Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Contingency Acid Sulphate Soil Management Plan

Proposed Industrial Development
238-258 Captain Cook Drive, Kurnell

Prepared for
Dicker Data Limited

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Glossary of Terms

AASS	Actual Acid Sulphate Soil
ANC	Acid Neutralising Capacity
ASS	Acid Sulphate Soil (including AASS and PASS) (also known as acid sulfate soil)
ASSMAC	Acid Sulphate Soil Management Advisory Committee
ASSMP	Acid Sulphate Soil Management Plan
bgl	below ground level
DECC	Department of Environment and Climate Change
DWE	Department of Water and Energy
DP	Douglas Partners Pty Ltd
ENV	Effective neutralising value
EPA	Environmental Protection Authority
FF	Fineness factor
GW	Groundwater
m	Metres
mg/kg	Milligrams per kilogram (or parts per million)
NATA	National Association of Testing Authorities
PASS	Potential Acid Sulphate Soil
pH	Unit measure of acidity/ alkalinity
pH_{KCL}	Potassium chloride pH
SPOCAS	Suspension peroxide oxidation combined acidity and sulphate
OSD	On-site Detention
PQL	Practical quantitation limit
RL	Reduced level (m AHD)
SKCl	KCl extractable sulphur
SP	Peroxide oxidation sulphur
SPOS	Peroxide Oxidisable Sulphur
SRAS	Residual Acid Soluble Sulphur
SWL	Standing water level
TAA	Total Actual Acidity
TPA	Total Potential Acidity
TSA	Total Sulphidic Acidity
TSS	Total Suspended Solids

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Contingency Acid Sulphate Soil Management Plan
Proposed Industrial Development
238-258 Captain Cook Drive, Kurnell

1. Introduction

1.1 Purpose and Overview

This Contingency Acid Sulphate Soil Management Plan (ASSMP) has been prepared by Douglas Partners Pty Ltd (DP) for a proposed industrial development at 238 - 258 Captain Cook Drive, Kurnell. DP previously prepared an ASSMP for this site in September 2015 for Kurnell Developments Pty Ltd (*Supplementary Acid Sulphate Management Plan,* DP Project 84677.01.R.001.Rev0, dated 8 September 2015).

This ASSMP has been updated at the request of Mr Geoffrey Hill of Devkon Pty Ltd to reflect the current proposed development and supersedes our previous plan dated 8 September 2015.

The purpose of this ASSMP is to:

- Provide general site coverage to supplement previous targeted assessment by DP;
- Outline the procedures for the identification of acid sulphate soil (ASS);
- Outline the procedures for the appropriate management/mitigation of potential environmental impacts that may result from the disturbance of ASS;
- Outline the procedures for the on-site treatment of ASS;
- Outline the procedures for the off-site disposal of ASS at a licensed facility;
- Provide a monitoring program for validating the effectiveness of the management process; and
- Provide emergency response procedures for potential environmental threats which could occur during ASS management.

This ASSMP has been developed as a contingency plan to provide the method of management in the event that ASS is disturbed by the development.

1.2 Site Identification

The site comprises 238 - 258 Captain Cook Drive, Kurnell. The site covers an approximately rectangular area of 17 hectares. It is bordered by a large warehouse to the north east, Captain Cook Drive to the north-west, bushland to the south east and an unnamed gravel road to the south west. The site is relatively flat, with surface levels in the vicinity of 4 m AHD.

1.3 Proposed Development

It is understood that development of the site comprises the staged construction of a warehouse and office building with associated at grade car parks, hardstands and access driveways. The stage 1 warehouse is approximately 120 m by 190 m in plan dimension. Proposed excavations within these areas may be in the order of 1 m.

2. Acid Sulphate Soils Background and Guidelines

2.1 Background

ASS are naturally occurring sediments containing iron sulphides, primarily pyrite, commonly deposited in alluvial and estuarine environments. The occurrence of ASS is associated with areas or regions that have previously been or are currently estuarine environments. Due to changes in sea level or geomorphologic changes to the coastal systems, these sediments are often overlain by terrestrial sediments.

When ASS are exposed to air (e.g. due to excavation or dewatering), the oxygen reacts with iron sulphides in the sediment, producing sulphuric acid. This acid can be produced in large quantities and is highly mobile in water. The process can also release iron and other metals present in the soils. The sulphuric acid (and metals) can drain into waterways causing severe short and long term socio-economic and environmental impacts, including damage to man-made structures and natural ecosystems.

ASS can either be classified as actual acid sulphate soils (AASS) that have already reacted with oxygen to produce acid, or potential acid sulphate soils (PASS). PASS are soils containing iron sulphide that have not been exposed to oxygen (e.g. soils below the water table). PASS therefore have not produced sulphuric acid, but have the potential to do so if exposure to oxygen occurs.

2.2 Guidelines

This ASSMP has been devised broadly in accordance with the following publications:

- NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), 1998. *Acid Sulfate Soil Manual* (ASSMAC, 1998);
- NSW Environmental Protection Authority (EPA), 2014. *Waste Classification Guidelines* (EPA, 2014); and
- Ahern CR, McElnea AE, Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines*. Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia (Ahern et al, 2004).

Reference has also been made to the following document:

- Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., 2014. *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines*.

Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government. (Dear et al, 2014).

The thresholds for determining the need to manage ASS are provided in Table 1. The Action Criteria are not the appropriate thresholds for determining if treated ASS has been successfully neutralised.

Table 1: Thresholds for ASS Assessment (ASSMAC 1998)

Material Type	Potential + Actual Acidity / Net Acidity	
	Equivalent Acidity (mol H+/tonne) (oven-dry basis)	Equivalent Sulphur (%S) (oven-dry basis)
ASSMAC Action Criteria for disturbance of 1 – 1000 tonnes		
coarse textured material i.e. sands to loamy sands	18	0.03
medium textured material i.e. sandy loams to light clay	36	0.06
fine textured material i.e. medium to heavy clays and silty clay	64	0.1
ASSMAC Action Criteria for disturbance of more than 1000 tonnes		
all textures	18	0.03

3. Regional Mapping and Previous Assessments

3.1 Regional Geological Mapping

Reference to the Wollongong - Port Hacking 1:100,000 Geology Sheet indicates that the site is underlain by Pleistocene transgressive dunes, typically comprising fine to very fine quartzose sand. The south eastern boundary of the site is located close to the boundary with swamp land, typically comprising peat, sandy peat and mud.

Reference to the corresponding 1:100,000 Soils Landscape Sheet indicates that the site is underlain by disturbed terrain, typically comprising level plain to hummocky terrain extensively disturbed by human activity. The south eastern boundary of the site is located close to the boundary with aeolian soils of the Kurnell association, typically comprising gently undulating to rolling coastal sand dunes.

Reference to the New South Wales 1:25,000 Acid Sulphate Soil Risk Mapping 1994 – 1998 indicates that the main development area in the north-west and central portions of the site is mapped as disturbed terrain, with soil investigations required to assess the area for ASS. The undeveloped parts of the site in the north east, south east and south west are mapped as having a high probability of

occurrence of ASS at depths of 1 m to 3 m below the ground surface. There will be a risk to the surrounding environment if ASS materials are disturbed by excavation activities.

3.2 Previous Assessments

DP has previously carried out a geotechnical investigation for assessment of hydraulic conductivity and acid sulphate soils in proposed infiltration areas of the site:

- DP *Report on Geotechnical Investigation Proposed Industrial Development, 238 - 258 Captain Cook Drive, Kurnell* (Project 84677, Document 1, February 2015) [DP 2015a].

The investigations included the drilling of six boreholes (BH1 to BH6), with four of these terminated in sandy soils at 3 m depth and the other two encountering auger refusal on sandstone at depths of 0.8 m and 2.5 m. The previous borehole locations are shown on Drawing 1 in Appendix B.

The boreholes generally encountered brown silty sand and clayey sand filling to depths of between 0.1 m and 0.3 m, overlying grey and brown sand, silty sand and clayey sand to depths of between 0.5 m and 3.0 m, overlying grey and grey-orange sandstone which was encountered in BH2 and BH4 only at depths of 0.5 m and 1.2 m respectively. Groundwater was observed whilst drilling at depths of approximately 1.5 m to 2.5 m, except in BH2 where groundwater was observed at 0.5 m depth and BH4 where no groundwater was observed down to the final depth of 2.5 m. The borehole logs from the previous investigations are presented in Appendix C.

Thirty-six soil samples (detailed in Appendix D) collected from BH1 to BH6 were screened by a NATA accredited laboratory to assess the potential for ASS on the site. Based on the results of the screening tests, six samples were then subjected to Suspension Peroxide Oxidation and Combined Acidity and Sulphate (SPOCAS) testing at a NATA accredited laboratory. The results of these tests were assessed against the action criteria triggering the need for an ASSMP, outlined in Table 4.4 of the New South Wales Acid Sulphate Soils Management Advisory Committee (ASSMAC) *Acid Sulphate Soil Manual* (1998).

Assessment of the SPOCAS laboratory test results against the ASSMAC action criteria indicated that an ASSMP was required for excavation and/or dewatering activities within some of the soils encountered on site. The action criteria were exceeded in tests conducted on brown and grey-brown silty sand present in BH3 below 2.2 m depth and in BH6 below 2.3 m depth.

DP produced an ASSMP in the following report:

- DP *Report on Acid Sulphate Soil Management Plan, Proposed Industrial Development, 238 - 258 Captain Cook Drive, Kurnell* (Project 84677, Document 2, February 2015) [DP 2015b].

3.3 Current Assessment

This supplementary assessment was requested by council as the previous assessment targeted areas of proposed excavation only and did not provide assessment of the entire site. The current assessment had a vertical investigation limit of 2 m bgl as opposed to 3 m bgl in DP 2015a, as the general excavation depth across the site is expected to be approximately 1m bgl outside the excavation areas targeted in DP 2015a.

The investigations included the drilling of 22 boreholes (BH101 to BH122), with all bores terminated in sandy soils at 2 m depth with the exception of BH105 which encountered auger refusal on sandstone at 1.6 m. The borehole locations are shown on Drawing 1 in Appendix B.

The boreholes generally encountered brown silty sand and clayey sand filling to depths of between 0.15 m and 2.0 m, overlying grey and brown sand and silty sand to from surface level to a depth of 2.0 m. Sandstone was only encountered in BH105 at a depth of 1.6 m. Free groundwater was not observed whilst drilling to depths of approximately 2.0m, however soils were often moist to wet from 1.5m. The borehole logs are presented in Appendix C.

106 soil samples (detailed in Appendix D) were collected from BH101 to BH122 and screened by a NATA accredited laboratory to assess the potential for ASS on the site. Based on the results of the screening tests, ten samples were then subjected to Suspension Peroxide Oxidation and Combined Acidity and Sulphate (SPOCAS) testing at a NATA accredited laboratory.

Assessment of the SPOCAS laboratory test results against the ASSMAC action criteria indicated that no ASS were present at the borehole locations to a maximum depth of 2.0m.

4. Results

The results of Acid Sulphate Screening and SPOCAS testing are presented in Appendix D.

5. ASS Occurrence at the Site

The current investigation which included the drilling of 22 boreholes to a depth of 2m or prior refusal did not detect any ASS with the top 2m soil profile of the site.

