised in the context of the project Safety Report. Any such review shall be undertaken either as an extension to contract for the works associated with this subject DP report or under additional conditions of engagement, with either option subject to agreement between DP and the payee

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

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

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

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

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

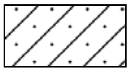
Soils


Topsoil

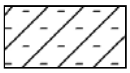

Peat


Clay

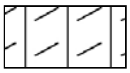

Silty clay

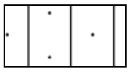

Sandy clay

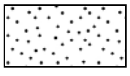

Gravelly clay

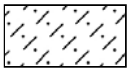

Shaly clay

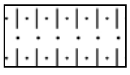

Silt


Clayey silt


Sandy silt

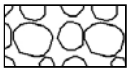

Sand

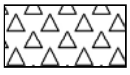

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

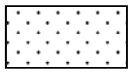

Talus

Sedimentary Rocks

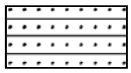

Boulder conglomerate

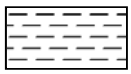

Conglomerate


Conglomeratic sandstone

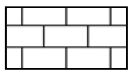

Sandstone


Siltstone


Laminite

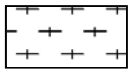

Mudstone, claystone, shale

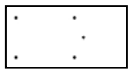

Coal


Limestone

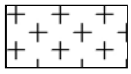
Metamorphic Rocks

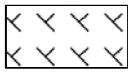

Slate, phyllite, schist

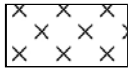

Gneiss

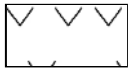

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Appendix B

Preliminary Concept Layout Drawings (2 sheets)
Test Pit and Borehole Location Plan
Geotechnical Constraints Plan

INDICATIVE RETAINING WALL SHOWN THUS
WITH INDICATIVE WALL HEIGHTS (+H)

TOTAL SITE AREA
APPROX. 212,770 m²

PROPOSED PAD 1
BEL 80.00

PROPOSED PAD 2
BEL 73.00

PROPOSED PAD 3
BEL 75.00

PROPOSED PAD 4
BEL 69.50

PROPOSED PAD 5
BEL 65.00

WAREHOUSE 1
4,445m²

WAREHOUSE 2
30,175m²

WAREHOUSE 3
22,780m²

WAREHOUSE 4
12,630m²

WAREHOUSE 5
31,080m²

OFFICE (2 STOREY) 890m²

OFFICE (2 STOREY) 3,020m²

OFFICE (2 STOREY) 2,200m²

OFFICE (2 STOREY) 1,240m²

CAR PARKING (443)

CAR PARKING (154)

CAR PARKING (60)

CAR PARKING (200)

SP TANK

SP PUMP TANKROOM

PUMP ROOM

LOADING DOCK

ROLLER SHUTTER x 17

ROLLER SHUTTER x 9

10m AWNING

ALDINGTON ROAD

INTERNAL ACCESS ROAD

SITE BOUNDARY

APPROX.

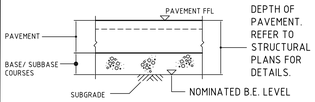
DEPTH RANGE

No.	FROM DEPTH	TO DEPTH	COLOUR	DEPTH RANGE VOLUME
1	-8.000	-6.000		57m³
2	-6.000	-4.000		3980m³
3	-4.000	-2.000		26253m³
4	-2.000	0.000		94830m³
5	0.000	2.000		188238m³
6	2.000	4.000		92817m³
7	4.000	6.000		45671m³
8	6.000	8.000		16668m³
9	8.000	10.000		978m³

LEGEND

LEVELS DATUM IS AHD.

- EXISTING CONTOUR
- B.E.L. CONTOUR (MAJOR 0.5m)
- B.E.L. CONTOUR (MINOR 0.25m)



NOMINATED B.E.L. DETAIL
N.T.S.

SUMMARY NOTES

BULK EARTHWORKS VOLUMES:
(SITE STRIP MATERIAL = - 42,570m³)

CUT MATERIAL = - 125,120m³
FILL MATERIAL = + 344,370m³

DETAILED EXCAVATION = - 34,000m³ (BASED ON 1,500m³/Ha)

BALANCE = + 185.250m³ (i.e. FILL REQUIRED)

NOTE:
EARTHWORK VOLUMES ARE APPROXIMATE ONLY.
NO ALLOWANCE HAS BEEN MADE FOR DELETERIOUS MATERIAL, EROSION AND SEDIMENT CONTROL OR BULKING OR COMPACTION OF FILLED SOILS.
CONTRACTOR TO ALLOW FOR THESE ITEMS AS REQUIRED

BULK EARTHWORKS PLAN
SCALE 1:750

6m 0 15 30 45 60 75m
SCALE 1:750 AT A0 SHEET SIZE

PRELIMINARY ONLY

AMENDMENTS	DATE	ISSUE
PRELIMINARY ONLY	27.11.18	A

ARCHITECT: REIDCAMPBELL

CLIENT:

PROJECT: PROPOSED LAND ACQUISITION
KEMPS CREEK
ALDINGTON ROAD

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD. REF.
DdV	DS	NOV '18	XC	A0	AS SHOWN	C013780.00-SKC03

Costin Roe Consulting Pty Ltd.
Consulting Engineers ACN 003 696 448
Level 1, 8 Windmill Street
Walsh Bay, Sydney NSW 2000
Tel: (02) 9251-7699 Fax: (02) 9241-3721
email: mail@costinroe.com.au ©

Costin Roe Consulting

PRECISION | COMMUNICATION | ACCOUNTABILITY

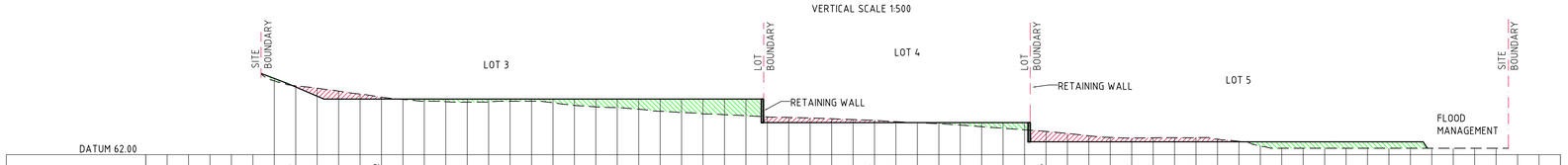
DRAWING TITLE: BULK EARTHWORKS PLAN
OPTION 2

DRAWING No: C013780.00-SKC03 ISSUE: A

DATUM 62.00

CHAINAGE	CUT/FILL DEPTH	BULK EARTHWORKS LEVEL	EXISTING SURFACE LEVEL
0.000			
10.000			
20.000			
30.000			
40.000			
50.000			
60.000	-0.718	82.269	82.987
70.000	-2.443	79.785	82.228
80.000	-4.594	75.000	81.594
90.000	-4.643	75.000	81.643
100.000	-5.433	75.000	80.433
110.000	-4.857	75.000	79.857
120.000	-4.250	75.000	79.250
130.000	-3.740	75.000	78.740
140.000	-3.274	75.000	78.274
150.000	-2.742	75.000	77.742
160.000	-2.478	75.000	77.478
170.000	-1.978	75.000	76.978
180.000	-1.592	75.000	76.592
190.000	-1.104	75.000	76.104
200.000	-0.894	75.000	75.894
210.000	-0.684	75.000	75.684
220.000	-0.255	75.000	75.255
230.000	0.105	75.000	74.895
240.000	0.598	75.000	74.402
250.000	0.905	75.000	74.095
260.000	0.995	75.000	74.005
270.000	1.336	75.000	73.664
280.000	1.700	75.000	73.300
290.000	-3.477	69.500	72.977
300.000	-3.156	69.500	72.656
310.000	-2.857	69.500	72.357
320.000	-2.588	69.500	72.088
330.000	-2.316	69.500	71.816
340.000	-2.032	69.500	71.532
350.000	-1.734	69.500	71.234
360.000	-1.404	69.500	70.904
370.000	-1.065	69.500	70.565
380.000	-0.719	69.500	70.219
390.000	-0.446	69.500	69.946
400.000	-0.179	69.500	69.679
410.000	0.119	69.500	69.381
420.000	-4.066	65.000	69.066
430.000	-3.688	65.000	68.688
440.000	-3.323	65.000	68.323
450.000	-2.977	65.000	67.977
460.000	-2.536	65.000	67.536
470.000	-2.295	65.000	67.295
480.000	-1.828	65.000	66.828
490.000	-1.605	65.000	66.605
500.000	-1.394	65.000	66.394
510.000	-0.978	65.000	65.978
520.000	-0.595	65.000	65.595
530.000	-0.304	65.000	65.304
540.000	-0.007	65.000	65.007
550.000	0.125	65.000	64.875
560.000	0.337	65.000	64.663
570.000	0.485	65.000	64.515
580.000			64.500
590.000			64.287
600.000			64.000
610.000			63.609
620.000			63.500
630.000			63.500
640.000			
650.000			
660.000			

