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Report on
Preliminary Geotechnical Investigation

Proposed Industrial Development
253 - 267 Aldington Road, Kemps Creek

Prepared for
RP Infrastructure Pty Ltd

Project 204098.00
October 2023

Douglas Partners
Geotechnics / Environment / Groundwater

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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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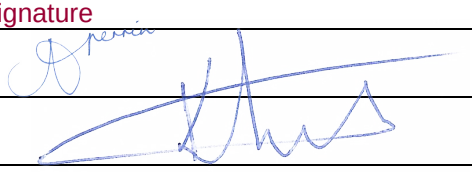
Author		27 October 2023
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Table of Contents

Page

Report on Preliminary Geotechnical Investigation
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1. Introduction

This preliminary geotechnical investigation has been prepared by Douglas Partners Pty Ltd (DP) for RP Infrastructure Pty Ltd (RP Infrastructure) to accompany a State Significant Development Application (**SSDA**) for the construction and operation of an industrial estate comprising four warehouse buildings at 253 – 267 Aldington Road, Kemps Creek, NSW 2178 ('the site') (SSD-23480429).

The application seeks consent for:

- Site preparation works including:
  - Demolition and removal of existing rural residential structures including removal of farm dams.
  - Remediation as required.
  - Bulk earthworks (193,100 m^3 of fill) and retaining walls.
- Staged construction and operation of an industrial estate with a total gross floor area (GFA) of 45,530 m^2, maximum floor space ratio (FSR) of 0.45:1, maximum height of 17.2 m, split over four warehouses contained within three buildings with ancillary hardstand and office spaces:
  - Stage 1
    - Warehouse 1A: 8,700 m^2 with 660 m^2 office space (total GFA – 9,360 m^2)
    - Warehouse 1B: 9,130 m^2 with 750 m^2 office space (total GFA - 9,880 m^2)
    - Warehouse 1C: 8,405 m^2 with 655 m^2 office space (total GFA - 9,060 m^2)
  - Stage 2
    - Warehouse 2 (temperature controlled): 16,930 m^2 with 790 m^2 office space (total GFA - 17,230 m^2)
- Use of the buildings for warehouse and distribution purposes 24 hours per day, 7 days per week.
- Ancillary development including:
  - Signage (A pylon estate sign approximately 5 m high and individual tenant signage adjacent each office).
  - Car Parking (261 vehicular spaces):
    - Warehouse 1A: 65 spaces
    - Warehouse 1B/1C: 117 spaces
    - Warehouse 2: 79 spaces
  - Landscaping
  - Retaining Walls

- Utility infrastructure and services connection; and
- Stormwater management including naturalised open channel drainage as well as below ground on-site detention of stormwater.

- Construction and dedication of new local roads and an interim intersection with Aldington Road,
- Subdivision of the site into two Torrens title allotments along with a road reserve lot for the widening of Aldington Road.

This report has been prepared to support DP's *Response to SEARs (SSD-2340429) – Geotechnical Summary (Soil and Water)* report[1].

The investigation was undertaken in accordance with DP's proposal 204098.00.P.001.Rev0, dated 22 April 2021. DP has previously prepared preliminary geotechnical investigation with the results presented in a Report (204098.00.R.001.Rev0), dated 2 July 2021. This revised report (204098.00.R.001.Rev1) was completed by DP, based on correspondence with RP Infrastructure, dated 14 September 2023, to reflect SSDA reporting requirements. It should be noted that apart from the requested updates, other components of the report have not been reviewed and/or updated.

The investigation comprised a site walkover inspection, test pit excavation 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.

The work was undertaken concurrently with DP's preliminary site investigation for contamination assessment which is reported separately (Project 204098.01.R.001.Rev3). Review of acid sulphate soils mapping has also been undertaken as part of the contamination assessment.

2. Site Description and Regional Geology

2.1 The Site[2]

The site is known as 253 – 267 Aldington Road, Kemps Creek and is legally described as Lot 9 in Deposited Plan (D.P.) 253503. The site is rectangular in shape with an area of approximately 10 hectares (ha).

The site has a primary frontage along its eastern boundary to Aldington Road of 160 m and a depth of 630 m. The site is currently occupied by a dwelling house, sheds and agricultural land as shown in the aerial photograph in Figure 1 below.

The site is undulating in parts but longitudinally falls slightly from Aldington Road at a reduced level (RL) of 54.00 to the western boundary with an RL 44.00 which equates to an average grade of 1.5% or 1 V in 65 H. The site also falls across the site from north to south at 4.3% or 1 V in 23 H.

[1] Douglas Partners Pty Ltd (2023) *Response to SEARs (SSD-23480429) – Geotechnical Summary (Soil and Water), Proposed Industrial Development, 253 – 267 Aldington Road, Kemps Creek, NSW*, REF. 204098.02.R.001.Rev2.
[2] Information contained within Section 2.1 was adopted, as requested form Urbis document *Consultant Standard Text – 253-267 Aldington Road Kemps Creek,* dated 14 September 2023.

The site is burdened by a 60.96 m wide Transgrid easement which runs north – south through the site. The easement is known as 'Dapto – Sydney West 330 kV Easement' and there is presently no high voltage transmission line infrastructure present. The site is approximately 5 kilometres (km) northeast of the future Western Sydney International (Nancy-Bird Walton) Airport, 14 km south-east of Penrith CBD and 38 km west of the Sydney Central Business District (CBD). The site is located within the suburb of Kemps Creek, which falls within the Penrith Local Government Area (LGA). It is in the Mamre Road Precinct within the broader Western Sydney Employment Area (WSEA) and is currently surrounded by rural residential land uses.

Multiple state significant developments (SSDs) and local development applications (DAs) are currently being progressed for industrial and warehouse development within the Mamre Road Precinct which will substantially change the nature of the surrounding area. The regional context is shown below in Figure 1 below.

Figure 1: Site Context

The surrounding land uses include:

- North: Pastoral/farmland extends towards the elevated Bakers Lane. Several properties have been purchased by developers for industrial development these include Frasers and Fife Stockland.
- South: Farm and pastoral lands with rural residential properties scattered within the landscape. The Mamre Road precinct extends further beyond Abbotts Road. A locally listed heritage item is located at 282 Aldington Road to the southeast.

- East: The site is bound to the east by Aldington Road. On the opposite side of Aldington Road several properties have been purchased in seeking approval for industrial development. Land rises to the east which provides a natural screen to the residential E4 Environmental Living zone beyond.
- West: Farm and pastoral lands to Mamre Road and beyond. Sites on Mamre Road have been purchased for industrial uses.

All land in the immediate surrounding context to the north, east and south has now been zoned for industrial uses.

At the time of the investigation (early 2021), one residence was located in the eastern section of the site with multiple caravans scattered across the site. The remainder of the site comprised rural land being used for farming or was unoccupied. Various features observed during the assessment are shown on the colour Photo Plates in Appendix C.

2.2 Regional Geology

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 siltstone encountered in two of the eight test locations.

Reference to the Map of Salinity Potential in Western Sydney (refer Figure 2) infers moderate salinity potential for the site. The site boundary is shown in Figure 2. The mapping is based on soil type, surface level and general groundwater considerations and, as such are approximate only.

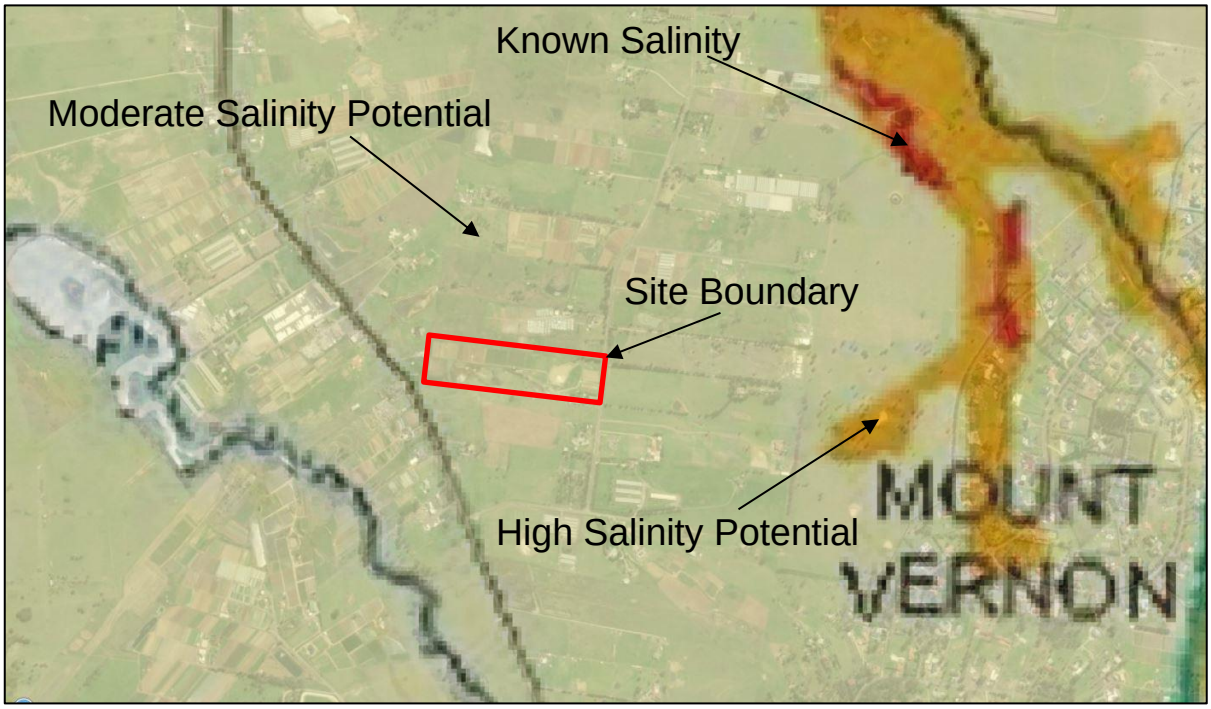


Figure 2: Map of Salinity Potential

Furthermore, published acid sulphate soils risk mapping indicates that the site is classified as "*an extremely low probability of occurrence*".