In the previous investigation (DP, 2015a) ASS was positively identified in the two samples tested from a depth of 3 m (BH3 and BH6), with none of the four samples tested from 2.0 m or 2.5 m depth recording ASS above the Action Criteria. Based on interpretation of the borehole logs, SPOCAS and field screening results, materials possibly containing ASS are considered to have been encountered from depths of approximately 2.2 m in some locations, or below the water table.

Based on expected depth of ASS, and the proposed excavation depth of 1.0 m, ASS is not expected to be encountered during the main excavation works at the site. ASS may, however, be encountered/ disturbed in the following scenarios:

- ASS being present higher in the profile than identified in the current assessment or DP (2015a). This could occur between sample locations due to heterogeneous subsurface conditions;
- Local deeper excavation (e.g. piling work or excavation for pits and tanks); or
- Dewatering below the depth to ASS.

The below interpretation of ASS occurrence is based on results from DP (2015a) and the current assessment, with the borehole locations shown on Drawing 1, Appendix B. Based on the results it is

considered that the following materials have an elevated risk of containing ASS and should be assumed to be ASS unless further investigation confirms otherwise:

- Brown and grey silty sand below the water table. ASS at the site may or may not have organic odours.
- Similar material immediately above the water table may also contain ASS.

6. Management Strategy

Based on the proposed excavation depth being above the depth at which ASS/ suspected ASS has been encountered in the sample locations, the management strategy for ASS at the site comprises:

- Identify where suspected ASS material may be or have been encountered during excavation works;
- Identify where suspected ASS material may be or have been impacted by dewatering; and
- If suspected ASS will be or has been disturbed, undertake further assessment to confirm the presence/ absence in the area/ depth of concern; and
- If the further assessment confirms that ASS will be or has been disturbed, implement one or more of the contingency plans detailed in the below sub-sections.

This will be done as follows:

Prior to Commencement of Excavation/ Dewatering:

- Review results of DP (2015) with respect to final plans for any proposed excavation and dewatering. Obtain advice from a geotechnical/ environmental consultant if required;
- If the review indicates that ASS may potentially be disturbed, undertake further assessment to confirm the presence/ absence of ASS in the area of concern, or assume that the material is ASS for planning purposes. It is considered that further assessment should be undertaken prior to commencement of works to allow appropriate planning;
- Further assessment would comprise test pitting in the area of concern and testing of the materials considered to possibly contain ASS; and
- If ASS is identified or assumed to be present in a location which will be disturbed by excavation or dewatering, determine the appropriate contingency plan(s) from those detailed in the below subsections.

During Excavation/ Dewatering:

Any materials confirmed or assumed to be ASS are to be managed in accordance with the applicable below contingency plan(s). The applicable contingency plans are likely to including at least one soil contingency plan and the surface and groundwater contingency plan. Materials confirmed or assumed to be ASS will include:

- Materials confirmed to be ASS based on testing prior to or during excavation/ dewatering works;
- Materials assumed to be ASS based on the review of previous results prior to excavation/ dewatering works in the absence of any further testing results; and

- Materials considered to possibly be ASS based on observations during excavation/ dewatering works in the absence of any further testing results. Materials should be inspected during excavation and if any materials are assumed to possibly contain ASS, obtain advice from a geotechnical/ environmental consultant if required.

6.1 Soil Contingency Plan 1 – Direct Disposal of Untreated PASS

This strategy involves excavation of PASS and direct trucking of the untreated PASS to a facility licenced to receive it. This option is only applicable to PASS in natural soils (i.e. not to AASS or to any filling material), that are not contaminated and only if the PASS is managed in accordance with Part 4 (Acid Sulphate Soils) of EPA (2014). This option will only be able to be implemented if the status and properties of the ASS have been determined prior to excavation. Based on the results to date, ASS identified in at the site is likely to be suitable for management using this option based on the ASS results; however, this is subject to assessment for potential contamination.

At the time of preparation of this ASSMP one facility in Sydney was licenced to receive untreated PASS. This facility is located in Kurnell and operated by Besmaw Pty Ltd. The EPA can be contacted on 131 555 to provide updated information on appropriately licenced landfills.

In addition to this ASSMP, specific requirements of EPA (2014) and the receiving facility must also be complied with.

Prior to this option being adopted an agreement must be made with the receiving facility to accept the materials. The agreement should detail the requirements for the management of the material to allow it to be accepted and the protocol and responsibility for the treatment and handling of any material rejected by the facility (i.e. due to it arriving at the facility in a condition which the facility cannot accept).

6.1.1 On Site Management, Monitoring and Transport

The following works are required:

- For soils loaded directly into a truck: Sampling and testing of field pH of at least one sample per truck load of untreated material to confirm the pH is greater than the receiving site acceptance requirements (i.e. pH ≥ 5.5 at the time of arrival);
- For soils stockpiled prior to loading into a truck: Given the higher risk of oxidation for stockpiles soils, sampling and testing of field pH of at least three samples per truck load of untreated material to confirm the pH is greater than the receiving site acceptance requirements (i.e. pH ≥ 5.5 at the time of arrival);
- Any materials with a field pH of less than 5.5 are not suitable for disposal as untreated PASS and must be managed in accordance with Section 6 or 7. Note some lowering of the field pH is likely to occur during transport, and as such the contractor may wish to consider an alternative management option for PASS with a field pH close to this limit (e.g. a field pH of 5.5 - 6 depending on soil type and pH screening results) in accordance with Section 6.2 or 6.3;
- Management of leachate/ runoff water potentially impacted by ASS in accordance with Section 6.4;

- All PASS must be kept wet during excavation and transport. Materials should be sprayed with water as required to keep them wet. Transport must be conducted in a sealed/lined truck to prevent water leaking from the truck during transport. Given the material will be wet, it will be heavy (estimated to be approximately 2 t/m^3), and this should be taken into account in loading of trucks to ensure they are not overweight;
- PASS must be transported to the receiving facility with minimal delay. All PASS must arrive at the receiving facility no more than 16 hours after excavation, but should be preferably excavated directly into trucks and taken to the receiving facility without delay to reduce the potential for the material to dry out and oxidise, thus reducing the pH (and potentially resulting in the rejection of the material by the receiving facility);
- Full time inspection of excavation and truck loading procedures by either a dedicated site engineer or an environmental consultant to confirm the works are carried out according to general good works practice and with the intention to minimise the aeration (i.e. oxidation) of the PASS, and to undertake the field pH testing and prepare documentation to be sent to the receiving facility with the truck;
- Documentation is to be sent with each truck load detailing the soil's excavation, transport and handling procedures and timing as well as the field pH recorded on site and the time the truck left the site. A copy of this documentation will also be kept on site. The documentation is to show that the PASS management has been conducted in general accordance with this ASSMP and EPA (2014) and have appropriately mitigated oxidation of the PASS. This documentation is to be provided to the receiving facility in accordance with the requirements of EPA (2014). It is expected that the receiving facility will have a standard pro-forma for the documentation required;
- Direct transport routes should be used to minimise transport times; and
- Once the PASS has been accepted by the receiving facility they are required to manage it in accordance with their licence conditions. It is not the role of this document to discuss management of material once it has been accepted by the receiving facility.

6.1.2 The Receiving Facility Acceptance Criteria

EPA (2014) only allows untreated PASS to be accepted if it has not dried out and if it has a pH equal to or greater than 5.5.

6.2 Soil Contingency Plan 2 – On-Site Treatment

This strategy comprises on-site treatment and can be applied to all materials containing ASS. On-site neutralisation, management, monitoring and validation of ASS should be undertaken as required using the methodology given below. Following on-site treatment, the material could be re-used on site or be disposed off-site.

6.2.1 Prior to Excavation

On-site treatment will require preparation of a Treatment Area(s), Stockpiling Area(s) and Leachate Collection Area(s).

Allowances should be made during construction planning to resume sufficient land to allow for these items. Leachate collection location, lining and construction should be similarly pre-planned.

Figure 1, below, shows a cross section of a typical treatment pad.

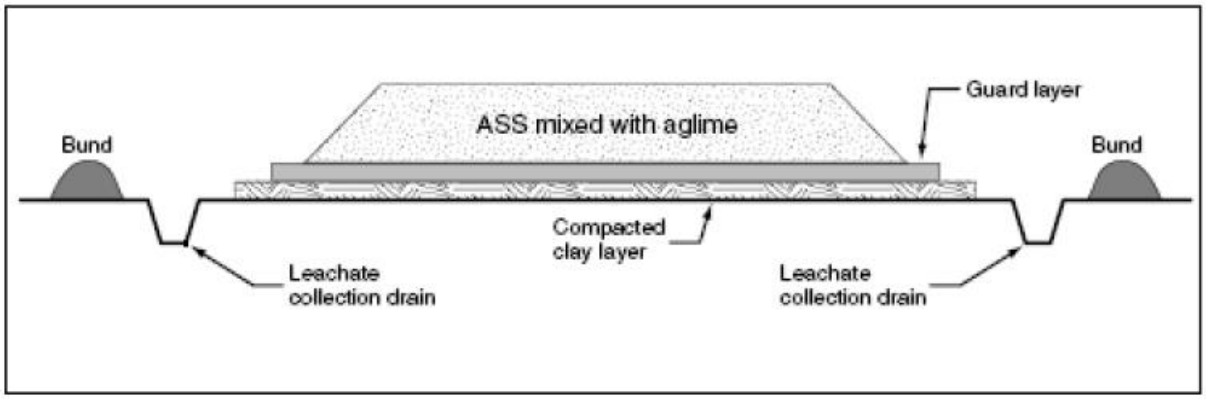


Figure 1: Schematic cross-section of a treatment pad, including clay layer, guard layer, leachate collection system and containment with bunding[1]

These areas should be prepared as follows:

- Prepare a treatment pad and (if required) stockpile pad of appropriate area for the volume of soil to be treated/stored. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues, with a natural (or shaped) fall to the local drainage sump;
- Lining of the surface of the pad with selected compacted clay (at least two layers to a combined compacted thickness of 0.5 m) or a geosynthetic liner as approved by the environmental consultant. A concrete pad may also be suitable subject to the construction details and location and subject to the approval of the environmental consultant;
- Apply a guard layer of fine agricultural lime ('ag lime') over the compacted clay or geosynthetic liner, to neutralise downward seepage. This guard layer of lime should be applied at a rate of 5 kg[2] ag lime/m^2 of surface area of the pad/metre height of stockpile, i.e. if a treatment stockpile height of 3 m is proposed, the guard layer would need to comprise 15 kg of ag lime per m^2 of surface area. The guard layer should be re-applied following removal of treated soils prior to addition of untreated ASS; and
- Liming pads should be bunded and a circumference drain excavated to collect and contain leachate. The drain and inner bund slopes should be lined with impermeable material and covered with a layer of fine lime applied to neutralise any possible leachate migrating from the stockpiled material. The drain should direct water into an appropriately sized detention basin, the base of which has been prepared in the same manner as the liming pad. Alternatively water from the drain can be pumped into on-site tanks for storage, testing and treatment.