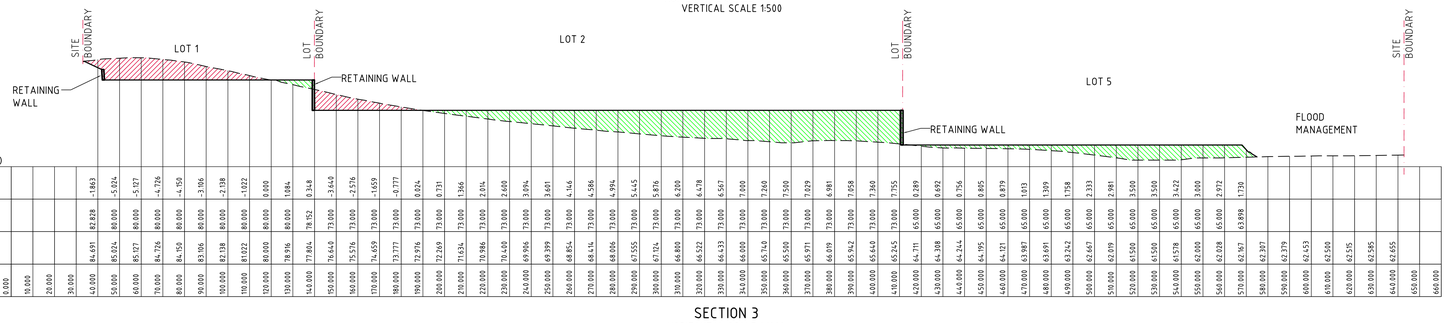
SECTION 1
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:500



DATUM 62.00

CHAINAGE	CUT/FILL DEPTH	BULK EARTHWORKS LEVEL	EXISTING SURFACE LEVEL
0.000			
10.000			
20.000			
30.000			
40.000			
50.000			
60.000	0.555	79.811	79.256
70.000	-0.269	77.872	78.082
80.000	-1.858	75.669	77.527
90.000	-1.861	75.000	76.861
100.000	-1.165	75.000	76.165
110.000	-0.442	75.000	75.442
120.000	0.086	75.000	74.914
130.000	0.500	75.000	74.500
140.000	0.621	75.000	74.379
150.000	0.721	75.000	74.279
160.000	0.691	75.000	74.309
170.000	0.500	75.000	74.500
180.000	0.500	75.000	74.500
190.000	0.649	75.000	74.351
200.000	1.485	75.000	73.515
210.000	1.824	75.000	73.176
220.000	2.000	75.000	73.000
230.000	2.373	75.000	72.627
240.000	2.853	75.000	72.147
250.000	3.127	75.000	71.873
260.000	3.456	75.000	71.544
270.000	3.660	75.000	71.340
280.000	3.895	75.000	71.105
290.000	-1.321	69.500	70.821
300.000	-1.204	69.500	70.704
310.000	-1.076	69.500	70.576
320.000	-0.992	69.500	70.492
330.000	-0.702	69.500	70.202
340.000	-0.503	69.500	70.003
350.000	-0.217	69.500	69.717
360.000	0.026	69.500	69.474
370.000	0.283	69.500	69.217
380.000	0.569	69.500	68.931
390.000	0.974	69.500	68.526
400.000	1.319	69.500	68.181
410.000	1.692	69.500	67.808
420.000	-2.435	65.000	67.435
430.000	-1.962	65.000	66.962
440.000	-1.414	65.000	66.414
450.000	-1.038	65.000	66.038
460.000	-0.878	65.000	65.878
470.000	-0.953	65.000	65.953
480.000	-0.977	65.000	65.977
490.000	-0.977	65.000	65.977
500.000	-0.920	65.000	65.920
510.000	-0.909	65.000	65.909
520.000	0.966	64.034	64.034
530.000	1.500	63.500	63.500
540.000	1.500	63.500	63.500
550.000	1.500	63.500	63.500
560.000	1.500	63.500	63.500
570.000	1.500	63.500	63.500
580.000	1.500	63.500	63.500
590.000	1.500	63.500	63.500
600.000	1.500	63.500	63.500
610.000	1.500	63.500	63.500
620.000	1.500	63.500	63.500
630.000	1.500	63.500	63.500
640.000			
650.000			
660.000			

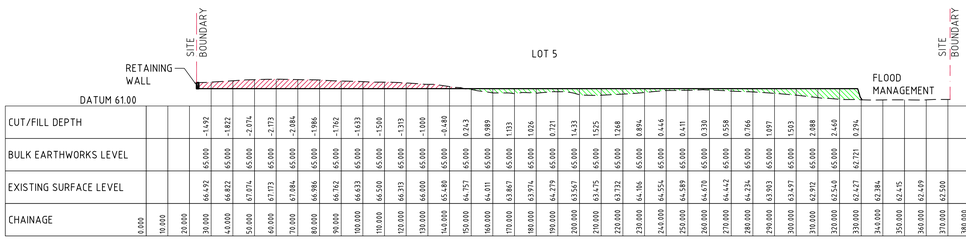
SECTION 2
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:500



DATUM 60.00

CHAINAGE	CUT/FILL DEPTH	BULK EARTHWORKS LEVEL	EXISTING SURFACE LEVEL
0.000			
10.000			
20.000			
30.000	-1.863	80.828	84.691
40.000	-5.024	80.000	85.024
50.000	-5.127	80.000	85.127
60.000	-4.726	80.000	84.726
70.000	-4.150	80.000	84.150
80.000	-3.306	80.000	83.306
90.000	-2.138	80.000	82.138
100.000	-1.022	80.000	81.022
110.000	0.000	80.000	80.000
120.000	0.084	80.000	79.916
130.000	0.348	80.000	79.652
140.000	-3.440	73.000	78.152
150.000	-2.576	73.000	77.804
160.000	-1.659	73.000	75.576
170.000	-0.777	73.000	74.659
180.000	0.024	73.000	73.377
190.000	0.731	73.000	72.976
200.000	1.366	73.000	72.269
210.000	2.014	73.000	71.634
220.000	2.469	73.000	70.986
230.000	3.094	73.000	70.469
240.000	3.601	73.000	69.906
250.000	4.146	73.000	69.399
260.000	4.586	73.000	68.854
270.000	4.994	73.000	68.414
280.000	5.445	73.000	68.006
290.000	5.876	73.000	67.555
300.000	6.200	73.000	67.124
310.000	6.478	73.000	66.800
320.000	6.567	73.000	66.522
330.000	7.000	73.000	66.433
340.000	7.260	73.000	66.000
350.000	7.500	73.000	65.740
360.000	7.629	73.000	65.500
370.000	6.981	73.000	65.971
380.000	7.058	73.000	66.019
390.000	7.360	73.000	65.942
400.000	7.755	73.000	65.640
410.000	0.289	65.000	65.245
420.000	0.692	65.000	64.711
430.000	0.756	65.000	64.308
440.000	0.805	65.000	64.244
450.000	0.879	65.000	64.195
460.000	1.013	65.000	64.121
470.000	1.309	65.000	63.987
480.000	1.758	65.000	63.691
490.000	2.333	65.000	63.242
500.000	2.981	65.000	62.667
510.000	3.550	65.000	62.019
520.000	3.500	65.000	61.550
530.000	3.500	65.000	61.560
540.000	3.422	65.000	61.578
550.000	3.000	65.000	62.000
560.000	2.972	65.000	62.028
570.000	1.730	63.898	62.167
580.000			62.397
590.000			62.379
600.000			62.453
610.000			62.500
620.000			62.585
630.000			62.585
640.000			62.695
650.000			
660.000			