3. Field Work

3.1 Methodology

The field work comprised a site walkover inspection by a geotechnical engineer and the excavation of eight test pits (Pits 11 – 18).

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) samples 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 test pit 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 site was occupied by a house and shed (MRP and Photo 1) along with a number of caravans and storage sheds;
- Along the western and northern boundaries and at the eastern site entrance, significant portions of the site were actively farmed using windrowed plots (MRPs and Photos 2 – 4);
- Three farm dams ranging in surface area from approximately 1100 m^2 to 7000 m^2 were present on the site (MRPs and Photos 5 – 7). Dam embankments ranged in height from approximately 0.5 m up to 2.5 m with batter slopes in the range 1V:2H to 1V:3H;
- 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 (MRPs and Photos 8 and 9);
- Two area were observed to be affected by water logging (MRPs and Photos 10 and 11). The water logging and heavy vegetation at MRP 10 appeared to be due to a channel originating from the Dam (MRP 5) which progressed east toward the centre of the site. The water logging and heavy vegetation at MRP 11 appeared to be due to a low-lying area without drainage;
- No signs of salt efflorescence or scalding were noted during the field investigation.

3.2.2 Subsurface Investigation

The test pit 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 and Topsoil Fill – silty clay topsoil and topsoil fill to depths of 0.2 – 0.8 m;
- Fill – silty clay and clayey gravel to depths of 0.2 – 1.1 m in Pits 13, 14 and 17;
- Silty Clay – variably soft to hard silty clay to depths of 1.9 – 2.6 m in Pits 12 and 15 and to the termination depth in the range 3 – 3.1 m in Pits 11, 13, 14 and 16 – 18; and
- Siltstone – siltstone bedrock was encountered at depths of 2.6 m and 1.9 m in Pits 12 and 15 respectively and continued to the refusal depth of 2.7 m in Pit 12 and to the termination depth of 3 m in Pit 15.

Groundwater was observed at a depth of 2.9 m (RL48.8 AHD) in Pit 11, 2.1 m (RL46.8 AHD) in Pit 14, 1.9 m (RL44.4 AHD) in Pit 17 and 0.3 m (RL45.5 AHD) in Pit 18 during excavation. No free groundwater was observed in the remaining pits for the short time that they were left open. It is also noted that the pits 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

4.1 Plasticity and Dispersion Testing

Disturbed samples were tested for measurement of field moisture content, plasticity and dispersion. The detailed laboratory test report sheets are given in Appendix D, with the results summarised in Table 1.

Table 1: Summary of Test Results – Plasticity and Dispersion

Pit No	Depth (m)	FMC (%)	LL (%)	PL (%)	PI (%)	LS (%)	ECN	Material
12	0.9 – 1.0	16.9	36	16	20	9.0	2	Silty Clay
18	1.4 – 1.5	17.9	38	16	22	9.0	2	Silty Clay

Where FMC = Field moisture content; LL = Liquid limit; LS = Linear shrinkage; PL = Plastic limit; PI = Plasticity Index; ECN = Emerson Class Number

The field moisture content of the two samples were slightly wet of the plastic limit. The results indicate the soils tested are of medium plasticity and would be susceptible to moderate shrink swell movements with changes in soil moisture content. Emerson Class test results of 2 indicate that the soil samples tested have a very high potential for dispersion when exposed to free water.

4.2 Shrink Swell Index

'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 2.

Table 2: Summary of Test Results – Shrink Swell Index

Pit No	Depth (m)	W_F (%)	I_{ss} (%/ΔpF)	Material
13	1.2 – 1.4	23.9	1.2	Silty Clay
17	0.8 – 1.0	19.9	0.8	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 low to moderate shrink-swell potential and are consistent with the results of the plasticity index testing.

4.3 California Bearing Ratio

Two 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 3.

Table 3: Summary of Test Results – California Bearing Ratio (CBR)

Pit No	Depth (m)	W_F (%)	OMC (%)	MDD (t/m^3)	Swell (%)	CBR (%)	Material
13	1.2 – 1.4	24.8	24.0	1.61	0.5	5.0	Clay
17	0.8 – 1.0	22.3	21.5	1.67	0.5	3.5	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 3 indicate the soils were approximately 0.8% wet of standard optimum moisture content (SOMC).

4.4 Salinity, Aggressivity and Sodicity Testing

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 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	36	6.0 – 8.2
Chlorides		(mg/kg)	9	10 – 2800
Sulphates		(mg/kg)	9	10 – 390
Aggressivity [AS 2159]	to Concrete	-	45	non-aggressive
	to Steel	-	36	non-aggressive – moderately aggressive
Exchangeable Sodium (Na)		(meq/100g)	3	0.7 – 1.2
CEC (cation exchange capacity)		(meq/100g)	3	5.2 – 13.0
Sodicity [Na/CEC]		(ESP%)	3	6.8 – 15.0
Sodicity Class		[after DLWC]	3	Sodic
EC1:5 [Lab.]		(mS/cm)	36	11.4 – 1851.0
Resistivity		Ω.cm	36	540.2 – 87719.3
ECe [M x EC1:5] [1]		(dS/m)	36	0.1 – 15.7
Salinity Class [after Richards]		-	36	Non-Saline – Very Saline

Note: 1 M is soil textural factor

4.4.1 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 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.

The results indicate that of the 36 samples tested for aggressivity:

- All 36 were non-aggressive to concrete; and
- Four samples were moderately aggressive to steel, 10 were mildly aggressive to steel and 22 were non-aggressive to steel.

4.4.2 Salinity

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

The results indicate that of the 36 samples tested for salinity:

- 10 samples were non-saline;
- 14 samples were slightly saline;
- 9 samples were moderately saline; and
- 3 sample was very saline.

4.4.3 Sodicity

The sodicity tests show sodic soils, indicating a potential for erosion of exposed soils.

5. Proposed Development

It is understood that the site will be developed for industrial purposes. Preliminary project information provided by the client indicates that the proposed development will likely include five warehouse structures constructed on flat benched building platforms, along with roads and associated infrastructure to service the developed platforms. 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 industrial development. 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 or topsoil fill to depths of up to 0.8 m, although generally 0.2 – 0.3 m;
- Uncontrolled fill to depths of up to 1.1 m, also to be expected in dam walls;
- A residual clay profile, typically of stiff to hard consistency, to depths ranging from 1.9 to in excess of 3.0 m across the site. Soft to firm clays were encountered in areas within the vicinity of dams, areas prone to waterlogging and low lying areas;
- Siltstone bedrock of low strength encountered from 2.6 m in Pit 12 and very low to low strength from 1.9 m in Pit 15;

- Groundwater at depths of 0.3 – 2.5 m in Pits 11, 14, 17 and 18 during excavation, possibly being controlled by the adjacent dams.

6.3 Earthworks

6.3.1 Site Preparation

To prepare the general area of the site (other than farm dams) for the proposed industrial development, 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 (such as those identified in Section 6.2) that are identified during test rolling may need to be treated by excavation to a stiff stratum and replaced with engineered fill (refer Section 6.3.7). 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. If the site soils are reused, some moisture conditioning (wetting or drying) may be required for the earthworks and pavement subgrade construction. 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. It should be feasible to drain the ponds, reuse the existing filling in the dam walls (subject to environmental protocols and selective removal of deleterious portions) and recondition any saturated soil from the base of the dams for reuse either for landscaping or structural fill.

Any discharge or disposal of the pond water should be 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 if encountered during earthworks, although not encountered within the excavated test pits, will require heavy ripping with a minimum a D9 or equivalent plant. 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 boundary. However, this will need to be determined once the details of the proposed excavations and equipment are known.

Excavations in soil and weathered rock should include provision for temporary support using batters, benching or shoring.

Reference must be made to the individual logs which are included in Appendix C. The earthworks 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 and stronger 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 204098.01.R.001.Rev0) carried out in conjunction with this preliminary geotechnical investigation.

6.3.6 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.

6.3.7 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.

6.4 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 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, higher loads are proposed, or the proposed structures are settlement sensitive, a footings-to-rock systems would be required. The principal advantage of footings-to-rock systems would be that settlements (both total and differential) would be negligible.

6.7 Pavement Subgrade

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 2 – 4.5%. A CBR value of 7% could be adopted for preliminary design of pavements on rock subgrades.

All pavement subgrades should be investigated prior to detailed design and verified during earthworks construction.

Where the pavement subgrade has a CBR of less than 3% then improvement can be made by either excavating and replacement or by lime stabilisation of the in-situ materials.

6.8 Seismic Site Factor

The site stratigraphy comprises minor filling and topsoil underlain by soft to hard clay with a variable depth to rock, in most areas greater than 3 m. Therefore, the site sub-soil class when assessed in accordance with AS 1170.4:2007 is Class C_e (shallow soil site). It is noted that the sub-soil class can be affected by site works and should be verified during the detailed design process and it may be that some of the development site become Class B_e (rock site).

7. Salinity Management Plan

7.1 Bulk Earthworks

The following management strategies are confined to the management of those factors with a potential to impact on the bulk earthworks aspects of the development:

A. Management should focus on capping of the upper surface of the sodic soils, both exposed by excavation and placed as filling, with a more permeable material to prevent ponding, to reduce capillary rise, to act as a drainage layer and to reduce the potential for erosion.

B. When possible, placement of excavated soils in fill areas with similar salinity characteristics (i.e.: to place material on to in-situ soils with a similar or higher aggressivity or salinity classification). Where this is not possible or not tracked, all fill areas will require to be treated as moderately aggressive to steel and very saline.