[1] Figure reproduced from Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., 2014. *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines*. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government. (Dear et al, 2014).
[2] Based on the recommendations of Dear et al (2014)

6.2.2 Treatment Process

- Prepare a treatment/ stockpiling pad in accordance with Section 6.2.1;
- Remove non-ASS overburden from the area containing ASS if material types can be separated during works;
- Transport ASS material requiring treatment to the treatment area in sealed trucks;
- Manage ASS during stockpiling and treatment to minimise dust and leachate generation (e.g. by covering, or lightly conditioning with water). If wet weather prevails, stop works and cover the stockpiled material with a plastic sheet to reduce the formation of leachate;
- Spread the ASS onto the guard layer in a layer of 0.2 to 0.3 m thickness, leaving a 1 m flat area between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the lime guard layer;
- Let the ASS dry to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be undertaken);
- Apply ag lime (refer to Section 6.2.3) to the stockpiled soil, at the indicative liming rate in Section 6.2.4 and harrow/ mix thoroughly prior to spreading the next layer;
- Continue the spreading/liming/mixing cycle. This can be done one layer at a time, or with multiple ASS layers placed on top of each other;
- Assess the success of the treatment using verification testing in accordance with Section 6.2.5. Samples will need to be collected from all layers, which is likely to require use of plant for sampling. The verification testing has two components: field screening and laboratory analysis. Laboratory analysis will only be undertaken after the field screening results have passed;
- If verification sampling indicates that additional neutralisation is required, add additional lime and mix;
- When verification testing indicates that lime neutralisation is complete, then the stockpiled soil may be removed from the treatment pad;
- Re-use the treated ASS on-site or undertake waste classification assessment and dispose off-site in accordance with Sections 6.2.7 and 6.2.8; and
- Management of leachate water in accordance with Section 6.4.

6.2.3 Neutralising Materials for Soils

Agricultural lime commonly known as ag lime is the preferred neutralisation material for the management of ASS, as this material is usually the cheapest and most readily available product for acid neutralisation. Furthermore, ag lime is slightly alkaline (pH of 8.5 to 9), non-corrosive, of low solubility and does not present handling problems. Ag lime comprises calcium carbonate ($CaCO_3$), typically made from limestone that has been finely ground and sieved to a fine powder.

It is generally preferable if an ag lime with a purity of 95% or better is used (i.e. NV >95, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated NV = 100). The ag lime should be fine and dry, as texture and moisture can also decrease the effective neutralising value. Ag lime with a NV of 95% to 98% is usually used. There could be economic justification for using a less pure grade of ag lime,

however, this would require a higher application rate, requiring the lime dosing rates given in Section 6.2.4 to be adjusted by a factor of 100/NV. Potential cost savings from using less pure material may be offset by the corresponding increase in the transport and disposal costs.

Coarse grained calcite is not recommended, as one of the products of the neutralisation reaction is gypsum ($CaSO_4.2H_2O$) which has a relatively low solubility and tends to coat the reacting calcite grain, forming a partial barrier against further reaction.

Gypsum may also give off hydrogen sulphide if in reaction with acidic conditions and can itself result in the generation of sulphuric acid.

Dolomitic ag lime, or magnesium blend ag lime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.

An alternative neutralising material can be used subject to prior approval by a suitably qualified scientist or engineer.

6.2.4 Lime Application Rate

Based on the "worst case" results of the SPOCAS analysis to date, and assuming the use of 95% NV ag lime, the recommended initial treatment rate of 130 kg of lime per tonne of ASS as calculated by the laboratory as part of the SPOCAS analysis.

If specific laboratory results are available for a "batch" of ASS, a liming rate based on these results may be used.

It is noted that the acid production will vary both horizontally and vertically through the ASS profile due to the variability of natural systems. The liming rate to be calculated from the analytical results should therefore be considered as a "starting point", and pH monitoring should be conducted during treatment to assess the progress of the neutralisation, and need for additional mixing and/ or addition of ag lime. Material will only be considered to have been successfully treated when all soil has been validated in accordance with Section 6.2.5.

If an alternate neutralising product is used, a specific dosing rate will need to be calculated. The required dosing rate should be calculated from one of the following formulas.[3]

Equation 1:

Neutralising Material Required (kg CaCO3/tonne soil) = Net acidity (S% x 30.59) x 1.02 x FOS x 100/ENV

Equation 2:

Neutralising Material Required (kg CaCO3/m3 soil) = D (tonne/m3) x Net acidity (S% x 30.59) x 1.02 x FOS x 100/ENV10

[3] Sourced from WA Department of Environment and Conservation *Treatment and management of soils and water in acid sulfate soil landscapes* (July 2011)

Where:

%S = net acidity (% S units). This value is obtained from the SPOCAS/ chromium suite analytical results and should be the "worst case" result of the acid or sulphur trails of all samples;

30.59 converts to kg H2SO4/tonne

1.02 is used to stoichiometrically convert units of sulfuric acid (H2SO4) to units of calcium carbonate (CaCO3).

FOS (factor of safety) = a minimum value of 1.5 needs to be adopted, although values of up to 2 can be suitable;

ENV = Effective Neutralising Value (e.g. Approx. 95% for fine ag lime).

Notes:

- The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with ASSMAC (1998);
- The "worst case" of the acid or sulphur trail results should be used. Where the acid trail is used the mol H+/t should be converted to %S as per the formula given above.

Whilst the above formulas are provided, the environmental consultant will provide the liming rate based on the soil analysis results. The WA Department of Environment Regulation also provides a calculator for liming rates at http://www.der.wa.gov.au/your-environment/acid-sulfate-soils/.

6.2.5 Validation Testing

Validation of works should be conducted as follows:

- During and following neutralisation, the soils will require pH screening to confirm that the appropriate quantities of lime have been added and the soils have been suitably mixed/blended. The pH testing should be undertaken on the treated material at the following frequency:
  - One sample per 25 m^3 of treated soil or a minimum of six samples per treatment batch (for field and oxidised pH screening tests);
- Once the pH screening results all meet the criteria given in Section 6.2.6, laboratory validation testing will be required at the following rate:
  - At least one sample per 1,000 m^3 or at least one per batch of treated material, whichever is greater (the sample(s) with the "worst case" pH screening results should be selected for laboratory analysis). The laboratory testing can comprise the SPOCAS or the full Chromium Suite analytical method. It is noted that the fastest turnaround of analytical results is three days from receipt of the sample at the laboratory (with the timing generally commencing from the morning after the samples are received by the laboratory), and this timing may not always be available from the laboratory. This should be taken into account to ensure adequate on-site storage is available for treated and untreated ASS; and
- Compare the validation results with the acceptance criteria given in Section 6.2.6. If all results meet the acceptance criteria, the ASS will be considered to have been successfully treated.

6.2.6 Acceptance Criteria for Treated ASS

The acceptance criteria are based on the results of "field" and peroxide pH testing and laboratory testing. ASS will be considered to have been successfully treated when all of the following are met:

- field pH (i.e. field pH in water) is ≥ 5.5 (and preferably ≤8.5 for any materials to be re-used on-site);
- peroxide pH (i.e. pH after forced oxidation) is ≥ 6.5;
- pH_{KCL} is ≥ 6.5;
- TAA = 0;
- TPA = 0 (preferably, although TPA<ANC may be considered suitable subject to specific assessment); and
- Net acidity is < 0.

The net acidity is calculated from SPOCAS/ chromium suite analytical results as follows:

Net Acidity ($\%_{Sulphur}$) = (S_{pos} or S_{Cr}) + TAA + S_{RAS} – ANC / FF

Further treatment of the soil will be required if any of the above conditions are not met.

6.2.7 On-Site Re-Use of Treated ASS

The treated material will be suitable for re-use on site subject to the final pH not presenting a risk to the environment or building materials for its proposed placement location.

The treatment process can result in elevated pH of soil (e.g. greater than pH 8.5), which may potentially impact plant growth.

If on-site re-use is proposed, individual batches of treated soil should be assessed for their suitability to remain on site.

6.2.8 Disposal of Treated ASS

Waste classification of treated ASS material to be disposed of off-site is to be conducted in accordance with EPA (2014) and the *Protection of the Environment Operations (POEO) Act* 1997 (the POEO Act 1997).

With regard to ASS, Part 4 (Acid Sulphate Soils) of EPA (2014) states that ASS must be treated (neutralised) prior to acceptance by a landfill (unless it is to be disposed of as “PASS” to an appropriately licensed landfill). After treatment the soil should be chemically assessed in accordance with Part 1 of EPA (2014). This will determine whether any other contaminants are present in the material. When the classification has been established, the soil should be disposed of to a landfill that can lawfully accept that classification of waste. The treated ASS would (at a minimum) be classifiable as General Solid Waste, however, chemical testing needs to be conducted to confirm the classification prior to disposal and a higher classification could apply.

Prior arrangements should be made with the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the ASS has been treated in accordance with the neutralising techniques outlined in an ASSMP produced in accordance with ASSMAC (1998) and that the waste has also been classified in accordance with EPA (2014).

6.3 Soil Contingency Plan 3 - Off-Site Treatment

This strategy comprises off-site treatment and can be applied to all materials containing ASS. This is likely to be the most expensive management option for the ASS.

6.3.1 Prior to Excavation

Prior to disturbance of potential ASS, the following will be undertaken:

- Identification of a suitable, appropriately licenced treatment facility. It is advised that the waste generator is responsible for ensuring that waste is disposed to a facility/ site which is legally able to accept it, as required by the POEO Act 1997;
- Provision of test results to the facility;
- Determining and addressing any specific requirements of the treatment facility, and amending this ASSMP as required to check that all requirements are met; and
- Confirming that the treatment facility will accept ASS from the site on the dates required.

6.3.2 Management and Transport

- Excavation and disposal of non-ASS overburden from the area containing ASS if material types can be separated during works;
- Any ASS material requiring transport to the treatment facility should be loaded directly into sealed trucks (sufficient to contain any water draining from the soils) and covered. Given that the soil is likely to be wet, and as such heavier than dry soils, it is critical that an accurate estimate of the weight of the material is made so that trucks are not overloaded. If the material is to be stockpiled overnight on-site prior to transport, it will need to be stockpiles in an area prepared in the same manner as the liming pad described in Section 6.2.1;
- Transport of the ASS to the waste facility by a direct route to minimise transport time; and
- Management of leachate water and groundwater in accordance with Section 6.4.

6.3.3 Treatment

The treatment facility must manage, treat and dispose of the ASS in accordance with their licence conditions.

6.4 Contingency Plan for Surface Water and Groundwater Management

Water is the main mechanism by which acid and metals from oxidised ASS are mobilised and transported. Careful management of water is therefore paramount to effective management of potential adverse impacts from ASS.

The below sections provide strategies for management, assessment and disposal of water which has been in contact with the ASS. This could comprise water leaching from the ASS or surface water. The proposed works are not expected to require significant groundwater dewatering.

Management of water is of particular concern at the subject site given the shallow water table and the sandy soils, allowing surface water to readily infiltrate into the groundwater.

6.4.1 Leachate and Surface Water Collection

All water that has been in contact with ASS/ assumed ASS must be managed, assessed, treated and appropriately disposed of.

Water from the ASS treatment/ storage area should be collected in the lined drains/ detention basin constructed in accordance with Section 6.2.1, or in a tank. The stored water should not be in direct contact with groundwater or surface water, and should be stored away from overland flow paths. Any other water which may have come into contact with ASS should be collected in an on-site detention basin/ tank.

All water which has potentially come into contact with ASS requires management in accordance with the below sections.

6.4.2 Dewatering Management

No significant dewatering is expected to be required for the proposed development.