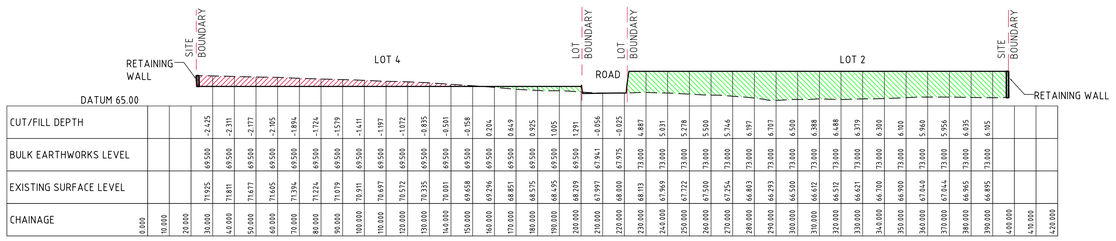
SECTION 3
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:500



DATUM 61.00

CHAINAGE	CUT/FILL DEPTH	BULK EARTHWORKS LEVEL	EXISTING SURFACE LEVEL
0.000			
10.000			
20.000			
30.000	-1.492	65.000	66.492
40.000	-1.822	65.000	66.822
50.000	-2.074	65.000	67.074
60.000	-2.173	65.000	67.173
70.000	-2.084	65.000	67.084
80.000	-1.986	65.000	66.986
90.000	-1.762	65.000	66.762
100.000	-1.633	65.000	66.633
110.000	-1.500	65.000	66.500
120.000	-1.313	65.000	66.313
130.000	-1.000	65.000	66.000
140.000	-0.480	65.000	65.480
150.000	0.243	65.000	64.757
160.000	0.989	65.000	64.011
170.000	1.133	65.000	63.867
180.000	1.026	65.000	63.974
190.000	0.721	65.000	64.279
200.000	1.433	65.000	63.567
210.000	1.525	65.000	63.475
220.000	1.268	65.000	63.732
230.000	0.894	65.000	64.106
240.000	0.446	65.000	64.554
250.000	0.411	65.000	64.589
260.000	0.330	65.000	64.670
270.000	0.558	65.000	64.442
280.000	0.766	65.000	64.234
290.000	1.097	65.000	63.903
300.000	1.503	65.000	63.497
310.000	2.088	65.000	62.912
320.000	2.460	65.000	62.540
330.000	62.721		62.427
340.000	62.284		62.284
350.000	62.415		62.415
360.000	62.409		62.409
370.000	62.560		
380.000			
390.000			
400.000			
410.000			
420.000			

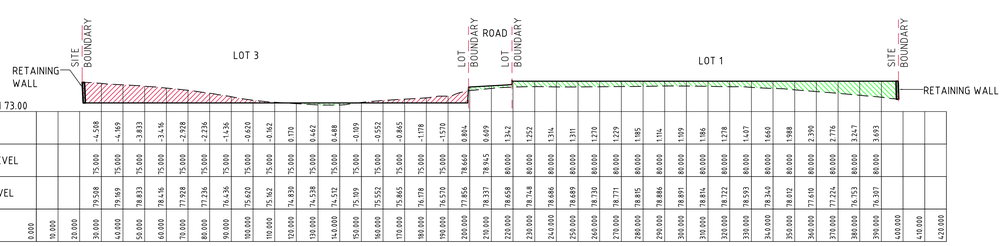
SECTION 4
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:500



DATUM 65.00

CHAINAGE	CUT/FILL DEPTH	BULK EARTHWORKS LEVEL	EXISTING SURFACE LEVEL
0.000			
10.000			
20.000			
30.000	-2.435	69.500	71.935
40.000	-2.311	69.500	71.811
50.000	-2.177	69.500	71.677
60.000	-2.105	69.500	71.605
70.000	-1.894	69.500	71.394
80.000	-1.724	69.500	71.224
90.000	-1.579	69.500	71.079
100.000	-1.411	69.500	70.911
110.000	-1.197	69.500	70.697
120.000	-1.072	69.500	70.572
130.000	-0.835	69.500	70.335
140.000	-0.591	69.500	70.091
150.000	-0.158	69.500	69.658
160.000	0.204	69.500	69.296
170.000	0.649	69.500	68.851
180.000	0.925	69.500	68.575
190.000	1.005	69.500	68.495
200.000	1.291	69.500	68.209
210.000	-0.056	67.975	67.941
220.000	-0.025	68.000	67.997
230.000	4.887	73.000	68.113
240.000	5.031	73.000	67.969
250.000	5.278	73.000	67.722
260.000	5.500	73.000	67.500
270.000	5.746	73.000	67.254
280.000	6.107	73.000	66.893
290.000	6.207	73.000	66.793
300.000	6.500	73.000	66.500
310.000	6.388	73.000	66.612
320.000	6.488	73.000	66.512
330.000	6.379	73.000	66.621
340.000	6.300	73.000	66.700
350.000	6.100	73.000	66.900
360.000	6.040	73.000	67.040
370.000	5.956	73.000	67.044
380.000	6.035	73.000	66.965
390.000	6.105	73.000	66.895
400.000			
410.000			
420.000			

SECTION 5
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:500



DATUM 73.00

CHAINAGE	CUT/FILL DEPTH	BULK EARTHWORKS LEVEL	EXISTING SURFACE LEVEL
0.000			
10.000			
20.000			
30.000	-4.508	75.000	79.508
40.000	-4.169	75.000	79.169
50.000	-3.833	75.000	78.833
60.000	-3.436	75.000	78.436
70.000	-2.928	75.000	77.928
80.000	-2.236	75.000	77.236
90.000	-1.436	75.000	76.436
100.000	-0.620	75.000	75.620
110.000	-0.062	75.000	75.062
120.000	0.170	75.000	74.830
130.000	0.462	75.000	74.538
140.000	0.488	75.000	74.512
150.000	-0.109	75.000	75.109
160.000	-0.552	75.000	75.552
170.000	-0.865	75.000	75.865
180.000	-1.178	75.000	76.178
190.000	-1.570	75.000	76.570
200.000	0.804	78.660	77.856
210.000	0.609	78.945	78.337
220.000	1.342	80.000	78.658
230.000	1.252	80.000	78.748
240.000	1.314	80.000	78.686
250.000	1.311	80.000	78.689
260.000	1.270	80.000	78.730
270.000	1.229	80.000	78.771
280.000	1.105	80.000	78.895
290.000	1.114	80.000	78.886
300.000	1.109	80.000	78.891
310.000	1.186	80.000	78.814
320.000	1.278	80.000	78.722
330.000	1.407	80.000	78.593
340.000	1.660	80.000	78.340
350.000	1.988	80.000	78.012
360.000	2.390	80.000	77.610
370.000	2.776	80.000	77.224
380.000	3.247	80.000	76.753
390.000	3.693	80.000	76.307
400.000			
410.000			
420.000			