C. With respect to imported fill material, testing should be undertaken prior to importation, to determine the salinity characteristics of the material, which should be non-aggressive and non-saline to slightly saline where possible but, in any case, not more aggressive or more saline than the material on which it is to be placed.

D. Sodic soils can also be managed by maintaining vegetation where possible and planting new salt tolerant species. The addition of organic matter, gypsum and lime can also be considered where appropriate. After gypsum addition, reduction of sodicity levels may require some time for sufficient infiltration and leaching of sodium into the subsoils, however capping of exposed sodic material should remain the primary management method. Topsoil added at the completion of bulk earthworks is, in effect, also adding organic matter which may help infiltration and leaching of sodium.

E. Avoiding water collecting in low lying areas, in depressions, or behind fill. This can lead to water logging of the soils, evaporative concentration of salts, and eventual breakdown in soil structure resulting in accelerated erosion.

F. Any pavements should be designed to be well drained of surface water. There should not be excessive concentrations of runoff or ponding that would lead to waterlogging of the pavement or additional recharge to the groundwater through any more permeable zones in the underlying filling material.

G. Surface drains should generally be provided along the top of batter slopes to reduce the potential for concentrated flows of water down slopes possibly causing scour.

H. Salt tolerant grasses and trees should be considered for landscaping, to reduce soil erosion as in Strategy A above and to maintain the existing evapo – transpiration and groundwater levels. Reference should be made to an experienced landscape planner or agronomist.

7.2 Civil Construction and Service Installation

The following additional strategies are recommended for completion of service installation including but not limited to; roads, drainage and services. These strategies should be complementary to standard good building practices, including cover to reinforcement within concrete.

I. Aggressivity results indicate soils that are non-aggressive to concrete (refer Drawing 3, Appendix B) and non-saline to very saline (refer Drawing 4, Appendix B). For these areas of the site, the durability requirements provided in Tables 6 and 7 should be taken into account by the designer.

Table 6: Recommended Durability Requirements for Concrete Foundations

Salinity Classification (Refer Drawing 4)	Concrete Aggressivity (Refer Drawing 3)	Recommended Durability Requirement (as per AS3600)		
		Minimum Concrete Strength (MPa)	Minimum Cover to Reinforcement (mm)	Minimum Cure Time (days)
Non-Saline to Slightly Saline	Non-aggressive Soils	20	-	3
Moderately Saline	Non-aggressive Soils	25	45	3
Very Saline	Non-aggressive Soils	32	50	7

Table 7: Recommended Durability Requirements for Concrete Piles

Concrete Aggressivity (Refer Drawing 3)	Recommended Durability Requirement (as per AS2159)	
	Minimum Concrete Strength (MPa)	Minimum Cover to Reinforcement (mm)
Non-Aggressive	32	45

J. Wet cast concrete pipes and currently manufactured spun concrete pipes are understood to have estimated compressive strengths of 50 MPa and 60 to 70 MPa, respectively, in excess of the requirements for mass concrete in Tables 6 and 7 above. Reference to the maximum and minimum test results of Table 4 (Section 4 of this report) and to Tables E1 and 3.1 of AS 4058 – 2007 "Precast concrete pipes" indicates that the site falls within the AS 4058 Clay/Stagnant (low sulphate) soil type (chlorides ≤20 000 ppm, pH≥4.5 and sulphates ≤1000 ppm) and (in the absence of tidal water flow) falls within the AS 4058 Normal durability environment. Under these conditions, AS 4058 – compliant reinforced concrete pipes of general purpose Portland cement, with a minimum cover to reinforcement of 10 mm, are expected to have a design life in excess of 100 years. Any concrete pipes installed within the site should employ AS 4058 – compliant steel reinforced pipes of general purpose Portland cement, with minimum cover to reinforcement of 10 mm, or should be fibre reinforced.

K. Resistivity results indicate soils that are non-aggressive to moderately aggressive to steel (Drawing 5, Appendix B). This drawing identifies mild aggressivity to steel (1000 – 2000 Ohm-cm) and moderate aggressivity steel (<1000 Ohm-cm) over the site. For these areas of soil identified as mildly aggressive to moderately aggressive to steel, the following corrosion allowances (as per AS 2159 – 2009) should be taken into account by the designer:
   - Mild: uniform corrosion allowance 0.01 – 0.02 mm/year;
   - Moderate: uniform corrosion allowance 0.02 – 0.04 mm/year.

   In instances where a coating is applied to the pile, if the design life of the pile is greater than the design life for the coating, consideration must be given to corrosion of the pile in accordance with the above list.

7.3 Industrial/Commercial Construction

This salinity investigation has been undertaken for the purpose of providing advice with regards to salinity relating to bulk earthworks and service installations only. A detailed salinity investigation will be required prior to subdivision certification (after completion of bulk earthworks) in order to provide more detailed recommendations for individual building pads. Such an investigation should be carried out well in advance of service installation, building and road construction.

8. Summary

The geotechnical investigation undertaken has indicated that most of the site will be suitable for industrial development, with comments given on geotechnical limitations, development guidelines, likely site classification, stability considerations, indicative design parameters and salinity management. It is considered that the salinity management strategies described herein when incorporated into the design and construction works are appropriate to mitigate the levels of salinity, aggressivity and sodicity identified at the site.

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 geotechnical investigations for determination of pavement thickness design and individual building construction;
- Routine inspections and earthworks monitoring during construction.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 253 - 267 Aldington Road, Kemps Creek in accordance with DP's proposal dated 22 April 2021 and acceptance from Mr Sam Franklin of RP Infrastructure Pty Ltd (formerly known as Root Partnerships Pty Ltd). The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of RP Infrastructure Pty Ltd 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.

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 1726-1993, 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 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate 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 $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

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 longer 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:

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

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

Symbols & Abbreviations

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

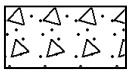
Symbols & Abbreviations

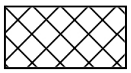
Graphic Symbols for Soil and Rock

General

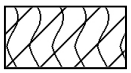

Asphalt


Road base


Concrete


Filling

Soils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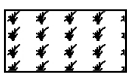
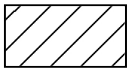
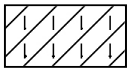
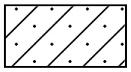
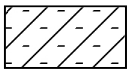