If any localised dewatering is required, the methods used should be chosen to minimise lowering of the water table beyond the excavation footprint both spatially and temporally.

Any water extracted as part of dewatering would need to be collected, assessed and treated in accordance with this section as having potentially been impacted by ASS.

6.4.3 Water Assessment

All water which has potentially come into contact with ASS requires assessment (and if necessary treatment) for the parameters listed in Table 2, below, as a minimum. This table also details the recommended monitoring frequencies and target thresholds.

Table 2: Suggested Water Monitoring Frequencies and Target Levels for Disposal to Stormwater

Test	Frequency	Target Level for Disposal to Stormwater
pH	Field measurement: • During storage as required to allow timely treatment; • Immediately prior to disposal; and • Daily checks during discharge period.	• pH 6.5 – 8.5
Total Suspended Solids (TSS)	Field measurement: • Immediately prior to disposal; and • As required based on visual observations; and	• water observed to be clear; • Turbidity <50 NTU

Test	Frequency	Target Level for Disposal to Stormwater
	Visual assessment: • Daily during discharge period.	
Oil and Grease	Visual assessment: • Immediately prior to disposal; and • Daily checks during discharge period; and Laboratory analysis: • As required based on visual observations.	• None observable • <10 mg/L
Iron (total and soluble)	Laboratory analysis: • Immediately prior to disposal; and • Weekly checks during discharge period; and • As required based on visual observations; and Visual assessment: • Daily during discharge	• ≤ 0.3 mg/L filterable iron • No obvious sign of iron staining/ settlement
Metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, zinc)	Laboratory analysis: • One round of testing before first disposal; • If first round of testing exceeds target levels then further testing prior to disposal is required	• ANZECC (2000) Trigger Levels for 95% Level of Protection for freshwater ecosystems
Contaminants of Concern	Laboratory analysis: • One round of testing before disposal for any water which has come into contact with contaminated/ potentially contaminated soil or water	• As required, based on what contaminants of concern (e.g. in soil or groundwater) the water has potentially been impacted by. This may include, inter alia, TRH, BTEX, metals or VOC

6.4.4 Treatment

Treatment of water from construction sites is commonly required for pH and total suspended solids (TSS). Aeration and removal of TSS also generally decreases metal concentrations in the water. Standard industry treatment methods and commercial treatment products are suitable for the site and are likely to provide the most efficient treatment.

If a suitable treatment method for man-made contaminants in the water (e.g. oil and grease or metals) cannot be implemented, an alternate disposal method may be required (e.g. to trucking off-site to a liquid waste disposal facility or disposal to sewer in accordance with a specific Trade Waste Agreement which would need to be obtained from Sydney Water).

6.4.5 Water Disposal

Water requiring off-site discharge should be disposed of in accordance with the POEO Act 1997, relevant guidelines, consents and licences. Consent for discharge should be obtained from the relevant authorities, where appropriate. The approval body for discharge into the stormwater system is the local Council.

6.4.6 Groundwater Monitoring

If ASS below the water table is disturbed by excavation or dewatering, the groundwater could be impacted by leaching of pH or metals from oxidised ASS. As such monitoring of groundwater for potential impacts would be required in these circumstances.

The groundwater monitoring should include wells in the vicinity of/ down gradient of ASS treatment area(s), and excavations were ASS is being excavated.
During excavation or treatment of ASS, weekly monitoring of groundwater should be conducted from three locations (across the site). Monitoring of pH will be used as an initial screen.

If a drop in pH of more than 0.5 pH units below the measured background pH is observed at any time during the monitoring programme, the measures detailed in Section 7 must be implemented.

7. Emergency Response Procedures

Construction activities which may cause potential environmental threats are summarised in Table 3 below, together with recommended “Emergency Response Procedures”.

Table 3: Contingency and Emergency Response Procedures

Construction Activity	Potential Environmental Threat	Emergency Response
Bulk excavation into ASS	Flooding of open excavation causing adjacent groundwater levels to rise, leading to potential acid leachate once the excavation is drained	• Inform site foreman and project manager/environmental representative; • Determine pH of groundwater / floodwater in excavation; • Correct groundwater / floodwater pH to bring pH in range of 6.5 to 8.5; • Drain pit to tanks/ basins for water quality assessment prior to discharge.

Construction Activity	Potential Environmental Threat	Emergency Response
Stockpiling / neutralisation of ASS	Stockpile washes or slips outside of bunded lime pad	• Inform site foreman and project manager/environmental representative; • Estimate volume of material breeching bund; • Conduct pH analysis of adjacent surface water (if potentially impacted); • Correct pH in any adjacent surface water (if impacted); • Move breeched soil into a bunded limed pad; • Over-excavate contaminated area to 0.2m depth, apply and mix lime at rate as for guard layers (5kg ag lime per m^2 of surface).
	Breach in stockpile containment bund	• Inform site foreman and project manager/environmental representative; • Close breach in bund; • Conduct pH analysis of adjacent surface water (if potentially impacted); • Correct pH in any adjacent surface water (if impacted);
Dewatering/ ASS excavation/ ASS treatment	Groundwater pH decrease by 0.5-1 pH unit below background	• Increase pH monitoring to every second day; • Undertake groundwater assessment of metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, zinc and iron); • Assess possible cause(s) of pH drop; • Implement measures to prevent further decrease in pH.
	Groundwater pH decrease by more than 1 pH unit below background	• As per pH drop of 0.5-1; and • Assess the need for corrective measures to increase pH to background level.

For all construction incidents which pose an environmental threat, an incident report must be completed in order that:

- The cause of the incident may be determined; additional control measures may be implemented; and
- Work procedures may be modified to reduce the likelihood of the incident re-occurring.

8. Protection of Engineered Materials in Contact with ASS

If engineered materials which are sensitive to acid are to be installed in excavations near where ASS has been exposed a “guard layer” should be placed to protect these materials. Following completion of the excavation, the newly exposed ASS should be covered with a guard layer (which can also serve

as a working platform) to counteract the generation of acidic leachate due to the soils being exposed to air. This layer could be constructed of crushed recycled concrete mixed with limestone to form a 300 mm thick layer.

9. Responsibilities

The responsible party for the main issues relating to ASS management are presented in Table 4. This section does not cover responsibilities related to general construction site activities.

Table 4: Responsibilities

Issue	Responsibility	Verified by / Subject to the Approval of:-
Implementation of this ASSMP	Contractor	Principal Contractor
Monitoring	Contractor / Environmental Consultant	Environmental Consultant
Liaison with landfill operator	Contractor	Principal Contractor
Record keeping	Contractor	Principal Contractor/ Environmental Consultant
Corrective action for non-compliance	Contractor	Principal Contractor/ Environmental Consultant
Changes to ASSMP	Environmental Consultant	Principal Contractor

10. Reporting

ASSMAC does not require formal reporting of ASS management; however, it is important to keep records of implementation of this ASSMP, including any management and validation process to show compliance with the guidelines. The records should be provided to the Project Principal, and to the consent authority upon request. The records should include documentation of review/ inspection for possible/suspected ASS material in any areas of excavation/ dewatering, and details of any treatment/ management and off-site disposal of ASS materials. This would include records showing that any treated materials were successfully validated.

11. Conclusion

Whilst ASS has been recorded at the site, it has been identified below the expected level of excavation, and as such is not expected to be disturbed by the proposed development works.

However, there may be some potential for disturbance, as discussed in Section 5 of this ASSMP.

This ASSMP has therefore been developed as a contingency plan to provide the method of management in the event that ASS is disturbed by the development.

It is considered that implementation of this ASSMP if required (i.e. triggered by the eventualities outlined in Section 5) will enable appropriate management of the associated potential risk related to the potential disturbance of ASS during the proposed development.

12. Limitations

Douglas Partners (DP) has prepared this plan for this project at 238-258 Captain Cook Drive, Kurnell, in accordance with DP's email proposal dated 21 August 2018 and acceptance received from Mr Geoffrey Hill of Devkon Pty Ltd (acting on behalf of Dicker Data Limited) dated 21 August 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Dicker Data Limited for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of 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 sub-surface 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. Sub-surface 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. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This plan must be read in conjunction with all of the attached 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 the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role

respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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

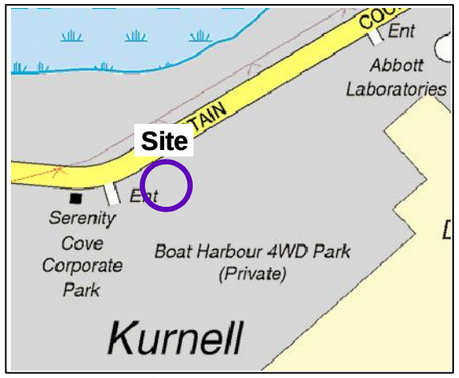
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate 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.

Appendix B

Drawings



Locality Plan

0 10 20 30 40 60 80 100 150 200 250m

1:2500 @ A3

NOTE:
1. Base drawing from Nearmap.com
2. Test locations are approximate only

LEGEND

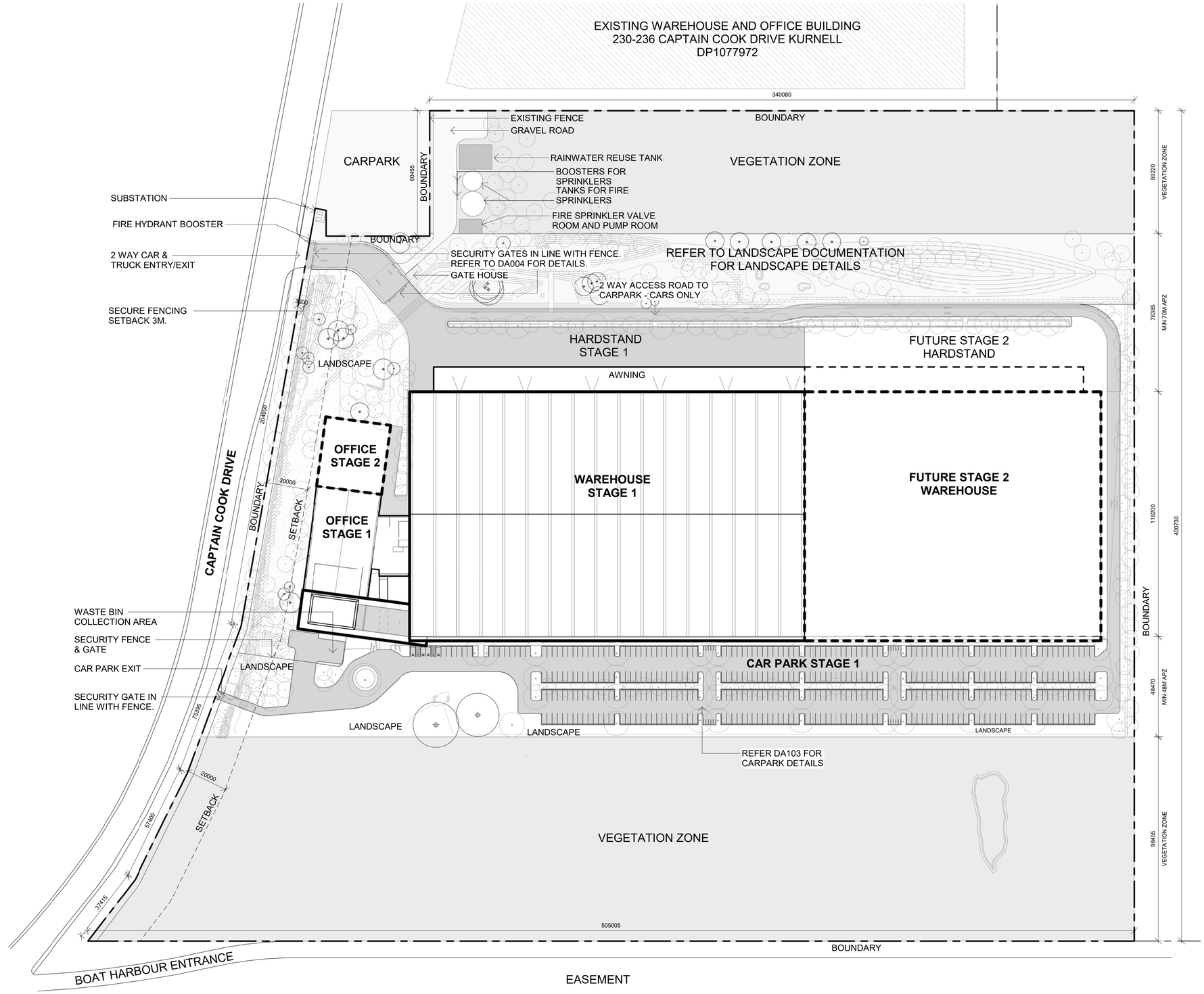
- Previous borehole by DP (report 84677.00 dated Feb 2015)
- Current borehole location