SECTION 6
HORIZONTAL SCALE 1:1000
VERTICAL SCALE 1:500

LEGEND:

- DENOTES FILL AREA
- DENOTES CUT AREA
- BULK EARTHWORKS SURFACE PROFILE
- EXISTING SURFACE PROFILE

5m 0 10 20 30 40 50m
SCALE 1:500 AT A0 SIZE SHEET

10m 0 10 20 30 40 50 60 70 80 90 100m
SCALE 1:1000 AT A0 SIZE SHEET

PRELIMINARY ONLY

AMENDMENTS	DATE	ISSUE
PRELIMINARY ONLY	27.11.18	A

ARCHITECT: REIDCAMPBELL

CLIENT:

PROJECT: PROPOSED LAND ACQUISITION
KEMPS CREEK
ALDINGTON ROAD

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
DdW	DS	NOV 18	XC	A0	AS SHOWN	C013780.00-SKC04

Costin Roe Consulting Pty Ltd.
Consulting Engineers ACN 003 666 448
Level 1, 8 Windmill Street
Walsh Bay, Sydney NSW 2000
Tel: (02) 9251-7699 Fax: (02) 9241-5731
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Costin Roe Consulting

PRECISION | COMMUNICATION | ACCOUNTABILITY

DRAWING TITLE: BULK EARTHWORKS SECTIONS
OPTION 2

DRAWING No: C013780.00-SKC 04 ISSUE: A

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Stockland Commercial Property		
OFFICE: Macarthur	DRAWN BY: ECR	
SCALE: As shown	DATE: 12.04.2019	

TITLE: **Test Location Plan**
Proposed Commercial/Industrial Development
106 - 142 Aldington Road, Kemps Creek, NSW

N
MGA

PROJ. #: 92345.00	
DRAWING No:	1
REVISION:	0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Stockland Commercial Property		
OFFICE: Macarthur	DRAWN BY: ECR	
SCALE: As shown	DATE: 12.04.2019	

TITLE: **Geotechnical Constraints**
Proposed Commercial/Industrial Development
106 - 142 Aldington Road, Kemps Creek, NSW

N
MGA

PROJ. #: 92345.00	
DRAWING No:	2
REVISION:	0

Appendix C

Test Pit Logs (Pits 1 – 4, 6, 7, 9 – 12)
Borehole Logs (Bores 5 and 8)
Site Photographs

TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 77.8 mAHD
EASTING: 296453
NORTHING: 6253476

PIT No: 1
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
77	0.2	TOPSOIL - dark brown silty clay with a trace of rootlets, moist		E	0.0				
	0.5	FILLING - typically stiff, red and brown silty clay, MC~PL		D/E	0.2				
		SILTY CLAY - stiff, red brown silty clay with a trace of sandstone gravel, MC<PL			0.5				
	1	- becoming hard below 0.9m		U_{50}	0.75				
				D/E	1.0				
					1.05				
76				D/E	1.5		pp = 400-500		
	1.9	SHALE - very low strength, highly weathered, red brown shale with low strength, highly weathered bands		D	2.0				
75	2			D	2.5				
	3			D	3.0				
	3.0	Pit discontinued at 3.0m - limit of investigation							
74	4								
73	5								
72	6								
71	7								
70	8								
69	9								
68									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 69.2 mAHD
EASTING: 296613
NORTHING: 6253437

PIT No: 2
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
69	0.3	TOPSOIL - dark brown silty clay with a trace of rootlets, moist		E	0.0				
		SILTY CLAY - stiff, red silty clay with a trace of ironstone gravel, MC~PL			0.2				
				D/E	0.5				
68	1			D/B/E	1.0				
		- becoming hard, red and grey with iron indurated bands, MC<PL below 1.2m		D/E	1.5		pp = 400		
67	2	- becoming grey mottled red below 1.9m		D	2.0		pp >600		
				D	2.5		pp = 600		
66	3	3.0 Pit discontinued at 3.0m - limit of investigation		D	3.0		pp = 500-600		
65	4								
64	5								
63	6								
62	7								
61	8								
60	9								

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 65.9 mAHD
EASTING: 296719
NORTHING: 6253439

PIT No: 3
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
65	0.0	TOPSOIL - dark brown silty clay with rootlets, moist		E	0.0				
	0.3	SILTY CLAY - stiff, brown and red silty clay, MC~PL			0.2				
				D/E	0.5				
	1			D/E	1.0				
		- becoming hard, with a trace of gravel below 0.9m							
				D/E	1.5		pp = 400		
64	2	- becoming red and grey with iron indurated bands below 1.9m		D/E	2.0		pp = 400		
				D/E	2.5		pp = 400		
63	3			D/E	3.0		pp = 400		
	3.0	Pit discontinued at 3.0m - limit of investigation							
62	4								
61	5								
60	6								
59	7								
58	8								
57	9								
56									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 61.6 mAHD
EASTING: 296924
NORTHING: 6253344

PIT No: 4
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
61.6	0.2	TOPSOIL - dark brown silty clay with rootlets, moist		E	0.0				
		SILTY CLAY - stiff, brown silty clay with a trace of gravel, MC~PL		D/E	0.2				
				U_{50}	0.5				
	1	- becoming very stiff, grey and orange below 0.9m			0.7				
				D/E	1.5		pp = 300		
	2	- with iron indurated bands below 1.8m; MC>PL below 1.9m		D/E	2.0		pp = 100-200		
				D/E	2.5		pp <100	04-04-19	
	3	3.0 Pit discontinued at 3.0m - limit of investigation		D/E	3.0		pp <100		

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 2.5m

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 74.3 mAHD
EASTING: 296501
NORTHING: 6253285

PIT No: 6
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
74	0.2	TOPSOIL - pale brown silty clay, dry (fill)		E	0.0				
		SILTY CLAY - very stiff, pale brown silty clay, MC<PL			0.2				
				D/E	0.5				
73	1	- becoming hard below 1.0m		D/E	1.0				
	1.4	SHALE - extremely low strength, extremely weathered, brown and grey shale with very low strength, extremely weathered bands		D/E	1.5				
72	2			D/E	2.0				
				D/E	2.5				
71	3			D/E	3.0				
	3.0	Pit discontinued at 3.0m - limit of investigation							
70	4								
69	5								
68	6								
67	7								
66	8								
65	9								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Pit excavated in track; MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 67.3 mAHD
EASTING: 296708
NORTHING: 6253271

PIT No: 7
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
67	0.1	TOPSOIL - dark brown silty clay with a trace of rootlets, moist		E	0.0				
					0.2				
		SILTY CLAY - stiff, red and grey silty clay with a trace of gravel, MC~PL		D/E	0.5				
				U_{50}	0.85				
66	1	- becoming hard, MC<PL below 0.8m		D/E	1.0				
		- with iron indurated bands below 1.3m		D/E	1.5		pp >600		
65	2			D	2.0		pp >600		
				D	2.5		pp >600		
64	3			D	3.0		pp >600		
	3.0	Pit discontinued at 3.0m - limit of investigation							
63	4								
62	5								
61	6								
60	7								
59	8								
58	9								

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 73.8 mAHD
EASTING: 296570
NORTHING: 6253138

PIT No: 9
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
73	0.1	TOPSOIL - dark brown silty clay with rootlets, moist		E	0.0				
	0.5	FILL - typically stiff, dark brown silty clay with household rubble (tiles), moist		D/B/E	0.5				
		SILTY CLAY - stiff, red mottled grey silty clay with ironstone gravel, MC<PL							
72	1	- becoming hard, MC<PL below 1.0m		D/E	1.0				
		- with iron indurated bands below 1.4m		D/E	1.5		pp = 400-500		
71	2			D/E	2.0		pp = 400-500		
				D/E	2.5		pp = 500		
	3	3.0 Pit discontinued at 3.0m - limit of investigation		D/E	3.0		pp = 400-500		
70	4								
69	5								
68	6								
67	7								
66	8								
65	9								
64									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 68.0 mAHD
EASTING: 296760
NORTHING: 6253102