Peat

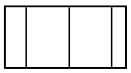

Clay

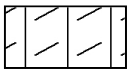

Silty clay

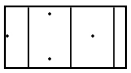

Sandy clay

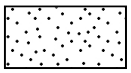

Gravelly clay

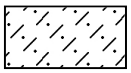

Shaly clay

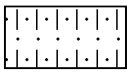

Silt


Clayey silt


Sandy silt

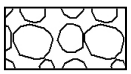

Sand

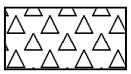

Clayey sand


Silty sand


Gravel

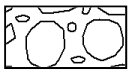

Sandy gravel


Cobbles, boulders

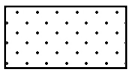

Talus

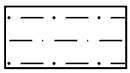
Sedimentary Rocks

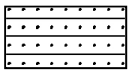

Boulder conglomerate

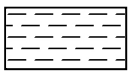

Conglomerate


Conglomeratic sandstone

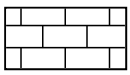

Sandstone


Siltstone

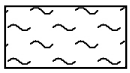

Laminite

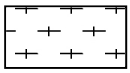

Mudstone, claystone, shale

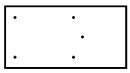

Coal


Limestone

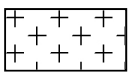
Metamorphic Rocks

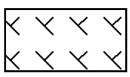

Slate, phyllite, schist

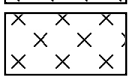

Gneiss

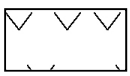

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

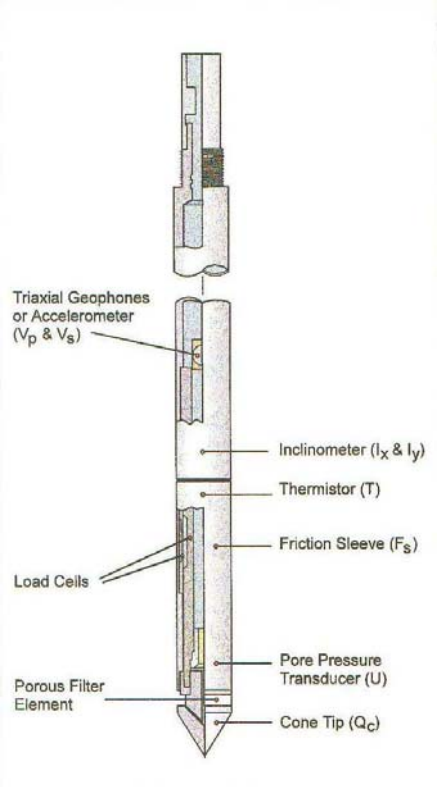


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

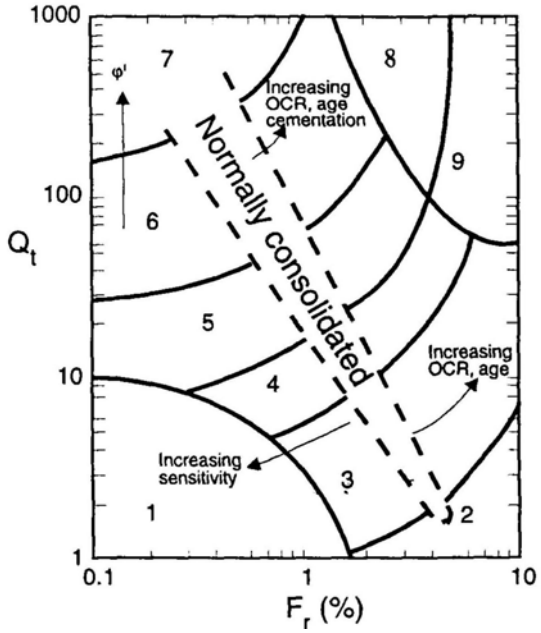


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

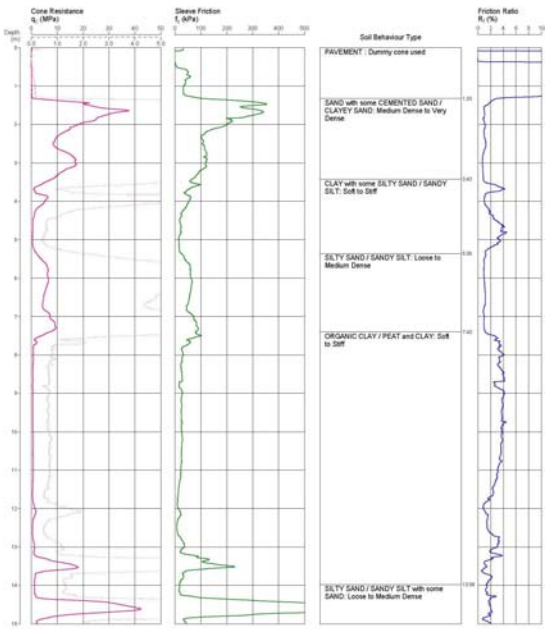


Figure 4: Sample Cone Plot

Appendix B

Drawing 1 – Test Pit Location Plan
Drawing 2 – Geotechnical Constraints
Drawing 3 – Aggressivity to Concrete Map
Drawing 4 – Soil Salinity Map
Drawing 5 – Aggressivity to Steel Map

Site Locality

TP09
TP08
TP07
TP17
TP14
TP06
TP6A
TP11
TP15
TP10
TP01
TP05
TP18
TP16
TP04
TP02
TP03
TP12
TP13

Legends

Boundary

Test Pit (Geotech+Contamination)

Test Pit (Contamination)

0 50 100 150 200 m

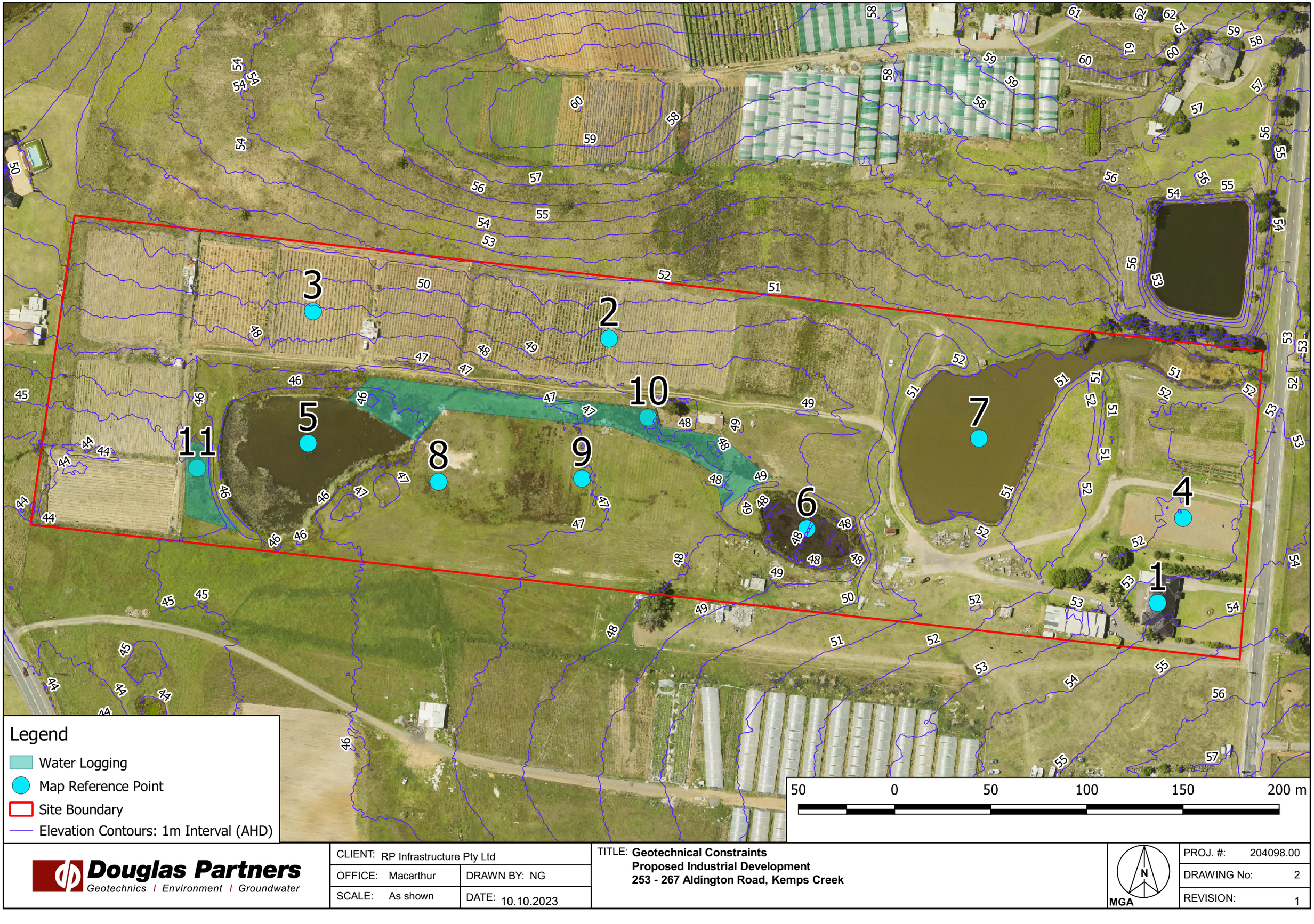
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	RP Infrastructure Pty Ltd		
OFFICE:	Macarthur	DRAWN BY:	RB
SCALE:	As shown	DATE:	10.10.2023

TITLE: **Test Pit Plan**
Proposed Industrial Development
253-267 Aldington Road, Kemps Creek

MGA

PROJ. #:	204098.00
DRAWING No:	1
REVISION:	1



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: RP Infrastructure Pty Ltd		
OFFICE: Macarthur	DRAWN BY: NG	
SCALE: As shown	DATE: 10.10.2023	

TITLE: **Geotechnical Constraints**
Proposed Industrial Development
253 - 267 Aldington Road, Kemps Creek

PROJ. #:	204098.00
DRAWING No:	2
REVISION:	1

TP11
TP12
TP13
TP14
TP15
TP16
TP17
TP18

Legend
- Site Boundary
- Non-Aggressive to Concrete
- Test Pit

50 0 50 100 150 200 m

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	RP Infrastructure Pty Ltd		
OFFICE:	Macarthur	DRAWN BY:	NG
SCALE:	As shown	DATE:	10.10.2023

TITLE: **Aggressivity to Concrete Map**
Proposed Industrial Development
253 - 267 Aldington Road, Kemps Creek

N
MGA

PROJ. #:	204098.00
DRAWING No:	3
REVISION:	1

TP17
TP14
TP11
TP15
TP18
TP16
TP12
TP13

Legend
- Site Boundary
- Test Pit
- Slightly Saline
- Moderately Saline
- Very Saline

50 0 50 100 150 200 m

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	RP Infrastructure Pty Ltd		
OFFICE:	Macarthur	DRAWN BY:	NG
SCALE:	As shown	DATE:	10.10.2023

TITLE: **Soil Salinity Map**
Proposed Industrial Development
253 - 267 Aldington Road, Kemps Creek

N
MGA

PROJ. #:	204098.00
DRAWING No:	4
REVISION:	1

TP11
TP12
TP13
TP14
TP15
TP16
TP17
TP18

Legend

- Site Boundary
- Test Pit
- Non-Aggressive to Steel
- Mild Aggressivity to Steel
- Moderate Aggressivity to Steel

50 0 50 100 150 200 m

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	RP Infrastructure Pty Ltd		
OFFICE:	Macarthur	DRAWN BY:	NG
SCALE:	As shown	DATE:	10.10.2023

TITLE: **Aggressivity to Steel Map**
Proposed Industrial Development
253 - 267 Aldington Road, Kemps Creek