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Dicker Data Limited		TITLE: **Borehole Location Plan** **Proposed Industrial Development** **238-258 Captain Cook Drive, KURNELL**
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE: 1:2500 @ A3	DATE: 22.8.2018	

N

PROJECT No:	84677.02
DRAWING No:	1
REVISION:	0



EXISTING BUILDINGS
260 SIR CAPTAIN COOK DRIVE
SP72545

KEY

PROPOSED TREES
(DETAILED & DESIGNED BY LANDSCAPE ARCHITECT). REFER TO LANDSCAPE DOCUMENTATION FOR DETAILS

EXISTING TREES
REFER TO LANDSCAPE AND ARBORIST DOCUMENTATION FOR DETAILS

1 **SITE PLAN - STAGE 1**

SCALE 1 : 1000

PRELIMINARY

WMK Architecture
L1 346-348 Kent St
Sydney NSW 2000
Telephone 02 9299 0401
Facsimile 02 9299 0402
wmkarchitecture.com
ABN 25 082 956 929

0 1 2 3 4m
1:100

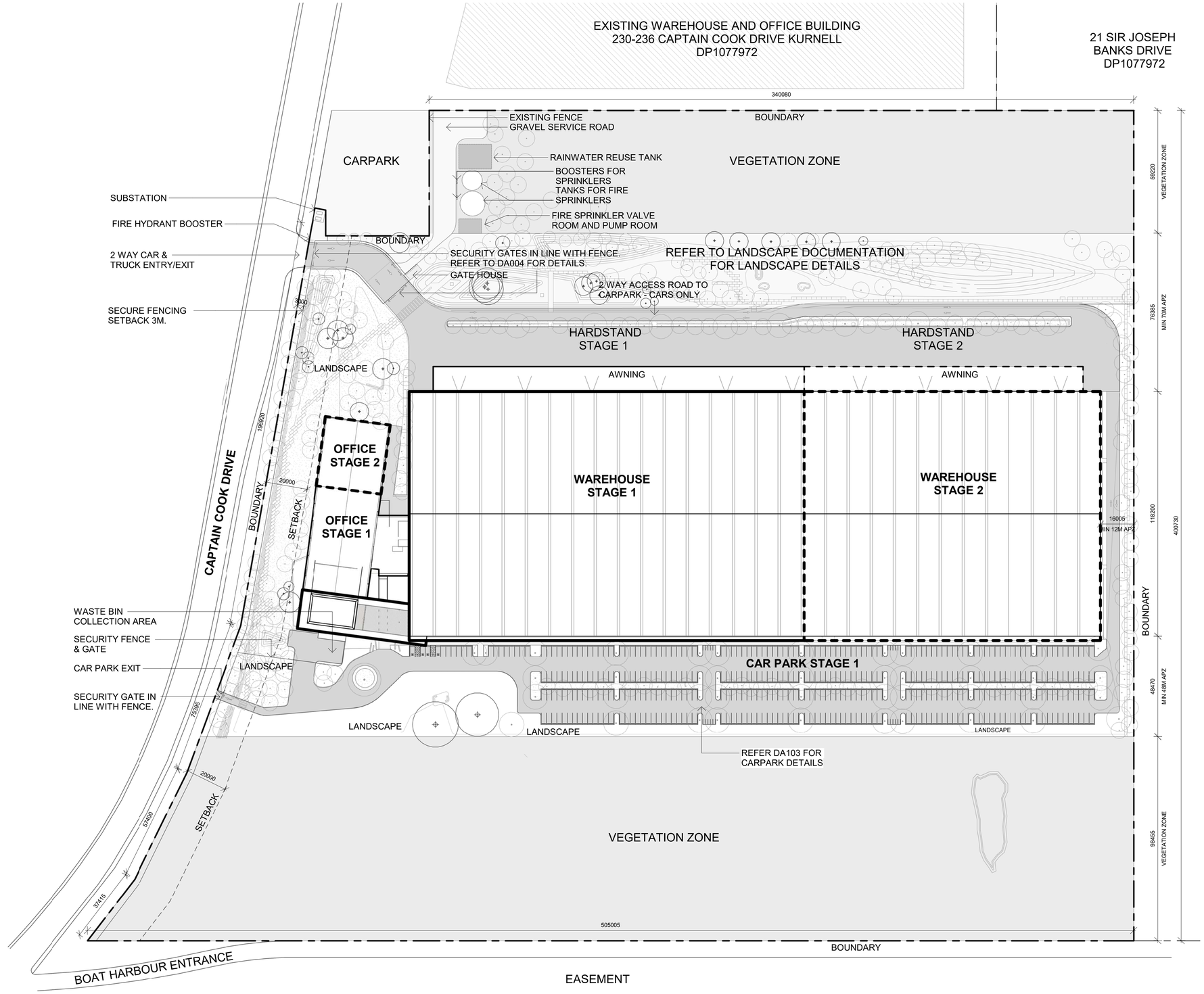
Issue	Description	Date

Client
DICKER DATA PTY LTD

Project
238-258 CAPTAIN COOK DRIVE, KURNELL, NSW 2231

Title
SITE PLAN STAGE 1

Drawing No.	Issue
DA001A	
Scale	**Drawing Size**
1 : 1000@A1	A1
Project No.	**Drawn By**
16202	PK
CAD Reference	
*DWG-REVIT	



KEY

- PROPOSED TREES (DETAILED & DESIGNED BY LANDSCAPE ARCHITECT). REFER TO LANDSCAPE DOCUMENTATION FOR DETAILS
- EXISTING TREES REFER TO LANDSCAPE AND ARBORIST DOCUMENTATION FOR DETAILS

1 **SITE PLAN - STAGE 2**

SCALE 1 : 1000

PRELIMINARY

WMK Architecture
L1 346-348 Kent St
Sydney NSW 2000
Telephone 02 9299 0401
Facsimile 02 9299 0402
wmkarchitecture.com
ABN 25 082 956 929

0 1 2 3 4m 1:100

Issue	Description	Date

Client DICKER DATA PTY LTD

Project 238-258 CAPTAIN COOK DRIVE, KURNELL, NSW 2231

Title SITE PLAN STAGE 2

Drawing No. DA001B	**Issue**
Scale 1 : 1000@A1	**Drawing Size** A1
Project No. 16202	**Drawn By** Author
CAD Reference *DWG/REVIT	

Appendix C

Results of Field Work

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, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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

Rock Strength

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

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Degree of Fracturing

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

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

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

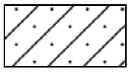
Soils


Topsoil

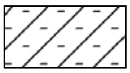

Peat


Clay

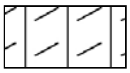

Silty clay

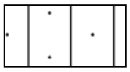

Sandy clay

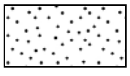

Gravelly clay

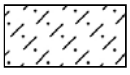

Shaly clay

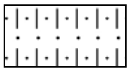

Silt


Clayey silt


Sandy silt

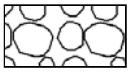

Sand

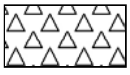

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

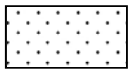

Talus

Sedimentary Rocks

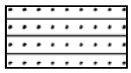

Boulder conglomerate

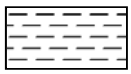

Conglomerate


Conglomeratic sandstone

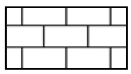

Sandstone


Siltstone


Laminite

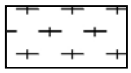

Mudstone, claystone, shale

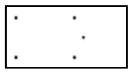

Coal


Limestone

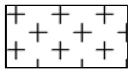
Metamorphic Rocks

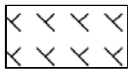

Slate, phyllite, schist

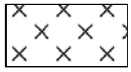

Gneiss

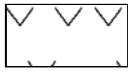

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 2.5 AHD
EASTING: 333786
NORTHING: 6234043
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.04	ASPHALTIC CONCRETE							
	0.15	ROADBASE							
		FILLING - brown, clayey, fine sand filling, damp		A	0.5				
				A	1.0				
	1.4	SAND - loose, grey, fine to medium sand, moist		A	1.5				
		- brown and wet from 1.6m							
	2.0	Bore discontinued at 2.0m		A	2.0				
		- target depth reached							

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.5 AHD
EASTING: 333848
NORTHING: 6233940
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - brown, silty, fine sand, damp 0.0-0.05m: with some rootlets		A	0.1				
				A	0.5				
	0.8	FILLING - brown, fine to medium sand filling, damp		A	1.0				
	1.4	FILLING - grey, fine to medium sand filling with some ash and gravel, damp		A	1.5				
	2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.4 AHD
EASTING: 333865
NORTHING: 6233905
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	SAND - loose, light brown, fine to medium sand, damp		A	0.1				
				A	0.5				
	1			A	1.0				1
		- grey and moist from 1.4m		A	1.5				
	2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
	3								3
	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 2.5 AHD
EASTING: 333885
NORTHING: 6233860
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	SILTY SAND - loose, brown, silty fine sand, damp 0.0-0.05m: with some rootlets		A	0.1				
		SAND - loose, light brown, fine sand, damp		A	0.5				
	1			A	1.0				
		- grey from 1.3m		A	1.5				
		- moist from 1.7m							
	2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.3 AHD
EASTING: 333926
NORTHING: 6233770
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTY SAND - loose, brown, silty, fine sand, damp		A	0.1				
	0.2	SAND - loose, dark grey, fine to medium sand, damp		A	0.5				
	1			A	1.0				1
		- brown and wet from 1.4m		A	1.5				
	1.6	Bore discontinued at 1.6m - refusal on possible sandstone bedrock							
	2								2
	3								3
	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.1 AHD
EASTING: 333771
NORTHING: 6233991
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3	0.04	ASPHALTIC CONCRETE							
	0.15	ROADBASE							
		SAND - loose, light brown, fine sand, damp		A	0.5				
2	1			A	1.0				1
				A	1.5				
		- dark grey, moist, with strong organic odour from 1.85m							
	2 2.0	Bore discontinued at 2.0m		A	2.0				2
1		- target depth reached							
	3								3
0									
	4								4
-1									