PIT No: 10
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
68	0.0	TOPSOIL - dark brown silty clay with rootlets, moist		E	0.0				
	0.3	SILTY CLAY - stiff, orange and red silty clay with a trace of gravel, MC~PL		D/E	0.2				
		- becoming hard below 0.7m			0.5				
67	1	- becoming red mottled grey below 0.9m		D/E	1.0		pp >600		
		- with very low strength, highly weathered, medium grained sandstone bands below 1.4m		D.E	1.5		pp = 300-400		
66	2	- becoming grey and red below 1.9m		D	2.0		pp >600		
	2.4	SHALE - extremely low strength, extremely weathered, red and grey shale with very low strength, extremely weathered bands		D	2.5				
65	3	Pit discontinued at 3.0m - limit of investigation		D	3.0				
64	4								
63	5								
62	6								
61	7								
60	8								
59	9								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: * Replicate sample BD1/04042019 collected at 0.0 - 0.2m; MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 64.0 mAHD
EASTING: 296863
NORTHING: 6253161

PIT No: 11
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
64	0.2	TOPSOIL - brown silty clay with a trace of rootlets, moist		E	0.0				
		SILTY CLAY - stiff, brown silty clay, MC~PL			0.2				
		- becoming very stiff below 0.4m		D/E	0.5				
63	1	- becoming brown and red with iron indurated bands below 0.9m		D/B/E	1.0				
				D/E	1.5		pp = 300-400		
62	2	- becoming grey and brown below 1.8m		D	2.0		pp = 300-400		
		- becoming MC>PL below 2.5m		D	2.5		pp = 200-250		
61	3			D	3.0		pp = 100-200	▽	
	3.0	Pit discontinued at 3.0m - limit of investigation							
60	4								
59	5								
58	6								
57	7								
56	8								
55	9								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Groundwater seepage observed at ~2.95m

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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TEST PIT LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 64.3 mAHD
EASTING: 296894
NORTHING: 6253085

PIT No: 12
PROJECT No: 92345.00
DATE: 4/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
64	0.1	TOPSOIL - dark brown clayey silt with a trace of rootlets, moist		E	0.0				
					0.2				
		SILTY CLAY - stiff, brown and grey silty clay with a trace of gravel, MC<PL		D/E	0.5				
63	1	- becoming very stiff, red and grey with extremely low strength, extremely weathered shale bands below 0.9m		D/E	1.0				
				D/E	1.5		pp = 300		
62	2	- becoming MC~PL below 1.8m		D/E	2.0		pp = 300		
				D/E	2.5		pp = 300		
		- becoming stiff, MC>PL below 2.8m							
61	3	3.0 Pit discontinued at 3.0m - limit of investigation		D/E	3.0		pp = 100-200		
60	4								
59	5								
58	6								
57	7								
56	8								
55	9								

RIG: John Deere 315SE backhoe - 400mm bucket

LOGGED: ABB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Groundwater seepage observed at ~2.95m

REMARKS: MC = moisture content; PL = plastic limit

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 84.2 mAHD
EASTING: 296403
NORTHING: 6253345
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 92345.00
DATE: 5/4/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
84	0.2	TOPSOIL - dark brown clayey silt, moist							E			
		FILL - typically dark brown silty clay with a trace of gravel, MC~PL							D/E			
83	0.8	SILTY CLAY - hard, pale brown silty clay with sand and carbonaceous staining, MC<PL							E			
	1								S			6,13,14 N = 27
		- becoming grey and brown with extremely low strength, extremely weathered shale bands below 1.5m							D/E			
82	2								D/E			
	2.8	SHALE - very low strength, highly weathered, grey shale with extremely low strength, extremely weathered bands							D/E			
									S			7,15,21 N = 36
81	3											
	4								D			
80	4.26								S			21,30/120mm,- refusal
		SHALE - very low strength, highly weathered, fractured, brown and grey shale with extremely low strength, extremely weathered bands						4.26m: J, sv, cu, ro, cly inf 4.28m: J, sh, pl, sm, cly co 4.47m: J, sh, pl, sm 4.51m: J, 60°, cu, cly co 100mm 4.61m: J, sv, ir, vr, fe stn 200mm 4.71m: J, sh, pl, ro, fe stn 4.76m: J, sh, cu, ro, fe stn 4.9m: J, sh, pl, ro, fe stn 5.58m: J, sh, pl, sm, cly inf 5.75m: Cs 150mm	C	100	0	
79	5											
	5.9	Bore discontinued at 5.9m - limit of investigation										
78	6											
77	7											
76	8											
75	9											

RIG: Hanjin DB8 **DRILLER:** Rockwell **LOGGED:** JHB/ABB **CASING:** QC to 4.0m

TYPE OF BORING: 150mm diameter SFA to 4.26m then NMLC coring to 5.9m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 81.4 mAHD
EASTING: 296402
NORTHING: 6253141
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 92345.00
DATE: 5/4/2019
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
81	0.2	TOPSOIL - dark brown clayey silt, moist							E			
		SILTY CLAY - very stiff, brown silty clay, MC~PL							D/E			
		- becoming hard, red, grey and brown, MC<PL below 0.7m							D/E			
80	1.5	- with very low strength, highly weathered and extremely low strength, extremely weathered shale bands below 1.3m							S			6,11,20 N = 31
		SHALE - very low strength, highly weathered, red, grey and brown shale with extremely low strength, extremely weathered bands							D/E			
79	2.55	SHALE - very low strength, highly weathered, highly fractured, brown and grey shale						2.55m: J, sv, pl, ro, fe stn	D/E			
		- becoming low strength, moderately weathered below 3.03m						2.69m: J, 60°, cu, vr, cly co 150mm	S			30/90mm,-,- refusal
		- becoming fractured below 3.22m						2.85m: fg zone 30mm 3.03m: J, sh, pl, ro, cly co 3.04m: J, sh, cu, ro, fe stn 3.09m: J, sh, cu, ro, fe stn 3.12m: J, sh, cu, ro, fe stn 3.16m: J, sh, cu, ro, fe stn 3.19m: J, sh, cu, ro, fe stn 3.21m: J, sh, cu, ro, fe stn 3.44m: J, 45°, cu, sm, fe stn	C	100	61	
78												
77												
76		- becoming medium strength below 5.3m						3.47m: J, sh, cu, ro, fe stn 3.49m: J, sh, cu, sm, fe stn 3.72m: J, sh, cu, ro, cly co 3.82m: J, sh, cu, ro, fe stn 3.93m: J, 60°, cu, ro, cln 120mm 4.22m: J, sh, pl, ro, fe stn 4.47m: J, sh, pl, ro, ca stn 4.56m: J, sh, pl, ro, ca stn 4.66m: J, sh, pl, ro, ca stn 5.22m: J, sh, cu, sm, fe stn 5.27m: fg zone 30mm 5.53m: J, sh, pl, sm, cly co 5.58m: J, sh, pl, sm, cly co 5.63m: J, sh, pl, sm, cly co 5.77m: J, sh, pl, sm, ca stn 5.86m: J, sh, pl, sm, ca stn 5.93m: J, sh, pl, sm, ca stn 6.05m: J, sv, ir, vr, fe stn	C	100	90	
75	6.12	- 100mm thick band of probable volcanic breccia at 6.0m										
		SANDSTONE - medium strength, slightly weathered, slightly fractured, grey fine grained sandstone										
74	7.43	Bore discontinued at 7.43m - limit of investigation										
73												
72												