N
MGA

PROJ. #:	204098.00
DRAWING No:	5
REVISION:	1

Appendix C

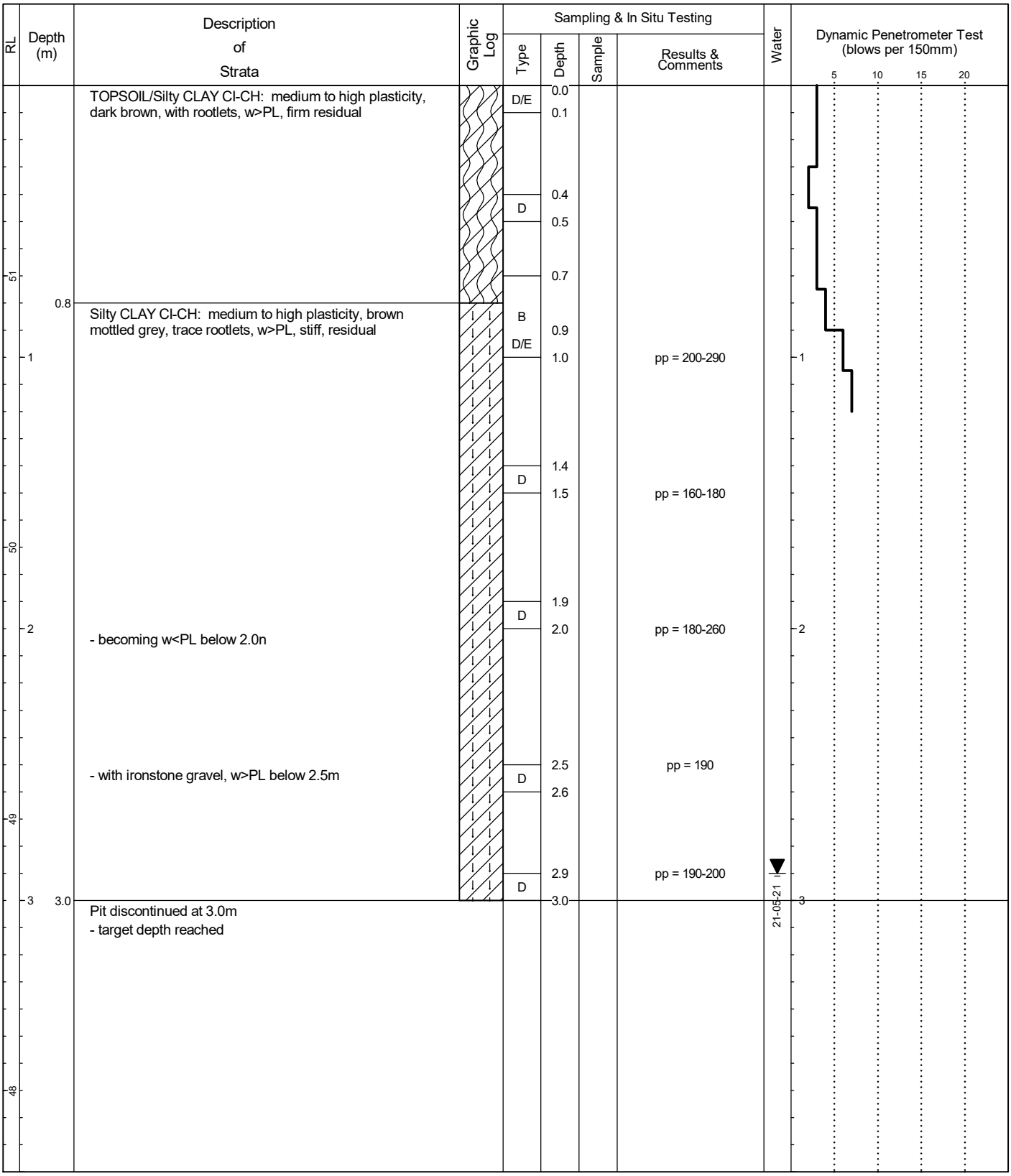
Test Pit Logs (Pits 11 – 18)
Site Photographs (Photo Plates 1 – 6)

TEST PIT LOG

CLIENT: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 51.7 mAHD
EASTING: 296036
NORTHING: 6252013

PIT No: 11
PROJECT No: 204098.00
DATE: 21/5/2021
SHEET 1 OF 1



RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 2.9m

REMARKS:

☐ 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: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 52.0 mAHD
EASTING: 296018
NORTHING: 6251938

PIT No: 12
PROJECT No: 204098.00
DATE: 21/5/2021
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)
52	0.15	TOPSOIL/Silty CLAY CI-CH: medium to high plasticity, dark brown, with rootlets, trace sand, w~PI, firm, residual		D/E	0.0–0.1				
		Silty CLAY CI-CH: medium to high plasticity, brown, trace rootlets, w<PL, stiff, residual		D/E	0.4–0.5				
51	1			D	0.9–1.0				1
		- becoming grey mottled brown, trace ironstone gravel below 1.6m		D	1.4–1.5				
50	2			D	1.9–2.0				2
				D	2.4–2.5				
	2.6	SILTSTONE: grey, low strength, highly weathered		D	2.6				
	2.7	Pit discontinued at 2.7m - refusal on low strength siltstone			2.7				
49	3								3

RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ 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: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 51.5 mAHD
EASTING: 295929
NORTHING: 6251911

PIT No: 13
PROJECT No: 204098.00
DATE: 21/5/2021
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)
									5 10 15 20
		FILL/TOPSOIL: Silty CLAY CL-CI, low to medium plasticity, dark brown, with siltstone gravel and rootlets, w<PL, poorly compacted		D	0.0				
	0.2	FILL/Silty CLAY CI-CH: medium to high plasticity, pale grey, with siltstone gravel, trace rootlets, w<PL, poorly compacted			0.1				
				D	0.4				
51		- becoming brown to dark brown below 0.5m			0.5				
		- bitumen between 0.7 - 0.75m							
		- brick fragments below 0.9m		D	0.9				
	1				1.0				1
	1.1	Silty CLAY CI-CH: medium to high plasticity, red brown with grey, w<PL, very stiff, residual			1.2				
				B U_{50}					
					1.4				
				D	1.45				
50					1.5				
					1.7				
				D					
	2	- trace ironstone gravel below 2.0m			2.0		pp = 280-300		2
					2.4				
				D					
49		- becoming grey with orange below 2.5m			2.5		pp = 300-310		
					2.9				
				D					
	3 3.0	Pit discontinued at 3.0m - target depth reached			3.0		pp = 300-350		3
48									

RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ 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: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 48.9 mAHD
EASTING: 295837
NORTHING: 6252007

PIT No: 14
PROJECT No: 204098.00
DATE: 21/5/2021
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)
									5 10 15 20
	0.15	FILL/Clayey GRAVEL: fine to coarse grained, pale brown, with tiles, concrete and sand, moist, apparently well compacted		D/E	0.0 0.1				
		Silty CLAY CI: medium plasticity, dark brown, trace rootlets, w<PL, firm, residual							
				D	0.4				
	0.5	Silty CLAY CI- CH: medium to high plasticity, red brown, trace rootlets, w~PL, stiff, residual			0.5				
48				D/B	0.9				
	1				1.0				1
		- becoming brown mottled grey, trace ironstone gravel below 1.4m		D	1.4 1.5		pp = 120-150		
47				D	1.9				
	2	- becoming brown mottled grey, trace ironstone gravel below 1.4m			2.0		pp = 100-110	21-05-21	2
		- becoming w>PL, firm to stiff below 2.4m		D	2.4				
		- becoming firm below 2.5m			2.5		pp = 50-60		
46				D	2.9				
	3				3.0				3
	3.1	Pit discontinued at 3.1m - target depth reached							
45									

RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 2.1m

REMARKS:

☐ 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: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 43.9 mAHD
EASTING: 295456
NORTHING: 6251986

PIT No: 15
PROJECT No: 204098.00
DATE: 21/5/2021
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)
		TOPSOIL/Silty CLAY CI-CH: medium to high plasticity, dark brown, with rootlets, w>PL, soft, residual		D	0.0				
				E	0.1				
	0.3				0.2				
		Silty CLAY CI-CH: medium to high plasticity, brown mottled grey, trace rootlets, w>PL, stiff then very stiff, residual		D	0.4				
					0.5				
43					0.9				
	1			D	1.0				1
		- with ironstone gravel below 1.2m							
				D	1.4				
					1.5				
		- becoming grey with orange below 1.6m							
42	1.9				1.9				
		SILTSTONE: grey brown, very low strength, highly weathered		D	2.0				
	2								2
					2.4				
				D	2.5				
		- becoming low strength below 2.5m							
41					2.9				
	3			D					3
	3.0	Pit discontinued at 3.0m - target depth reached			3.0				
40									

RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ 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: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 47.3 mAHD
EASTING: 295717
NORTHING: 6251929

PIT No: 16
PROJECT No: 204098.00
DATE: 21/5/2021
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)
47	0.3	TOPSOIL/Silty CLAY CL-CI: low to medium plasticity, dark brown, with rootlets, trace sand, w>PL, soft, residual		D	0.0				
					0.1				
		Silty CLAY CI: medium plasticity, red brown, trace rootlets, soft to firm, w>PL, residual		D	0.4				
					0.5				
					0.9				
		- becoming very stiff to hard below 0.9m		D					
46	1				1.0		pp = 450-570		1
					1.4				
				D					
		- becoming brown, trace ironstone gravel below 1.5m			1.5		pp = 300-320		
					1.9				
				D					
45	2				2.0		pp = 250-300		2
		- becoming grey with orange below 2.2m							
					2.4				
				D					
					2.5		pp = 400-480		
					2.9				
				D					
	3 3.0	Pit discontinued at 3.0m - target depth reached			3.0		pp = 300-420		3
44									

RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ 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)