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 2.9 AHD
EASTING: 333783
NORTHING: 6233917
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	FILLING - brown, silty, fine sand topsoil filling, damp 0.0-0.05m: with some rootlets		A	0.1				
		FILLING - brown, fine sand filling with some silt, damp		A	0.5				
2	1			A	1.0				1
	1.2	SILTY SAND - dark grey, silty, fine sand with clay and organic matter, moist		A	1.5				
1		- wet with strong organic odour from 1.7m							
	2 2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
0	3								3
-1	4								4
-2									

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.1 AHD
EASTING: 333836
NORTHING: 6233852
DIP/AZIMUTH: 90°/--

BORE No: 108
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - brown, silty, fine sand filling, damp 0.0-0.05m: with some rootlets		A	0.0				
	0.3	SAND - loose, light brown, fine to medium sand, damp		A	0.5				
	1			A	1.0				
		- light grey and moist from 1.1m							
				A	1.5				
		- brown and wet from 1.7m							
	2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.2 AHD
EASTING: 333874
NORTHING: 6233783
DIP/AZIMUTH: 90°/--

BORE No: 109
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	SAND - loose, light grey, fine to medium sand, damp		A	0.1				
		- light brown from 0.4m		A	0.5				
	1			A	1.0				1
				A	1.5				
		- brown from 1.8m							
	2 2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
	3								3
	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333688
NORTHING: 6233934
DIP/AZIMUTH: 90°/--

BORE No: 110
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		FILLING - brown, silty, fine sand filling, damp		A	0.1				
		0.0-0.05m: with some rootlets							
	0.2	SAND - loose, brown, fine to medium sand, damp		A	0.5				
2	1			A	1.0				1
		- moist from 1.4m		A	1.5				
		- dark grey with organic odour from 1.6m							
1	2	2.0		A	2.0				2
		Bore discontinued at 2.0m							
		- target depth reached							
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333716
NORTHING: 6233883
DIP/AZIMUTH: 90°/--

BORE No: 111
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		FILLING - brown, silty sand filling, humid 0.0-0.05m: with some rootlets		A	0.1				
	0.2	SAND - loose, brown, fine to medium sand, humid		A	0.5				
2	1			A	1.0				1
		- moist from 1.4m		A	1.5				
		- wet and dark grey with sulphurous odour from 1.7m							
1	2 2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.3 AHD
EASTING: 333777
NORTHING: 6233838
DIP/AZIMUTH: 90°/--

BORE No: 112
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - brown, silty, fine sand filling, humid 0.0-0.05m: with some rootlets		A	0.1				
	0.2	SAND - loose, grey, fine to medium sand, humid		A	0.5				
	1			A	1.0				1
		- light brown from 1.2m		A	1.5				
		- wet from 1.7m							
	2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 2.8 AHD
EASTING: 333816
NORTHING: 6233745
DIP/AZIMUTH: 90°/--

BORE No: 113
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - light brown, fine to medium gravelly sand filling, humid		A	0.1				
	0.2	SAND - loose, light brown, fine to medium sand, humid		A	0.5				
	1			A	1.0				1
		- moist from 1.5m		A	1.5				
		- wet from 1.7m							
	2 2.0	Bore discontinued at 2.0m		A	2.0				2
		- target depth reached							
	3								3
	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333874
NORTHING: 6233726
DIP/AZIMUTH: 90°/--

BORE No: 114
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		SAND - loose, brown, fine sand, damp		A	0.1				
				A	0.5				
2	1			A	1.0				1
		- grey from 1.2m							
		- wet from 1.5m		A	1.5				
		- light brown from 1.6m							
1	2	2.0		A	2.0				2
		Bore discontinued at 2.0m - target depth reached							
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 2.9 AHD
EASTING: 333632
NORTHING: 6233881
DIP/AZIMUTH: 90°/--

BORE No: 115
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	FILLING - brown, silty, fine sand filling, humid 0.0-0.05m: with some rootlets		A	0.1				
		SAND - loose, light brown, fine to medium sand, humid		A	0.5				
2	1			A	1.0				1
		- grey and wet with organic odour from 1.5m		A	1.5				
1	2 2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
0	3								3
-1	4								4
-2									

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333647
NORTHING: 6233804
DIP/AZIMUTH: 90°/--

BORE No: 116
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		FILLING - brown, fine to medium sand filling, humid							
	0.3	SAND - loose, brown, fine to medium sand, humid		A	0.5				
2	1			A	1.0				1
				A	1.5				
		- dark grey and wet from 1.7m							
1	2.0	Bore discontinued at 2.0m		A	2.0				2
		- target depth reached							
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333745
NORTHING: 6233744
DIP/AZIMUTH: 90°/--

BORE No: 117
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		FILLING - light brown, silty, fine sand filling, damp 0.0-0.05m: with some rootlets		A	0.1				
	0.5	SAND - loose, light brown, fine to medium grained sand, damp		A	0.5				
2	1			A	1.0				1
		- light grey and moist from 1.3m							
				A	1.5				
		- wet from 1.6m							
1	2 2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.1 AHD
EASTING: 333795
NORTHING: 6233672
DIP/AZIMUTH: 90°/--

BORE No: 118
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		SILTY SAND - loose, light brown, silty, fine sand, damp		A	0.0				
		0.0-0.05m: with some rootlets							
				A	0.5				
	0.8								
2	1	SAND - loose, brown, fine to medium sand, damp		A	1.0				1
		- dark grey from 1.5m		A	1.5				
		- wet from 1.6m							
1	2	2.0		A	2.0				2
		Bore discontinued at 2.0m							
		- target depth reached							
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.2 AHD
EASTING: 333867
NORTHING: 6233654
DIP/AZIMUTH: 90°/--

BORE No: 119
PROJECT No: 84677.01
DATE: 12/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTY SAND - loose, brown, silty, fine sand, humid		A	0.1				
				A	0.5				
	0.6	SAND - loose, light brown, fine to medium sand, humid							
	1			A	1.0				1
		- dark grey and moist from 1.5m		A	1.5				
		- wet from 1.7m							
	2.0	Bore discontinued at 2.0m		A	2.0				2
		- target depth reached							
	3								3
	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333585
NORTHING: 6233892
DIP/AZIMUTH: 90°/--

BORE No: 120
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		FILLING - brown, silty, fine sand filling, damp		A	0.1				
	0.2	SAND - loose, brown, fine to medium sand, damp		A	0.5				
2	1			A	1.0				1
				A	1.5				
		- grey and wet from 1.7m							
1	2 2.0	Bore discontinued at 2.0m - target depth reached		A	2.0				2
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.0 AHD
EASTING: 333666
NORTHING: 6233731
DIP/AZIMUTH: 90°/--

BORE No: 121
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		SAND - loose, light brown, fine to medium sand, damp		A	0.1				
		0.0-0.05m: with some rootlets		A	0.5				
2	1			A	1.0				1
		- moist from 1.4m		A	1.5				
		- dark grey and wet with organic odour from 1.8m							
1	2 2.0			A	2.0				2
		Bore discontinued at 2.0m - target depth reached							
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Kurnell Developments Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 238-258 Captain Cook Drive, Kurnell

SURFACE LEVEL: 3.1 AHD
EASTING: 333785
NORTHING: 6233603
DIP/AZIMUTH: 90°/--

BORE No: 122
PROJECT No: 84677.01
DATE: 13/8/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
3		SILTY SAND - loose, brown, silty, fine sand, humid		A	0.1				
				A	0.5				
	0.6	SAND - loose, grey, fine sand, humid							
2	1			A	1.0				1
				A	1.5				
		- wet from 1.8m							
1	2	2.0 Bore discontinued at 2.0m - target depth reached		A	2.0				2
0	3								3
-1	4								4

RIG: 3.5T Excavator **DRILLER:** A & A Hire **LOGGED:** MW **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Appendix D

Results of Laboratory Testing

Acid Sulphate Soil Screening and Laboratory Results (February 2015)

Sample	Depth	Date Sampled	Description	ASS Screening				SPOCAS										
				pH_F (field pH test)	pH $_{Ox}$	pH change	Reaction Rate	pH $_{kcl}$	pH $_{Ox}$	s-TAA pH 6.5	s-TPA pH 6.5	s-TSA pH 6.5	S_{KCl}	S_P	S_{POS}	s-ANC_E	a-Net Acidity	Liming rate
				pH Units	pH units	pH units	-	pH units	pH units	%w/w S	%w/w S	%w/w S	%w/w S	%w/w	%w/w	%w/w S	moles H^+/t	kg $CaCO_3$/t
BH1	0.1	28/01/15	brown silty sand filling, moist	8.3	6.3	-2	Moderate											
BH1	0.5	28/01/15	orange-brown sand, moist	9	7.4	-1.6	Moderate											
BH1	1	28/01/15	dark grey sand, moist	8.6	6.5	-2.1	Slight											
BH1	1.5	28/01/15	grey sand, moist	8.3	5.8	-2.5	Slight											
BH1	2	28/01/15	grey sand, moist	8.5	5.9	-2.6	Slight											
BH1	2.5	28/01/15	grey sand, wet, slight organic odour	8.3	6	-2.3	Slight	6.7	5.6	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.05	<10	<0.75
BH1	3	28/01/15	brown sand, wet	7.6	4.8	-2.8	Slight											
BH2	0.1	28/01/15	grey to dark grey silty sand, moist	8.3	5.8	-2.5	Moderate											
BH2	0.3	28/01/15	grey to dark grey silty sand, wet	7.3	5.7	-1.6	Slight											
BH2	0.5	28/01/15	grey to dark grey silty sand, wet	6.8	5.6	-1.2	Slight											
BH2	0.8	28/01/15	sandstone	5.3	4.9	-0.4	Slight											
BH3	0.1	28/01/15	brown silty sand filling, moist	7.9	5.9	-2	Moderate											
BH3	0.5	28/01/15	orange-brown sand, moist	8.7	6.4	-2.3	Slight											
BH3	1	28/01/15	orange-brown sand, moist	9.1	6.4	-2.7	Slight											
BH3	1.5	28/01/15	dark grey clayey sand, moist	7.7	5.4	-2.3	Moderate											
BH3	2	28/01/15	dark brown silty sand, moist	7.6	5.7	-1.9	Slight	7	4.1	<0.01	<0.01	<0.01	<0.005	0.006	0.005	<0.05	<10	<0.75
BH3	2.5	28/01/15	dark brown silty sand, wet, with organic odour	7.5	5.7	-1.8	Slight											
BH3	3	28/01/15	grey- brown silty sand, wet, with organic odour	7.5	2.4	-5.1	Vigorous	6.3	2.7	<0.01	0.02	0.02	0.006	0.21	**0.21**	<0.05	**130**	9.7
BH4	0.1	28/01/15	brown clayey sand filling, moist	7.6	5.3	-2.3	Moderate											
BH4	0.5	28/01/15	dark grey clayey sand, moist	8.1	5.8	-2.3	Moderate											
BH4	1	28/01/15	dark grey clayey sand, some cementation, moist to wet	5.7	4.8	-0.9	Slight											
BH4	1.5	28/01/15	sandstone	5.1	4.5	-0.6	Slight											
BH5	0.1	28/01/15	dark brown silty sand filling, moist	7.1	5.3	-1.8	Slight											
BH5	0.5	28/01/15	orange-brown sand, moist	8.7	6.5	-2.2	Moderate											
BH5	1	28/01/15	orange-brown sand, moist	8.9	6.4	-2.5	Slight											
BH5	1.5	28/01/15	dark grey clayey sand, moist	8	6.1	-1.9	Moderate											
BH5	2	28/01/15	grey silty sand, wet	8.3	6.3	-2	Moderate	9.3	6.9	<0.01	<0.01	<0.01	<0.005	0.007	0.006	0.11	<10	<0.75
BH5	2.5	28/01/15	brown silty sand, wet	7.6	5.8	-1.8	Slight											
BH5	3	28/01/15	brown silty sand, wet	7.4	1.7	-5.7	Moderate											
BH6	0.1	28/01/15	brown silty sand filling, moist	8.5	6.1	-2.4	Slight											
BH6	0.5	28/01/15	grey silty sand, moist	8.6	6	-2.6	Slight											