RIG: Hanjin DB8 **DRILLER:** Rockwell **LOGGED:** JHB/ABB **CASING:** QC to 4.0m

TYPE OF BORING: 150mm diameter SFA to 2.55m then NMLC coring to 7.43m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Commercial Property
PROJECT: Proposed Commercial/Industrial Subdivision
LOCATION: 106 - 142 Aldington Road, Kemps Creek

SURFACE LEVEL: 81.4 mAHD
EASTING: 296402
NORTHING: 6253141
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 92345.00
DATE: 5/4/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
71	11							70mm 6.1m: J, sh, cu, sm, cln 6.17m: J, sh, cu, sm, ca stn 6.46m: J, 80°, cu, ro, cln 240mm 7.12m: J, 80°, cu, ro, fe stn 200mm				
70	12											
69	13											
68	14											
67	15											
66	16											
65	17											
64	18											
63	19											
62												

RIG: Hanjin DB8 **DRILLER:** Rockwell **LOGGED:** JHB/ABB **CASING:** QC to 4.0m

TYPE OF BORING: 150mm diameter SFA to 2.55m then NMLC coring to 7.43m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. MC = moisture content; PL = plastic limit

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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Photograph 1 - View from Aldington Road embankment looking south

Photograph 2 - View from Aldington Road looking east

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 92345.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 1
	106 - 142 Aldington Road, Kemps Creek	REV: 0
	CLIENT: Stockland Commercial Property	DATE: May-19

Photograph 3 - View from northeastern portion of site looking west

Photograph 4 - Looking east along central dam embankment

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs Proposed Commercial/Industrial Subdivision 106 - 142 Aldington Road, Kemps Creek CLIENT: Stockland Commercial Property	PROJECT: 92345.00 PLATE No: 2 REV: 0 DATE: May-19

Photograph 5 - View from dam embankment looking north to low lying area

Photograph 6 - View looking south east across the central dam

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT:	92345.00
	Proposed Commercial/Industrial Subdivision	PLATE No:	3
	106 - 142 Aldington Road, Kemps Creek	REV:	0
	CLIENT: Stockland Commercial Property	DATE:	May-19

Photograph 7 - View looking east across northern dam

Photograph 8 - View of hill slope above northern dam (MRP 8)

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 92345.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 4
	106 - 142 Aldington Road, Kemps Creek	REV: 0
	CLIENT: Stockland Commercial Property	DATE: May-19

Photograph 9 - View from Aldington Road looking north

Photograph 10 - Typical filling stockpile

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 92345.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 5
	106 - 142 Aldington Road, Kemps Creek	REV: 0
	CLIENT: Stockland Commercial Property	DATE: May-19

Appendix D

Laboratory Test Report Sheets
Salinity Summary Table

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: tim.white@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667B
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 16/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **TP2 (1.0m)**
Lot No: **TP2**
Material: SILTY CLAY - red silty clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**1.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.83		
Optimum Moisture Content (%)	16.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.80		
Field Moisture Content (%)	17.3		
Moisture Content at Placement (%)	15.8		
Moisture Content Top 30mm (%)	22.0		
Moisture Content Rest of Sample (%)	17.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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Macarthur Laboratory
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Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667D
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 17/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **Depth: 0.5m**
Lot No: **TP7**
Material: SILTY CLAY - red and grey silty clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**1.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.63		
Optimum Moisture Content (%)	21.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.60		
Field Moisture Content (%)	25.1		
Moisture Content at Placement (%)	20.9		
Moisture Content Top 30mm (%)	34.7		
Moisture Content Rest of Sample (%)	26.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	24		
Swell (%)	1.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
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Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667F
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 17/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **Depth: 0.5m**
Lot No: **TP9**
Material: SILTY CLAY - red silty clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**0.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.67		
Optimum Moisture Content (%)	21.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.66		
Field Moisture Content (%)	23.6		
Moisture Content at Placement (%)	21.3		
Moisture Content Top 30mm (%)	32.9		
Moisture Content Rest of Sample (%)	23.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	24		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
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Email: john.purcell@douglaspartners.com.au

Report Number: **PREVIEW**
Issue Number:
Date Issued:
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667I
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 10/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **BH5 (1.0m)**
Material: SILTY CLAY - dark brown silty clay with trace gravel

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	45		
Plastic Limit (%)	19		
Plasticity Index (%)	**26**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.5		
Cracking Crumbling Curling	Curling		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667G
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 10/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **TP10 (0.5m)**
Material: SILTY CLAY - orange-red silty clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	70		
Plastic Limit (%)	19		
Plasticity Index (%)	**51**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	17.0		
Cracking Crumbling Curling	Curling		

Material Test Report

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Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667H
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 16/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **TP11 (1.0m)**
Lot No: **TP11**
Material: SILTY CLAY - stiff brown silty clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**4.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.82		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.82		
Field Moisture Content (%)	17.1		
Moisture Content at Placement (%)	17.3		
Moisture Content Top 30mm (%)	20.8		
Moisture Content Rest of Sample (%)	18.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	24		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Material Test Report

Douglas Partners
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Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667I
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 10/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **BH5 (1.0m)**
Material: SILTY CLAY - dark brown silty clay with trace gravel

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	45		
Plastic Limit (%)	19		
Plasticity Index (%)	**26**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.5		
Cracking Crumbling Curling	Curling		

Material Test Report

Douglas Partners
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Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667J
Date Sampled: 05/04/2019
Dates Tested: 09/04/2019 - 12/04/2019
Sampling Method: AS1289 1.2.1 6.4 (a) - Sampling from layers in earthworks or pavement - uncompacted
Sample Location: **TP4 (0.5m)**
Material: SILTY CLAY - brown silty clay

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**1**		
Soil Description	As above		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	22.0		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: tim.white@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Sample Number: 19-667K
Date Sampled: 05/04/2019
Dates Tested: 09/04/2019 - 12/04/2019
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **TP6 (1.0m)**
Material: SILTY CLAY - very stiff pale brown silty clay

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	As above		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	22.0		

Material Test Report

Report Number: **92345.00-1**
Issue Number: 1
Date Issued: 15/05/2019
Client: Stockland Commercial Property
Level 25, 133 Castlereagh Street, Sydney NSW 2000
Contact: Marcus Donnelly
Project Number: 92345.00
Project Name: Proposed Commercial/Industrial Subdivision
Project Location: 106 - 142 Aldington Road, Kemps Creek
Work Request: 667
Date Sampled: 04/04/2019
Dates Tested: 09/04/2019 - 09/04/2019

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
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18 Waler Crescent Smeaton Grange NSW 2567
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Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Tim White
Lab manager
NATA Accredited Laboratory Number: 828

Shrink Swell Index AS 1289 7.1.1 & 2.1.1				
Sample Number	19-667A	19-667C	19-667E	
Sampling Method	AS1289 1.2.1 6.4	AS1289 1.2.1 6.4	AS1289 1.2.1 6.4	
Date Sampled	04/04/2019	04/04/2019	04/04/2019	
Date Tested	09/04/2019	09/04/2019	09/04/2019	
Material Source	U50 push tube	U50 push tube	U50 push tube	
Sample Location	TP1 (0.75-1.05m)	TP4 (0.5-0.9m)	TP7 (0.5-0.85m)	
Inert Material Estimate (%)	5	0	3	
Pocket Penetrometer before (kPa)	350	240	450	
Pocket Penetrometer after (kPa)	200	220	60	
Shrinkage Moisture Content (%)	20.5	23.3	23.5	
Shrinkage (%)	**4.1**	**5.0**	**3.3**	
Swell Moisture Content Before (%)	20.7	23.5	23.9	
Swell Moisture Content After (%)	24.0	25.4	25.1	
Swell (%)	**1.3**	**0.0**	**0.0**	
Shrink Swell Index Iss (%)	**2.6**	**2.8**	**1.8**	
Visual Description	SILTY CLAY - red-brown silty clay	SILTY CLAY - brown clay	SILTY CLAY - red and grey silty clay	
Cracking	Moderately Cracked	Slightly Cracked	Moderately Cracked	
Crumbling	No	No	No	
Remarks	**	**	**	