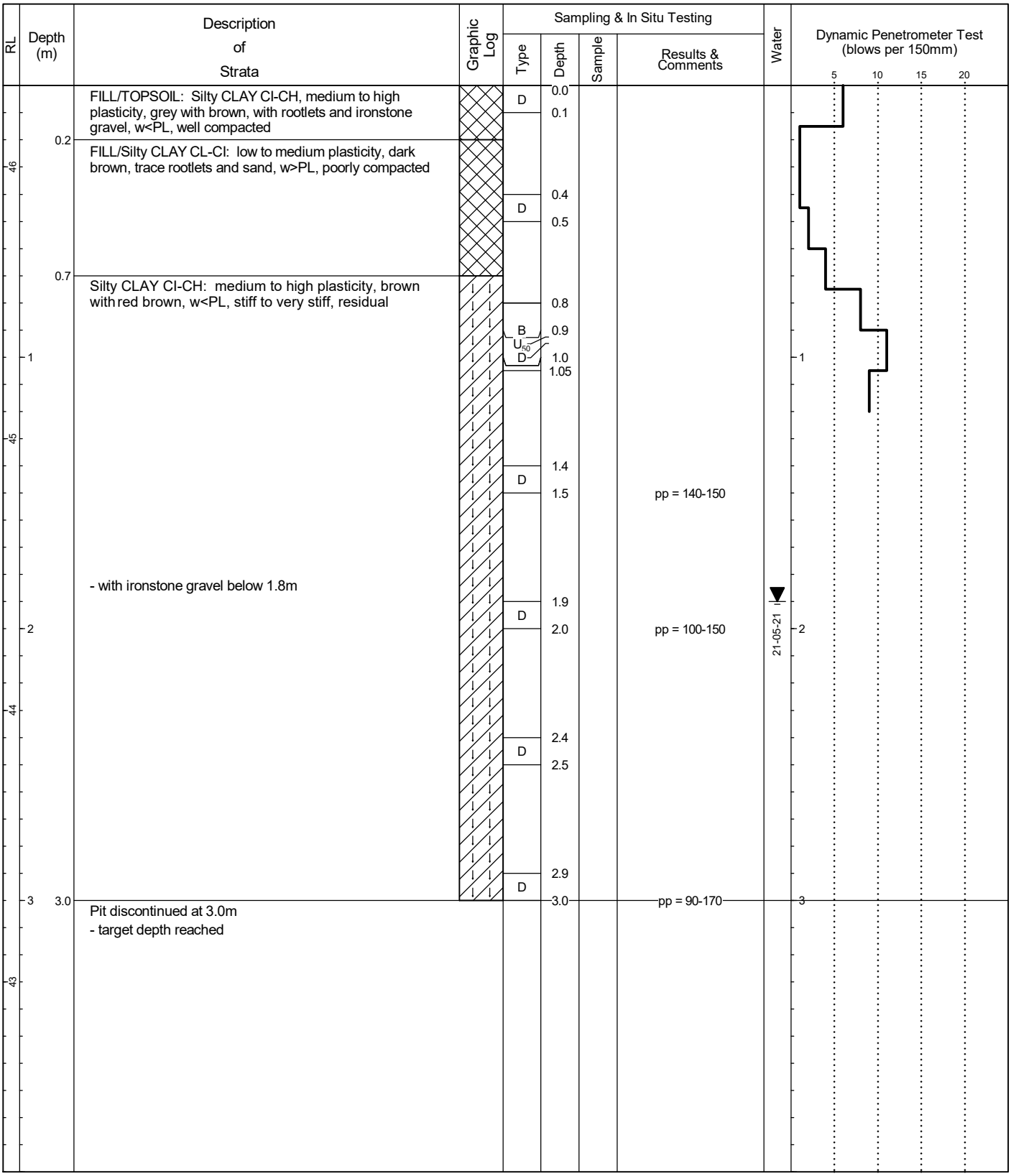
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 46.3 mAHD
EASTING: 295649
NORTHING: 6252005

PIT No: 17
PROJECT No: 204098.00
DATE: 21/5/2021
SHEET 1 OF 1



RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 1.9m

REMARKS:

☐ 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: RP Infrastructure Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 253 - 267 Aldington Road, Kemps Creek, NSW

SURFACE LEVEL: 45.8 mAHD
EASTING: 295579
NORTHING: 6251936

PIT No: 18
PROJECT No: 204098.00
DATE: 21/5/2021
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)
45	0.3	TOPSOIL/Silty CLAY CI-CH: medium to high plasticity, dark brown, with rootlets, w>PL, soft, residual		D	0.1 0.2				
		Silty CLAY CI-CH: medium to high plasticity, pale grey then red brown, trace rootlets, w>PL, firm to very stiff then hard, residual		D	0.4 0.5			21-05-21	
		- becoming red brown, w<PL below 0.55		U_{50}	0.55 0.8				
	1			D	0.9 1.0				1
44		- becoming brown, trace ironstone gravel, w>PL, soft below 1.8m		D	1.4 1.5				
	2			D	1.9 2.0				2
43				D	2.4 2.5				
	3			D	2.9				3
42	3.0	Pit discontinued at 3.0m - target depth reached			3.0				

RIG: 8T backhoe - 400mm bucket

LOGGED: RB

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 0.3m

REMARKS:

☐ 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

Photograph 1 - Viewof residence from central portion of the site looking southwest

Photograph 2 - View of farmed plots looking west from central portion of site

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 204098.00
	Proposed Industrial Development	PLATE No: 1
	253 - 267 Aldington Road, Kemps Creek	REV: 1
	CLIENT: RP Infrastructure Pty Ltd	DATE: Oct-2023

Photograph 3 - View of farmed plots looking north from central portion of site

Photograph 4 - View of farmed plots looking east toward Aldington Road from central portion of site

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 204098.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 2
	253 - 267 Aldington Road, Kemps Creek	REV: 1
	CLIENT: RP Infrastructure Pty Ltd	DATE: Oct- 2023

Photograph 5 - View of western dam looking south from central portion of site

Photograph 6 - View of central dam looking north-west from southern portion of site

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 204098.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 3
	253 - 267 Aldington Road, Kemps Creek	REV: 1
	CLIENT: RP Infrastructure Pty Ltd	DATE: Oct-2023

Photograph 7 - View of eastern dam looking east from central portion of site

Photograph 8 - View of low-lying ground looking north-east from southern portion of site

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 204098.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 4
	253 - 267 Aldington Road, Kemps Creek	REV: 1
	CLIENT: RP Infrastructure Pty Ltd	DATE: Oct-2023

Photograph 9 - View of low-lying ground looking south-east from central portion of site

Photograph 10 - Water Logged area in central portion of the site looking south east

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 204098.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 5
	253 - 267 Aldington Road, Kemps Creek	REV: 1
	CLIENT: RP Infrastructure Pty Ltd	DATE: Oct-2023

Photograph 11 - Water Logged area in western portion of the site, west of the dam, looking south

Douglas Partners Geotechnics / Environment / Groundwater	Site Photographs	PROJECT: 204098.00
	Proposed Commercial/Industrial Subdivision	PLATE No: 6
	253 - 267 Aldington Road, Kemps Creek	REV: 1
	CLIENT: RP Infrastructure Pty Ltd	DATE: Oct-2023

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: meregal.henakaa@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Nilusha Arachchi
clean lab
Laboratory Accreditation Number: 828

Report Number: **204098.00-1**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5669
Sample Number: MA-5669AN
Date Sampled: 21/05/2021
Dates Tested: 27/05/2021 - 08/06/2021
Sample Location: **TP12 , Depth: 0.9 - 1.0 m**
Material: Silty CLAY: brown

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	36		
Plastic Limit (%)	16		
Plasticity Index (%)	**20**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	As above		
Nature of Water	Distilled water		
Temperature of Water (^{o}C)	22		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	16.9

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: meregal.henakaa@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Nilusha Arachchi
clean lab
Laboratory Accreditation Number: 828

Report Number: **204098.00-1**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5669
Sample Number: MA-5669AM
Date Sampled: 21/05/2021
Dates Tested: 27/05/2021 - 08/06/2021
Sample Location: **TP18 , Depth: 1.4 - 1.5 m**
Material: Silty CLAY: pale grey

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	38		
Plastic Limit (%)	16		
Plasticity Index (%)	**22**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	Curling		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	As above		
Nature of Water	Distilled water		
Temperature of Water (^{o}C)	22		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	17.9

Material Test Report

Report Number: **204098.00-1**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5669
Dates Tested: 27/05/2021 - 27/05/2021
Location: Kemps Creek

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: meregal.henakaa@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Nilusha Arachchi
clean lab
Laboratory Accreditation Number: 828

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	MA-5669A	MA-5669B			
Date Sampled	21/05/2021	21/05/2021			
Date Tested	27/05/2021	27/05/2021			
Material Source	**	**			
Sample Location	13 (1.2- 1.4 m)	17 (0.8- 1.0 m)			
Inert Material Estimate (%)	0	0			
Pocket Penetrometer before (kPa)	400	380			
Pocket Penetrometer after (kPa)	380	360			
Shrinkage Moisture Content (%)	23.5	18.5			
Shrinkage (%)	**2.2**	**1.5**			
Swell Moisture Content Before (%)	23.9	19.9			
Swell Moisture Content After (%)	26.3	20.7			
Swell (%)	**-0.0**	**0.0**			
Shrink Swell Index Iss (%)	**1.2**	**0.8**			
Visual Description	Silty CLAY: red brown with grey	Silty CLAY: brown with red brown			
Cracking	HC	MC			
Crumbling	No	No			
Remarks	**	**			

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Material Test Report

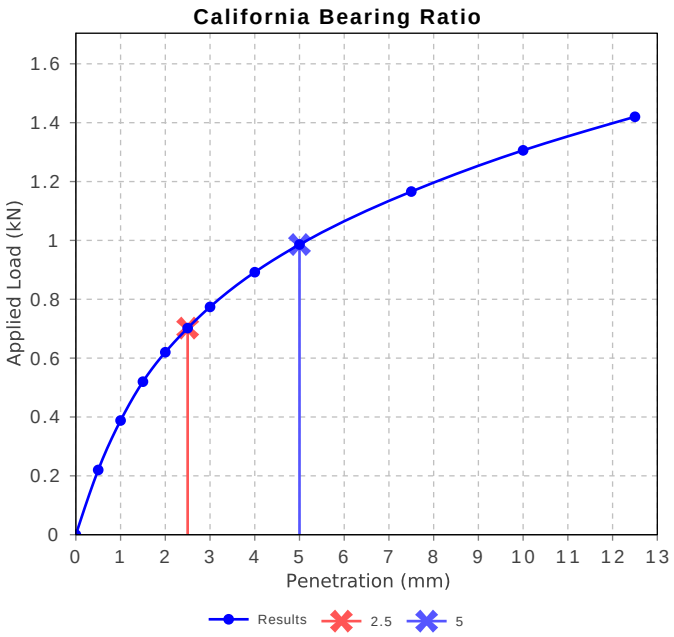
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: ramon.arancibia@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Ramon Arancibia
Assistant Laboratory Manager
Laboratory Accreditation Number: 828