Sample	Depth	Date Sampled	Description	ASS Screening				SPOCAS										
				pH_F (field pH test)	pH_{Ox}	pH change	Reaction Rate	pH_{kcl}	pH_{Ox}	s-TAA pH 6.5	s-TPA pH 6.5	s-TSA pH 6.5	S_{KCl}	S_P	S_{POS}	s-ANC_E	a-Net Acidity	Liming rate
				pH Units	pH units	pH units	-	pH units	pH units	%w/w S	%w/w S	%w/w S	%w/w S	%w/w	%w/w	%w/w S	moles H^+/t	kg $CaCO_3$/t
BH6	1	28/01/15	grey sand, moist	8.6	6	-2.6	Slight											
BH6	1.5	28/01/15	brown sand, moist	8.2	5.8	-2.4	Moderate											
BH6	2	28/01/15	brown sand, wet	8	6.1	-1.9	Slight	7.6	6.8	<0.01	<0.01	<0.01	<0.005	<0.005	0.005	0.08	<10	<0.75
BH6	2.5	28/01/15	brown silty sand, wet, organic odour	7.5	5.9	-1.6	Slight											
BH6	3	28/01/15	brown silty sand, wet, organic odour	7.5	1.5	-6	Moderate	6.6	3	<0.01	0.07	**0.07**	0.005	0.15	**0.14**	<0.05	**57**	4.3
Action Criteria																		
For <1,000 tonnes of sand, or > 1,000 tonnes of any soil texture												0.03			0.03		18	

Notes

Bold Result above action criteria

Acid Sulphate Soil Screening and Laboratory Results (September 2015)

Sample	Depth	Date Sampled	Description	ASS Screening				SPOCAS										
				pH_F (field pH test)	pH_{Ox}	pH change	Reaction Rate	pH_{kcl}	pH_{Ox}	s-TAA pH 6.5	s-TPA pH 6.5	s-TSA pH 6.5	S_{KCl}	S_P	S_{POS}	s-ANC_E	a-Net Acidity	Liming rate
				pH Units	pH units	pH units	-	pH units	pH units	%w/w S	%w/w S	%w/w S	%w/w S	%w/w	%w/w	%w/w S	moles H^+/t	kg $CaCO_3$/t
BH101	0.5	13/08/15	filling - brown Clayey sand	8.1	7.8	-0.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH101	1	13/08/15	filling - brown Clayey sand	8.7	6.3	-1.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH101	1.5	13/08/15	grey sand, moist	9.2	6.8	-2.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH101	2	13/08/15	grey sand, wet	7.9	5.8	-2.1	Slight	7.6	4.6	<0.01	<0.01	<0.01	<0.005	0.02	0.01	<0.05	<10	<0.75
BH102	0.5	13/08/15	filling - brown sand	8.0	6	-2.0	Slight	-	-	-	-	-	-	-	-	-	-	-
BH102	1	13/08/15	filling - brown sand	8.2	6.1	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH102	1.5	13/08/15	filling – grey sand with some ash and gravel	8.1	6.2	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH102	2	13/08/15	filling – grey sand with some ash and gravel	8.2	6.1	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH103	0.1	13/08/15	brown sand, damp	8.2	6.2	-2.0	Slight	-	-	-	-	-	-	-	-	-	-	-
BH103	0.5	13/08/15	brown sand, damp	8.4	6.5	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH103	1	13/08/15	brown sand, damp	8.3	6.7	-1.6	Slight	-	-	-	-	-	-	-	-	-	-	-
BH103	1.5	13/08/15	grey sand, moist	8.6	6.1	-2.5	Slight	-	-	-	-	-	-	-	-	-	-	-
BH103	2	13/08/15	grey sand, moist	8.5	6.3	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH104	0.1	13/08/15	brown sand, damp	8.1	6.2	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH104	0.5	13/08/15	brown sand, damp	8.2	6.2	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH104	1	13/08/15	brown sand, damp	8.2	6.1	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH104	1.5	13/08/15	grey sand, damp	8.6	6.3	-2.3	Slight	9.4	7.2	<0.01	<0.01	<0.01	<0.005	0.02	<0.005	0.15	<10	<0.75
BH104	2	13/08/15	grey sand, moist	8.1	5.6	-2.5	Slight	-	-	-	-	-	-	-	-	-	-	-
BH105	0.1	12/08/15	Brown silty sand, damp	8.1	5.8	-2.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH105	0.5	12/08/15	grey sand, damp	8.2	5.6	-2.6	Slight	-	-	-	-	-	-	-	-	-	-	-
BH105	1	12/08/15	grey sand, damp	8.0	5.8	-2.2	Slight	6.0	4.9	<0.01	<0.01	<0.01	<0.005	0.02	<0.005	<0.05	<10	<0.75
BH105	1.5	12/08/15	brown sand, wet	7.5	5.9	-1.6	Slight	-	-	-	-	-	-	-	-	-	-	-
BH106	0.5	13/08/15	brown sand, damp	8.7	7.2	-1.5	Slight	-	-	-	-	-	-	-	-	-	-	-
BH106	1	13/08/15	brown sand, damp	8.5	6.4	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH106	1.5	13/08/15	brown sand, damp	8.4	4.9	-3.5	Slight	-	-	-	-	-	-	-	-	-	-	-
BH106	2	13/08/15	grey sand, moist, organic odour	8.1	5.2	-2.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH107	0.1	12/08/15	filling – silty sand	7.3	6.1	-1.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH107	0.5	12/08/15	filling - sand	7.4	6.0	-1.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH107	1	12/08/15	filling - sand	7.5	5.9	-1.6	Slight	6.6	5.3	<0.01	<0.01	<0.01	<0.005	0.02	<0.005	<0.05	<10	<0.75
BH107	1.5	12/08/15	black silty sand, moist, organic odour	7.6	5.2	-2.4	Slight	-	-	-	-	-	-	-	-	-	-	-

Sample	Depth	Date Sampled	Description	ASS Screening				SPOCAS										
				pH_F (field pH test)	pH_{Ox}	pH change	Reaction Rate	pH_{kcl}	pH_{Ox}	s-TAA pH 6.5	s-TPA pH 6.5	s-TSA pH 6.5	S_{KCl}	S_P	S_{POS}	s-ANC_E	a-Net Acidity	Liming rate
				pH Units	pH units	pH units	-	pH units	pH units	%w/w S	%w/w S	%w/w S	%w/w S	%w/w	%w/w	%w/w S	moles H^+/t	kg $CaCO_3$/t
BH107	2	12/08/15	black silty sand, wet, organic odour	7.4	6.0	-1.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH108	0.1	12/08/15	filling – silty sand	7.8	6.1	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH108	0.5	12/08/15	brown sand, damp	8.0	6.0	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH108	1	12/08/15	brown sand, damp	8.0	5.9	-2.1	Slight	6.6	5.6	<0.01	<0.01	<0.01	<0.005	0.02	<0.005	<0.05	<10	<0.75
BH108	1.5	12/08/15	grey sand, moist	7.9	6.0	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH108	2	12/08/15	grey sand, moist	7.8	6.1	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH109	0.1	12/08/15	grey sand, damp	8.3	6.3	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH109	0.5	12/08/15	grey sand, damp	8.3	6.3	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH109	1	12/08/15	grey sand, damp	8.2	5.9	-2.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH109	1.5	12/08/15	grey sand, damp	8.2	6.0	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH109	2	12/08/15	brown sand, damp	8.0	6.1	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH110	0.1	13/08/15	filling – silty sand	8.6	6.6	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH110	0.5	13/08/15	brown sand damp	8.8	6.7	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH110	1	13/08/15	brown sand damp	9.0	6.7	-2.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH110	1.5	13/08/15	brown sand, moist	9.2	6.8	-2.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH110	2	13/08/15	grey sand, moist, organic odour	8.1	6.1	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH111	0.1	13/08/15	filling – silty sand	7.7	5.4	-2.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH111	0.5	13/08/15	brown sand, humid	7.7	5.6	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH111	1	13/08/15	brown sand, humid	7.7	5.6	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH111	1.5	13/08/15	brown sand, moist	7.6	5.6	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH111	2	13/08/15	grey sand, wet, sulphur odour	7.2	5.5	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH112	0.1	12/08/15	filling - brown silty sand	7.6	5.8	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH112	0.5	12/08/15	grey sand, humid	7.9	6.0	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH112	1	12/08/15	grey sand, humid	8.0	6.0	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH112	1.5	12/08/15	grey sand, humid	8.0	5.9	-2.1	Slight	6.6	5.7	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.05	<10	<0.75
BH112	2	12/08/15	grey sand, wet	8.0	6.0	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH113	0.1	12/08/15	filling – gravelly sand	8.1	6.3	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH113	0.5	12/08/15	brown sand, humid	8.3	6.3	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH113	1	12/08/15	brown sand, humid	8.1	6.0	-2.1	Slight	6.5	5.6	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.05	<10	<0.75
BH113	1.5	12/08/15	brown sand, moist	8.3	6.1	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH113	2	12/08/15	brown sand, wet	8.0	6.3	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH114	0.1	12/08/15	brown sand, damp	8.4	6.4	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH114	0.5	12/08/15	brown sand, damp	8.1	6.1	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH114	1	12/08/15	brown sand, damp	8.2	6.1	-2.1	Slight	7.5	6.0	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.05	<10	<0.75
BH114	1.5	12/08/15	grey sand, wet	8.0	6.2	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-