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
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www.envirolab.com.au

CERTIFICATE OF ANALYSIS 215350

Client Details

Client	Douglas Partners Pty Ltd Smeaton Grange
Attention	Cindy Murphy, Eric Riggle
Address	18 Waler Crescent, Smeaton Grange, NSW, 2567

Sample Details

Your Reference	**92345.00, Kemps Creek**
Number of Samples	72 Soil
Date samples received	10/04/2019
Date completed instructions received	10/04/2019

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	16/04/2019
Date of Issue	16/04/2019

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Matt Tang

Results Approved By
Giovanni Agosti, Group Technical Manager
Ken Nguyen, Reporting Supervisor
Matthew Tang, Asbsestos Supervisor
Nick Sarlamis, Inorganics Supervisor
Steven Luong, Organics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		215350-13	215350-14	215350-15	215350-16	215350-17
Your Reference	UNITS	TP1/0.5	TP1/1.0	TP1/1.5	TP2/0.5	TP2/1.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	[NA]	5.9	4.9	5.8	5.3
Electrical Conductivity 1:5 soil:water	µS/cm	[NA]	500	900	160	310
Chloride, Cl 1:5 soil:water	mg/kg	25	[NA]	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	20	[NA]	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-18	215350-19	215350-20	215350-21	215350-22
Your Reference	UNITS	TP2/1.5	TP3/0.5	TP3/1.0	TP3/1.5	TP3/2.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.0	6.2	5.7	5.7	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	550	58	84	100	180
Chloride, Cl 1:5 soil:water	mg/kg	780	[NA]	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	270	[NA]	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-23	215350-24	215350-25	215350-26	215350-27
Your Reference	UNITS	TP3/2.5	TP3/3.0	TP4/0.5	TP4/1.0	TP4/1.5
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.6	5.7	6.8	5.2	4.9
Electrical Conductivity 1:5 soil:water	µS/cm	300	280	100	880	1,300
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	62	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	20	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-28	215350-29	215350-30	215350-31	215350-32
Your Reference	UNITS	TP4/2.0	TP4/2.5	TP4/3.0	BH5/0.5	BH5/1.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	6.5	7.7	7.4	7.0	6.9
Electrical Conductivity 1:5 soil:water	µS/cm	760	780	630	51	46
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	10	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	<10	[NA]

Misc Inorg - Soil						
Our Reference		215350-33	215350-34	215350-37	215350-38	215350-39
Your Reference	UNITS	BH5/1.5	BH5/2.0	TP6/0.5	TP6/1.0	TP6/1.5
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	7.3	7.9	6.7	7.9	9.1
Electrical Conductivity 1:5 soil:water	µS/cm	30	150	440	510	530
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	<10	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	31	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-40	215350-41	215350-42	215350-43	215350-44
Your Reference	UNITS	TP6/2.0	TP6/2.5	TP6/3.0	TP7/0.5	TP7/1.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	8.6	9.3	9.5	6.1	5.4
Electrical Conductivity 1:5 soil:water	µS/cm	380	620	600	94	280
Chloride, Cl 1:5 soil:water	mg/kg	430	[NA]	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	52	[NA]	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-45	215350-46	215350-47	215350-48	215350-49
Your Reference	UNITS	TP7/1.5	BH8/0.5	BH8/1.0	BH8/1.5	BH8/2.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.3	6.4	5.3	5.2	5.0
Electrical Conductivity 1:5 soil:water	µS/cm	280	190	640	530	370
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	720	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	360	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-50	215350-51	215350-52	215350-53	215350-54
Your Reference	UNITS	BH8/2.5	TP9/0.5	TP9/1.0	TP9/1.5	TP9/2.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.1	7.3	5.3	5.0	5.0
Electrical Conductivity 1:5 soil:water	µS/cm	380	92	480	590	810
Chloride, Cl 1:5 soil:water	mg/kg	280	[NA]	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	300	[NA]	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-55	215350-56	215350-57	215350-58	215350-59
Your Reference	UNITS	TP9/2.5	TP9/3.0	TP10/0.5	TP10/1.0	TP10/1.5
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.0	5.3	5.9	5.2	5.0
Electrical Conductivity 1:5 soil:water	µS/cm	860	760	77	340	600
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	850	[NA]	[NA]	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	300	[NA]	[NA]	[NA]

Misc Inorg - Soil						
Our Reference		215350-60	215350-61	215350-62	215350-63	215350-64
Your Reference	UNITS	TP11/0.5	TP11/1.0	TP11/1.5	TP12/0.5	TP12/1.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.4	4.8	4.9	5.3	4.8
Electrical Conductivity 1:5 soil:water	µS/cm	170	770	880	350	1,100
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	1,100	[NA]	1,400
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	92	[NA]	37

Misc Inorg - Soil					
Our Reference		215350-65	215350-66	215350-67	215350-68
Your Reference	UNITS	TP12/1.5	TP12/2.0	TP12/2.5	TP12/3.0
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019
Date analysed	-	14/04/2019	14/04/2019	14/04/2019	14/04/2019
pH 1:5 soil:water	pH Units	5.3	6.6	6.7	6.7
Electrical Conductivity 1:5 soil:water	µS/cm	800	830	720	880
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	840	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	140	[NA]

ESP/CEC						
Our Reference		215350-25	215350-34	215350-47	215350-62	215350-67
Your Reference	UNITS	TP4/0.5	BH5/2.0	BH8/1.0	TP11/1.5	TP12/2.5
Date Sampled		04/04/2019	04/04/2019	04/04/2019	04/04/2019	04/04/2019
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	15/04/2019	15/04/2019	15/04/2019	15/04/2019	15/04/2019
Date analysed	-	15/04/2019	15/04/2019	15/04/2019	15/04/2019	15/04/2019
Exchangeable Ca	meq/100g	2.1	18	1.7	0.2	0.1
Exchangeable K	meq/100g	<0.1	<0.1	0.1	<0.1	<0.1
Exchangeable Mg	meq/100g	4.9	2.4	4.1	6.2	4.0
Exchangeable Na	meq/100g	0.76	0.15	1.6	1.5	2.0
Cation Exchange Capacity	meq/100g	7.9	21	7.6	8.0	6.2
ESP	%	10	<1	21	19	32