Report Number: **204098.00-2**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5648
Sample Number: MA-5648B
Date Sampled: 21/05/2021
Dates Tested: 26/05/2021 - 04/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **13 (1.2 - 1.4m)**
Material: CLAY

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5.0**		
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)	1.61		
Optimum Moisture Content (%)	24.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.60		
Field Moisture Content (%)	24.8		
Moisture Content at Placement (%)	24.2		
Moisture Content Top 30mm (%)	27.0		
Moisture Content Rest of Sample (%)	25.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	45.1		
Swell (%)	0.5		
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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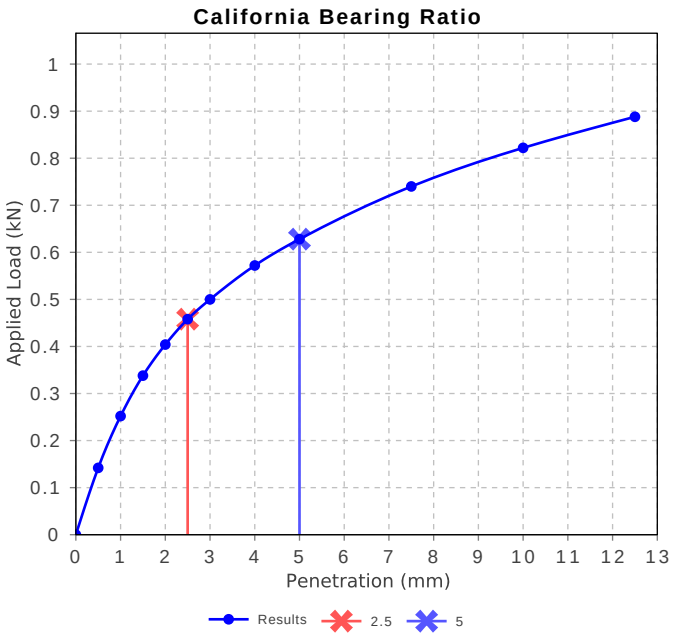
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: ramon.arancibia@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Ramon Arancibia
Assistant Laboratory Manager
Laboratory Accreditation Number: 828

Report Number: **204098.00-2**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5648
Sample Number: MA-5648A
Date Sampled: 21/05/2021
Dates Tested: 26/05/2021 - 04/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **17 (0.8 - 1.0m)**
Material: CLAY

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.5**		
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 (%)	21.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.67		
Field Moisture Content (%)	22.3		
Moisture Content at Placement (%)	21.6		
Moisture Content Top 30mm (%)	23.4		
Moisture Content Rest of Sample (%)	22.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	45.4		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report

Report Number: **204098.00-1**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5669
Dates Tested: 27/05/2021 - 04/06/2021
Location: Kemps Creek

Douglas Partners
Geotechnics / Environment / Groundwater
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Determination of pH of Soil (In-House) DP MAC1

Sample Number	Location	Depth (m)	Material	pH Value
MA-5669C	TP11	0.4 - 0.5	Soil	7.9
MA-5669D	TP11	0.9 - 1.0	Soil	7.4
MA-5669E	TP11	1.4 - 1.5	Soil	7.2
MA-5669F	TP11	1.9 - 2.0	Soil	7.5
MA-5669G	TP11	2.4- 2.5	Soil	7.5
MA-5669H	TP11	2.9 - 3.0	Soil	7.5
MA-5669I	TP13	0.4 - 0.5	Soil	7.6
MA-5669J	TP13	0.9 - 1.0	Soil	6.5
MA-5669K	TP13	1.4 - 1.5	Soil	6.6
MA-5669L	TP13	1.9 - 2.0	Soil	6.8
MA-5669M	TP13	2.4- 2.5	Soil	7.0
MA-5669N	TP13	2.9 - 3.0	Soil	6.9
MA-5669O	TP16	0.4 - 0.5	Soil	7.7
MA-5669P	TP16	0.9 - 1.0	Soil	7.3
MA-5669Q	TP16	1.4 - 1.5	Soil	6.8
MA-5669R	TP16	1.9 - 2.0	Soil	8.0
MA-5669S	TP16	2.4- 2.5	Soil	7.5
MA-5669T	TP16	2.9 - 3.0	Soil	7.3
MA-5669U	TP17	0.4 - 0.5	Soil	6.2
MA-5669V	TP17	0.9 - 1.0	Soil	6.0
MA-5669W	TP17	1.4 - 1.5	Soil	6.3
MA-5669X	TP17	1.9 - 2.0	Soil	6.5
MA-5669Y	TP17	2.4- 2.5	Soil	6.6
MA-5669Z	TP17	2.9 - 3.0	Soil	6.7
MA-5669AA	TP14	0.4 - 0.5	Soil	7.0
MA-5669AB	TP14	0.9 - 1.0	Soil	6.7
MA-5669AC	TP14	1.4 - 1.5	Soil	6.4
MA-5669AD	TP14	1.9 - 2.0	Soil	6.6
MA-5669AE	TP14	2.4- 2.5	Soil	6.7
MA-5669AF	TP14	2.9 - 3.0	Soil	7.0
MA-5669AG	TP15	0.9 - 1.0	Soil	8.2
MA-5669AH	TP15	0.9 - 1.0	Soil	7.7

Sample Number	Location	Depth (m)	Material	pH Value
MA-5669AI	TP15	1.4 - 1.5	Soil	7.7
MA-5669AJ	TP15	1.9 - 2.0	Soil	7.4
MA-5669AK	TP15	2.4 - 2.5	Soil	7.3
MA-5669AL	TP15	2.9 - 3.0	Soil	7.3

Material Test Report

Report Number: **204098.00-1**
Issue Number: 1
Date Issued: 08/06/2021
Client: Root Partnerships Pty Ltd
Level 5, Sydney NSW 2000
Contact: Sam Franklin
Project Number: 204098.00
Project Name: Proposed Industrial Development
Project Location: 253 - 267 Aldington Road, Kemps Creek NSW
Work Request: 5669
Dates Tested: 27/05/2021 - 07/06/2021
Location: Kemps Creek

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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Nilusha Arachchi
clean lab
Laboratory Accreditation Number: 828

Determination of EC of Soil (In-House) DP MAC2

Sample Number	Location	Depth (m)	Material	EC Value (µS/cm)
MA-5669C	TP11	0.4 - 0.5	Soil	333.20
MA-5669D	TP11	0.9 - 1.0	Soil	804.20
MA-5669E	TP11	1.4 - 1.5	Soil	786.40
MA-5669F	TP11	1.9 - 2.0	Soil	489.10
MA-5669G	TP11	2.4- 2.5	Soil	377.10
MA-5669H	TP11	2.9 - 3.0	Soil	372.10
MA-5669I	TP13	0.4 - 0.5	Soil	219.00
MA-5669J	TP13	0.9 - 1.0	Soil	188.60
MA-5669K	TP13	1.4 - 1.5	Soil	361.30
MA-5669L	TP13	1.9 - 2.0	Soil	180.10
MA-5669M	TP13	2.4- 2.5	Soil	111.20
MA-5669N	TP13	2.9 - 3.0	Soil	125.70
MA-5669O	TP16	0.4 - 0.5	Soil	11.40
MA-5669P	TP16	0.9 - 1.0	Soil	27.80
MA-5669Q	TP16	1.4 - 1.5	Soil	73.90
MA-5669R	TP16	1.9 - 2.0	Soil	221.90
MA-5669S	TP16	2.4- 2.5	Soil	298.90
MA-5669T	TP16	2.9 - 3.0	Soil	390.20
MA-5669U	TP17	0.4 - 0.5	Soil	1851.00
MA-5669V	TP17	0.9 - 1.0	Soil	1726.50
MA-5669W	TP17	1.4 - 1.5	Soil	1044.00
MA-5669X	TP17	1.9 - 2.0	Soil	957.60
MA-5669Y	TP17	2.4- 2.5	Soil	779.70
MA-5669Z	TP17	2.9 - 3.0	Soil	848.30
MA-5669AA	TP14	0.4 - 0.5	Soil	394.30
MA-5669AB	TP14	0.9 - 1.0	Soil	587.30
MA-5669AC	TP14	1.4 - 1.5	Soil	1038.00
MA-5669AD	TP14	1.9 - 2.0	Soil	593.60
MA-5669AE	TP14	2.4- 2.5	Soil	495.60
MA-5669AF	TP14	2.9 - 3.0	Soil	351.10
MA-5669AG	TP15	0.9 - 1.0	Soil	160.00
MA-5669AH	TP15	0.9 - 1.0	Soil	435.60

Sample Number	Location	Depth (m)	Material	EC Value (µS/cm)
MA-5669AI	TP15	1.4 - 1.5	Soil	359.80
MA-5669AJ	TP15	1.9 - 2.0	Soil	647.80
MA-5669AK	TP15	2.4 - 2.5	Soil	641.10
MA-5669AL	TP15	2.9 - 3.0	Soil	536.00

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CERTIFICATE OF ANALYSIS 269953

Client Details

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

Sample Details

Your Reference	**204098.00, Kemps Creek**
Number of Samples	9 Soil
Date samples received	26/05/2021
Date completed instructions received	26/05/2021

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	02/06/2021
Date of Issue	02/06/2021

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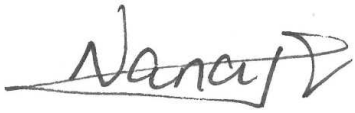
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Hannah Nguyen, Senior Chemist
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		269953-1	269953-2	269953-3	269953-4	269953-5
Your Reference	UNITS	TP11	TP11	TP13	TP14	TP14
Depth		0.4-0.5	1.4-1.5	0.4-0.5	0.4-0.5	1.4-1.5
Date Sampled		21/05/2021	21/05/2021	21/05/2021	21/05/2021	21/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021
Date analysed	-	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021
Chloride, Cl 1:5 soil:water	mg/kg	520	1,400	25	430	2,000
Sulphate, SO4 1:5 soil:water	mg/kg	210	270	200	210	310

Misc Inorg - Soil					
Our Reference		269953-6	269953-7	269953-8	269953-9
Your Reference	UNITS	TP15	TP15	TP16	TP17
Depth		0.4-0.5	1.4-1.5	0.4-0.5	0.4-0.5
Date Sampled		21/05/2021	21/05/2021	21/05/2021	21/05/2021
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	28/05/2021	28/05/2021	28/05/2021	28/05/2021
Date analysed	-	28/05/2021	28/05/2021	28/05/2021	28/05/2021
Chloride, Cl 1:5 soil:water	mg/kg	160	950	<10	2,800
Sulphate, SO4 1:5 soil:water	mg/kg	130	160	<10	390

ESP/CEC				
Our Reference		269953-1	269953-4	269953-6
Your Reference	UNITS	TP11	TP14	TP15
Depth		0.4-0.5	0.4-0.5	0.4-0.5
Date Sampled		21/05/2021	21/05/2021	21/05/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	01/06/2021	01/06/2021	01/06/2021
Date analysed	-	01/06/2021	01/06/2021	01/06/2021
Exchangeable Ca	meq/100g	1.1	1.9	4.6
Exchangeable K	meq/100g	<0.1	<0.1	0.3
Exchangeable Mg	meq/100g	5.6	2.6	7.2
Exchangeable Na	meq/100g	1.2	0.70	0.89
Cation Exchange Capacity	meq/100g	8.0	5.2	13
ESP	%	15	13	7

Method ID	Methodology Summary
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	269953-2
Date prepared	-			28/05/2021	1	28/05/2021	28/05/2021		28/05/2021	28/05/2021
Date analysed	-			28/05/2021	1	28/05/2021	28/05/2021		28/05/2021	28/05/2021
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	520	570	9	98	71
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	210	190	10	101	#

QUALITY CONTROL: ESP/CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			01/06/2021	[NT]	[NT]	[NT]	[NT]	01/06/2021	[NT]
Date analysed	-			01/06/2021	[NT]	[NT]	[NT]	[NT]	01/06/2021	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	110	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	107	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

MISC_INORG: Sulphate
High spike recovery was obtained for this sample. Sample matrix interference is suspected. However, an acceptable recovery was obtained for the LCS

Table D1: Summary Table - Laboratory Tests and Assessments

Test Pit	Sample ID	Sample Depth	pH	Chloride Concentration	Sulphate Concentration	Resistivity	Soil Condition	Sample Aggressivity 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
		(m bgl)	(pH units)	(mg/kg)	(mg/kg)	Ω.cm	[AS2159-2009]	[AS2159-2009]				
TP11		0.4 - 0.5	7.9	520	210	3001	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive
TP11		0.9 - 1.0	7.4			1243	B	Non-Aggressive		Non-Aggressive		Mild
TP11		1.4 - 1.5	7.2	1400	270	1272	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Mild
TP11		1.9 - 2.0	7.5			2045	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP11		2.4 - 2.5	7.5			2652	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP11		2.9 - 3.0	7.5			2687	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP13		0.4 - 0.5	7.6	25	200	4566	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive
TP13		0.9 - 1.0	6.5			5302	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP13		1.4 - 1.5	6.6			2768	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP13		1.9 - 2.0	6.8			5552	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP13		2.4 - 2.5	7			8993	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP13		2.9 - 3.0	6.9			7955	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP14		0.4 - 0.5	7	430	210	2536	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive
TP14		0.9 - 1.0	6.7			1703	B	Non-Aggressive		Non-Aggressive		Mild
TP14		1.4 - 1.5	6.4	2000	310	963	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Moderate
TP14		1.9 - 2.0	6.6			1685	B	Non-Aggressive		Non-Aggressive		Mild
TP14		2.4 - 2.5	6.7			2018	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP14		2.9 - 3.0	7			2848	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP15		0.4 - 0.5	8.2	160	130	6250	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive
TP15		0.9 - 1.0	7.7			2296	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP15		1.4 - 1.5	7.7	950	160	2779	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive
TP15		1.9 - 2.0	7.4			1544	B	Non-Aggressive		Non-Aggressive		Mild
TP15		2.4 - 2.5	7.3			1560	B	Non-Aggressive		Non-Aggressive		Mild
TP15		2.9 - 3.0	7.3			1866	B	Non-Aggressive		Non-Aggressive		Mild
TP16		0.4 - 0.5	7.7	10	10	87719	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive
TP16		0.9 - 1.0	7.3			35971	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP16		1.4 - 1.5	6.8			13532	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP16		1.9 - 2.0	8			4507	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP16		2.4 - 2.5	7.5			3346	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP16		2.9 - 3.0	7.3			2563	B	Non-Aggressive		Non-Aggressive		Non-Aggressive
TP17		0.4 - 0.5	6.2	2800	390	540	B	Non-Aggressive	Non-Aggressive	Non-Aggressive	Non-Aggressive	Moderate
TP17		0.9 - 1.0	6			579	B	Non-Aggressive		Non-Aggressive		Moderate
TP17		1.4 - 1.5	6.3			958	B	Non-Aggressive		Non-Aggressive		Moderate
TP17		1.9 - 2.0	6.5			1044	B	Non-Aggressive		Non-Aggressive		Mild
TP17		2.4 - 2.5	6.6			1283	B	Non-Aggressive		Non-Aggressive		Mild
TP17		2.9 - 3.0	6.7			1179	B	Non-Aggressive		Non-Aggressive		Mild

Table D1: Summary Table - Laboratory T

Test Pit	Sample ID	Sample Depth	Exchangeable Sodium (Na) Concentration	Cation Exchange Capacity	Sodicity [Na/CEC]	Sodicity Class	Soil Texture Group (for detailed soil logs see Report Appendix)	Textural Factor (M)	$EC_{1:5}$ [Lab.]	EC_e [M x $EC_{1:5}$]	Sample Salinity Class (Based on sample ECe)
		(m bgl)	(meq/100g)	(meq/100g)	(%)	[after DLWC]	[after DLWC]	[after DLWC]	(microS/cm)	(deciS/m)	[Richards 1954]
TP11		0.4 - 0.5	1.2	8	15	Sodic	Light medium clay	8	333.2	2.7	Slightly Saline
TP11		0.9 - 1.0					Heavy clay	6	804.2	4.8	Moderately Saline
TP11		1.4 - 1.5					Heavy clay	6	786.4	4.7	Moderately Saline
TP11		1.9 - 2.0					Medium clay	7	489.1	3.4	Slightly Saline
TP11		2.4 - 2.5					Medium clay	7	377.1	2.6	Slightly Saline
TP11		2.9 - 3.0					Medium clay	7	372.1	2.6	Slightly Saline
TP13		0.4 - 0.5					Light clay	8.5	219	1.9	Non-Saline
TP13		0.9 - 1.0					Light medium clay	8	188.6	1.5	Non-Saline
TP13		1.4 - 1.5					Light medium clay	8	361.3	2.9	Slightly Saline
TP13		1.9 - 2.0					Light medium clay	8	180.1	1.4	Non-Saline
TP13		2.4 - 2.5					Light medium clay	8	111.2	0.9	Non-Saline
TP13		2.9 - 3.0					Light medium clay	8	125.7	1.0	Non-Saline
TP14		0.4 - 0.5	0.7	5.2	13	Sodic	Clay loam	9	394.3	3.5	Slightly Saline
TP14		0.9 - 1.0					Heavy clay	6	587.3	3.5	Slightly Saline
TP14		1.4 - 1.5					Medium clay	7	1038	7.3	Moderately Saline
TP14		1.9 - 2.0					Light medium clay	8	593.6	4.7	Moderately Saline
TP14		2.4 - 2.5					Medium clay	7	495.6	3.5	Slightly Saline
TP14		2.9 - 3.0					Medium clay	7	351.1	2.5	Slightly Saline
TP15		0.4 - 0.5	0.89	13	7	Sodic	Medium clay	7	160	1.1	Non-Saline
TP15		0.9 - 1.0					Heavy clay	6	435.6	2.6	Slightly Saline
TP15		1.4 - 1.5					Medium clay	7	359.8	2.5	Slightly Saline
TP15		1.9 - 2.0					Light medium clay	8	647.8	5.2	Moderately Saline
TP15		2.4 - 2.5					Medium clay	7	641.1	4.5	Moderately Saline
TP15		2.9 - 3.0					Medium clay	7	536	3.8	Slightly Saline
TP16		0.4 - 0.5					Clay loam	9	11.4	0.1	Non-Saline
TP16		0.9 - 1.0					Medium clay	7	27.8	0.2	Non-Saline
TP16		1.4 - 1.5					Medium clay	7	73.9	0.5	Non-Saline
TP16		1.9 - 2.0					Light medium clay	8	221.9	1.8	Non-Saline
TP16		2.4 - 2.5					Light clay	8.5	298.9	2.5	Slightly Saline
TP16		2.9 - 3.0					Light medium clay	8	390.2	3.1	Slightly Saline
TP17		0.4 - 0.5					Light clay	8.5	1851	15.7	Very Saline
TP17		0.9 - 1.0					Medium clay	7	1726.5	12.1	Very Saline
TP17		1.4 - 1.5					Light medium clay	8	1044	8.4	Very Saline
TP17		1.9 - 2.0					Medium clay	7	957.6	6.7	Moderately Saline
TP17		2.4 - 2.5					Light medium clay	8	779.7	6.2	Moderately Saline
TP17		2.9 - 3.0					Light medium clay	8	848.3	6.8	Moderately Saline