Appendix D: Summary Table - Laboratory Tests and Assessments

Test Pit	Sample Depth	pH	Chloride Concentration	Sulphate Concentration	Resistivity	Soil Condition	Sample Aggressivity Class					Exchangeable Sodium (Na) Concentration	Cation Exchange Capacity	Sodicity	Sodicity Class	Soil Texture Group	Textural Factor (M)	$EC_{1:5}$	EC_e	Sample Salinity Class
					By inversion of EC1:5		Aggr. to Concrete - from sample pH	Aggr. to Concrete - from Sulphate conc.	Aggr. to Steel - from sample pH	Aggr. to Steel - from Chloride conc.	Aggr. to Steel - from sample Resistivity			[Na/CEC]		(for detailed soil logs see Report Appendix)		[Lab.]	[M x $EC_{1:5}$]	(Based on sample ECe)
	(m bgl)	(pH units)	(mg/kg)	(mg/kg)	Ω.cm	[AS2159-2009]	[AS2159-2009]					(meq/100g)	(meq/100g)	(%)	[after DLWC]	[after DLWC]	[after DLWC]	(microS/cm)	(deciS/m)	[Richards 1954]
TP1	0.5		25	20		B		Non-Aggressive		Non-Aggressive						Heavy clay	6			
TP1	1.0	5.9			2000	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	500	3.0	Slightly Saline
TP1	1.5	4.9			1111	B	Mild		Non-Aggressive		Mild					Medium clay	7	900	6.3	Moderately Saline
TP2	0.5	5.8			6250	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	160	1.0	Non-Saline
TP2	1.0	5.3			3226	B	Mild		Non-Aggressive		Non-Aggressive					Heavy clay	6	310	1.9	Non-Saline
TP2	1.5	5	780	270	1818	B	Mild	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild					Heavy clay	6	550	3.3	Slightly Saline
TP3	0.5	6.2			17241	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	58	0.3	Non-Saline
TP3	1.0	5.7			11905	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	84	0.5	Non-Saline
TP3	1.5	5.7			10000	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	100	0.6	Non-Saline
TP3	2.0	5.6			5556	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	180	1.1	Non-Saline
TP3	2.5	5.6			3333	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Medium clay	7	300	2.1	Slightly Saline
TP3	3.0	5.7			3571	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Medium clay	7	280	2.0	Non-Saline
TP4	0.5	6.8	62	20	10000	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	0.76	7.9	10	Sodic	Heavy clay	6	100	0.6	Non-Saline
TP4	1.0	5.2			1136	B	Mild		Non-Aggressive		Mild					Heavy clay	6	880	5.3	Moderately Saline
TP4	1.5	4.9			769	B	Mild		Non-Aggressive		Moderate					Light clay	8.5	1300	11.1	Very Saline
TP4	2.0	6.5			1316	B	Non-Aggressive		Non-Aggressive		Mild					Light clay	8.5	760	6.5	Moderately Saline
TP4	2.5	7.7			1282	B	Non-Aggressive		Non-Aggressive		Mild					Light medium clay	8	780	6.2	Moderately Saline
TP4	3.0	7.4			1587	B	Non-Aggressive		Non-Aggressive		Mild					Light medium clay	8	630	5.0	Moderately Saline
BH5	0.5	7	10	10	19608	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive					Heavy clay	6	51	0.3	Non-Saline
BH5	1.0	6.9			21739	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Medium clay	7	46	0.3	Non-Saline
BH5	1.5	7.3			33333	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Medium clay	7	30	0.2	Non-Saline
BH5	2.0	7.9	10	31	6667	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	0.15	21	1	Non-Sodic	Heavy clay	6	150	0.9	Non-Saline
TP6	0.5	6.7			2273	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	440	2.6	Slightly Saline
TP6	1.0	7.9			1961	B	Non-Aggressive		Non-Aggressive		Mild					Medium clay	7	510	3.6	Slightly Saline
TP6	1.5	9.1	10	31	1887	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild					Medium clay	7.5	530	4.0	Slightly Saline
TP6	2.0	8.6	430	52	2632	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive					Medium clay	7	380	2.7	Slightly Saline
TP6	2.5	9.3			1613	B	Non-Aggressive		Non-Aggressive		Mild					Medium clay	7	620	4.3	Moderately Saline

Appendix D: Summary Table - Laboratory Tests and Assessments

Test Pit	Sample Depth	pH	Chloride Concentration	Sulphate Concentration	Resistivity	Soil Condition	Sample Aggressivity Class					Exchangeable Sodium (Na) Concentration	Cation Exchange Capacity	Sodicity	Sodicity Class	Soil Texture Group	Textural Factor (M)	$EC_{1:5}$	EC_e	Sample Salinity Class
					By inversion of EC1:5		Aggr. to Concrete - from sample pH	Aggr. to Concrete - from Sulphate conc.	Aggr. to Steel - from sample pH	Aggr. to Steel - from Chloride conc.	Aggr. to Steel - from sample Resistivity			[Na/CEC]		(for detailed soil logs see Report Appendix)		[Lab.]	[M x $EC_{1:5}$]	(Based on sample ECe)
	(m bgl)	(pH units)	(mg/kg)	(mg/kg)	Ω.cm	[AS2159-2009]	[AS2159-2009]					(meq/100g)	(meq/100g)	(%)	[after DLWC]	[after DLWC]	[after DLWC]	(microS/cm)	(deciS/m)	[Richards 1954]
TP6	3.0	9.5			1667	B	Non-Aggressive		Non-Aggressive		Mild					Medium clay	7	600	4.2	Moderately Saline
TP7	0.5	6.1			10638	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Medium clay	7	94	0.7	Non-Saline
TP7	1.0	5.4			3571	B	Mild		Non-Aggressive		Non-Aggressive					Heavy clay	6	280	1.7	Non-Saline
TP7	1.5	5.3			3571	B	Mild		Non-Aggressive		Non-Aggressive					Heavy clay	6	280	1.7	Non-Saline
BH8	0.5	6.4			5263	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	190	1.1	Non-Saline
BH8	1.0	5.3	720	360	1563	B	Mild	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild	1.6	7.6	21	Highly Sodic	Medium clay	7	640	4.5	Moderately Saline
BH8	1.5	5.2			1887	B	Mild		Non-Aggressive		Mild					Heavy clay	6	530	3.2	Slightly Saline
BH8	2.0	5			2703	B	Mild		Non-Aggressive		Non-Aggressive					Light clay	8.5	370	3.1	Slightly Saline
BH8	2.5	5.1	280	300	2632	B	Mild	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive					Light clay	8.5	380	3.2	Slightly Saline
TP9	0.5	7.3			10870	B	Non-Aggressive		Non-Aggressive		Non-Aggressive					Heavy clay	6	92	0.6	Non-Saline
TP9	1.0	5.3			2083	B	Mild		Non-Aggressive		Non-Aggressive					Heavy clay	6	480	2.9	Slightly Saline
TP9	1.5	5			1695	B	Mild		Non-Aggressive		Mild					Heavy clay	6	590	3.5	Slightly Saline
TP9	2.0	5			1235	B	Mild		Non-Aggressive		Mild					Heavy clay	6	810	4.9	Moderately Saline
TP9	2.5	5			1163	B	Mild		Non-Aggressive		Mild					Heavy clay	6	860	5.2	Moderately Saline
TP9	3.0	5.3	850	300	1316	B	Mild	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild					Heavy clay	6	760	4.6	Moderately Saline
TP10	0.5	5.9			12987	B	Non-Aggressive		Non-Aggressive		Non-Aggressive			<2	Non-Sodic	Heavy clay	6	77	0.5	Non-Saline
TP10	1.0	5.2			2941	B	Mild		Non-Aggressive		Non-Aggressive					Heavy clay	6	340	2.0	Slightly Saline
TP10	1.5	5			1667	B	Mild		Non-Aggressive		Mild					Medium clay	7	600	4.2	Moderately Saline
TP11	0.5	5.4			5882	B	Mild		Non-Aggressive		Non-Aggressive					Medium clay	7	170	1.2	Non-Saline
TP11	1.0	4.8			1299	B	Mild		Non-Aggressive		Mild					Medium clay	7	770	5.4	Moderately Saline
TP11	1.5	4.9	1100	92	1136	B	Mild	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild	1.5	8	19	Highly Sodic	Heavy clay	6	880	5.3	Moderately Saline
TP12	0.5	5.3			2857	B	Mild		Non-Aggressive		Non-Aggressive					Heavy clay	6	350	2.1	Slightly Saline
TP12	1.0	4.8	1400	37	909	B	Mild	Non-Aggressive	Non-Aggressive	Non-Aggressive	Moderate					Heavy clay	6	1100	6.6	Moderately Saline
TP12	1.5	5.3			1250	B	Mild		Non-Aggressive		Mild					Heavy clay	6	800	4.8	Moderately Saline
TP12	2.0	6.6			1205	B	Non-Aggressive		Non-Aggressive		Mild					Medium clay	7	830	5.8	Moderately Saline
TP12	2.5	6.7	840	140	1389	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild	2	6.2	32	Highly Sodic	Light clay	8.5	720	6.1	Moderately Saline
TP12	3.0	6.7			1136	B	Non-Aggressive		Non-Aggressive		Mild					Light clay	8.5	880	7.5	Moderately Saline