Sample	Depth	Date Sampled	Description	ASS Screening				SPOCAS										
				pH_F (field pH test)	pH_{Ox}	pH change	Reaction Rate	pH_{kcl}	pH_{Ox}	s-TAA pH 6.5	s-TPA pH 6.5	s-TSA pH 6.5	S_{KCl}	S_P	S_{POS}	s-ANC_E	a-Net Acidity	Liming rate
				pH Units	pH units	pH units	-	pH units	pH units	%w/w S	%w/w S	%w/w S	%w/w S	%w/w	%w/w	%w/w S	moles H^+/t	kg $CaCO_3$/t
BH114	2	12/08/15	brown sand, wet	7.9	6.6	-1.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH115	0.1	12/08/15	filling - brown silty sand	8.0	6.4	-1.6	Slight	-	-	-	-	-	-	-	-	-	-	-
BH115	0.5	12/08/15	brown sand, humid	8.6	6.6	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH115	1	12/08/15	brown sand, humid	8.8	6.8	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH115	1.5	12/08/15	grey sand, wet	9.1	6.8	-2.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH115	2	12/08/15	grey sand, wet	8.4	6.6	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH116	0.5	13/08/15	brown sand, humid	8.6	6.4	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH116	1	13/08/15	brown sand, humid	8.6	6.4	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH116	1.5	13/08/15	brown sand, humid	8.4	6.1	-2.3	Slight	7.2	5.7	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.05	<10	<0.75
BH116	2	13/08/15	brown sand, wet	7.8	5.8	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH117	0.1	12/08/15	filling - brown silty sand	8.3	6..5	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH117	0.5	12/08/15	brown sand, damp	8.6	6.7	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH117	1	12/08/15	brown sand, damp	8.3	6.2	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH117	1.5	12/08/15	grey sand, wet	8.3	6.9	-1.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH117	2	12/08/15	grey sand, wet	8.4	6.6	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH118	0.1	12/08/15	brown silty sand, damp	7.8	6.4	-1.4	Slight	-	-	-	-	-	-	-	-	-	-	-
BH118	0.5	12/08/15	brown silty sand, damp	8.2	6.6	-1.6	Slight	-	-	-	-	-	-	-	-	-	-	-
BH118	1	12/08/15	brown sand, damp	8.4	6.2	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH118	1.5	12/08/15	brown sand, damp	8.6	6.3	-2.3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH118	2	12/08/15	grey sand, wet	8.2	6.2	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH119	0.1	12/08/15	brown silty sand, humid	8.0	6.4	-1.6	Slight	-	-	-	-	-	-	-	-	-	-	-
BH119	0.5	12/08/15	brown silty sand, humid	8.3	6.3	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH119	1	12/08/15	grey sand, humid	8.6	6.1	-2.5	Slight	-	-	-	-	-	-	-	-	-	-	-
BH119	1.5	12/08/15	grey sand, humid	8.5	5.5	-3	Slight	-	-	-	-	-	-	-	-	-	-	-
BH119	2	12/08/15	brown sand, humid	7.7	5.9	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH120	0.1	13/08/15	filling - brown silty sand	8.4	6.6	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH120	0.5	13/08/15	brown sand, damp	8.5	7.0	-1.5	Slight	-	-	-	-	-	-	-	-	-	-	-
BH120	1	13/08/15	brown sand, damp	8.6	6.6	-2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH120	1.5	13/08/15	brown sand, damp	8.5	6.3	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH120	2	13/08/15	grey sand, wet	8.0	6.3	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH121	0.1	13/08/15	brown sand, damp	8.3	6.5	-1.8	Slight	-	-	-	-	-	-	-	-	-	-	-
BH121	0.5	13/08/15	brown sand, damp	8.2	6.3	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH121	1	13/08/15	brown sand, damp	8.1	6.1	-2	Slight	7.3	5.7	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.05	<10	<0.75
BH121	1.5	13/08/15	brown sand, moist	8.1	6.2	-1.9	Slight	-	-	-	-	-	-	-	-	-	-	-
BH121	2	13/08/15	grey sand, wet	7.7	6.0	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH122	0.1	13/08/15	brown silty sand, humid	8.0	6.3	-1.7	Slight	-	-	-	-	-	-	-	-	-	-	-
BH122	0.5	13/08/15	brown silty sand, humid	8.0	5.9	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
BH122	1	13/08/15	brown sand, humid	8.5	6.5	-2	Slight	-	-	-	-	-	-	-	-	-	-	-

Sample	Depth	Date Sampled	Description	ASS Screening				SPOCAS										
				pH_F (field pH test)	pH_{Ox}	pH change	Reaction Rate	pH_{kcl}	pH_{Ox}	s-TAA pH 6.5	s-TPA pH 6.5	s-TSA pH 6.5	S_{KCl}	S_P	S_{POS}	s-ANC_E	a-Net Acidity	Liming rate
				pH Units	pH units	pH units	-	pH units	pH units	%w/w S	%w/w S	%w/w S	%w/w S	%w/w	%w/w	%w/w S	moles H^+/t	kg $CaCO_3$/t
BH122	1.5	13/08/15	brown sand, humid	8.5	6.3	-2.2	Slight	-	-	-	-	-	-	-	-	-	-	-
BH122	2	13/08/15	brown sand, wet	8.2	6.1	-2.1	Slight	-	-	-	-	-	-	-	-	-	-	-
Action Criteria																		
For <1,000 tonnes of sand, or > 1,000 tonnes of any soil texture												0.03			0.03		18	

Appendix E

Laboratory Certificates and Chain of Custody

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

CERTIFICATE OF ANALYSIS 132766

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Matt West, Ray Blinman

Sample log in details:

Your Reference:	**84677.01, Kurnell**
No. of samples:	106 soils
Date samples received:	14/08/15
Date completed instructions received:	14/08/15

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:	21/08/15
Date of Preliminary Report:	Not Issued
Issue Date:	21/08/15

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

Results Approved By:

Jacinta Hurst
Laboratory Manager

sPOCAS field test						
Our Reference:	UNITS	132766-1	132766-2	132766-3	132766-4	132766-5
Your Reference	----------	BH101	BH101	BH101	BH101	BH101
Depth	----------	0.5	1	1.5	2	0.1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.1	8.7	9.2	7.9	8.0
pH_{FOX} (field peroxide test)*	pH Units	7.8	6.3	6.8	5.8	6.0
Reaction Rate*	-	Moderate	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-6	132766-7	132766-8	132766-9	132766-10
Your Reference	----------	BH102	BH102	BH102	BH102	BH103
Depth	----------	0.5	1	1.5	2	0.1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.0	8.2	8.1	8.2	8.2
pH_{FOX} (field peroxide test)*	pH Units	5.8	6.1	6.2	6.1	6.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-11	132766-12	132766-13	132766-14	132766-15
Your Reference	----------	BH103	BH103	BH103	BH103	BH104
Depth	----------	0.5	1	1.5	2	0.1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.4	8.3	8.6	8.5	8.1
pH_{FOX} (field peroxide test)*	pH Units	6.5	6.7	6.1	6.3	6.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-16	132766-17	132766-18	132766-19	132766-20
Your Reference	----------	BH104	BH104	BH104	BH104	BH105
Depth	----------	0.5	1	1.5	2	0.1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.2	8.2	8.6	8.1	8.1
pH_{FOX} (field peroxide test)*	pH Units	6.2	6.1	6.3	5.6	5.8
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-21	132766-22	132766-23	132766-24	132766-25
Your Reference	----------	BH105	BH105	BH105	BH106	BH106
Depth	----------	0.5	1	1.5	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.2	8.0	7.5	8.7	8.5
pH_{FOX} (field peroxide test)*	pH Units	5.6	5.8	5.9	7.2	6.4
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-26	132766-27	132766-28	132766-29	132766-30
Your Reference	----------	BH106	BH106	BH107	BH107	BH107
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.4	8.1	7.3	7.4	7.5
pH_{FOX} (field peroxide test)*	pH Units	6.4	5.7	5.2	5.5	5.6
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-31	132766-32	132766-33	132766-34	132766-35
Your Reference	----------	BH107	BH107	BH108	BH108	BH108
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	7.6	7.4	7.8	8.0	8.0
pH_{FOX} (field peroxide test)*	pH Units	4.9	5.2	6.1	6.0	5.9
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-36	132766-37	132766-38	132766-39	132766-40
Your Reference	----------	BH108	BH108	BH109	BH109	BH109
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	7.9	7.8	8.3	8.3	8.2
pH_{FOX} (field peroxide test)*	pH Units	6.0	6.1	6.3	6.3	5.9
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-41	132766-42	132766-43	132766-44	132766-45
Your Reference	----------	BH109	BH109	BH110	BH110	BH110
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.2	8.0	8.6	8.8	9.0
pH_{FOX} (field peroxide test)*	pH Units	6.0	6.1	6.6	6.7	6.7
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-46	132766-47	132766-48	132766-49	132766-50
Your Reference	----------	BH110	BH110	BH111	BH111	BH111
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	9.2	8.1	7.7	7.7	7.7
pHFOX (field peroxide test)*	pH Units	6.8	6.1	5.4	5.6	5.6
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-51	132766-52	132766-53	132766-54	132766-55
Your Reference	----------	BH111	BH111	BH112	BH112	BH112
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	7.6	7.2	7.6	7.9	8.0
pHFOX (field peroxide test)*	pH Units	5.6	5.5	5.8	6.0	6.0
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-56	132766-57	132766-58	132766-59	132766-60
Your Reference	----------	BH112	BH112	BH113	BH113	BH113
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	8.0	8.0	8.1	8.3	8.1
pHFOX (field peroxide test)*	pH Units	5.9	6.0	6.3	6.3	6.0
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-61	132766-62	132766-63	132766-64	132766-65
Your Reference	----------	BH113	BH113	BH114	BH114	BH114
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	8.3	8.0	8.4	8.1	8.2
pHFOX (field peroxide test)*	pH Units	6.1	6.3	6.4	6.1	6.1
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-66	132766-67	132766-68	132766-69	132766-70
Your Reference	----------	BH114	BH114	BH115	BH115	BH115
Depth	----------	1.5	2	0.1	0.5	1
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pHF (field pH test)*	pH Units	8.0	7.9	8.0	8.6	8.8
pHFOX (field peroxide test)*	pH Units	6.2	6.6	6.4	6.6	6.8
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-71	132766-72	132766-73	132766-74	132766-75
Your Reference	----------	BH115	BH115	BH116	BH116	BH116
Depth	----------	1.5	2	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	9.1	8.4	8.6	8.6	8.4
pH_{FOX} (field peroxide test)*	pH Units	6.8	6.6	6.4	6.4	6.1
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-76	132766-77	132766-78	132766-79	132766-80
Your Reference	----------	BH116	BH117	BH117	BH117	BH117
Depth	----------	2	0.1	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	7.8	8.3	8.6	8.3	8.3
pH_{FOX} (field peroxide test)*	pH Units	5.8	6.5	6.7	6.2	6.9
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-81	132766-82	132766-83	132766-84	132766-85
Your Reference	----------	BH117	BH118	BH118	BH118	BH118
Depth	----------	2	0.1	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.4	7.8	8.2	8.4	8.6
pH_{FOX} (field peroxide test)*	pH Units	6.6	6.4	6.6	6.2	6.3
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-86	132766-87	132766-88	132766-89	132766-90
Your Reference	----------	BH118	BH119	BH119	BH119	BH119
Depth	----------	2	0.1	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.2	8.0	8.3	8.1	8.1
pH_{FOX} (field peroxide test)*	pH Units	6.2	6.4	6.3	6.1	5.5
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-91	132766-92	132766-93	132766-94	132766-95
Your Reference	----------	BH119	BH120	BH120	BH120	BH120
Depth	----------	2.	0.1	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	7.7	8.4	8.5	8.6	8.5
pH_{FOX} (field peroxide test)*	pH Units	5.9	6.6	7.0	6.6	6.3
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-96	132766-97	132766-98	132766-99	132766-100
Your Reference	----------	BH120	BH121	BH121	BH121	BH121
Depth	----------	2	0.1	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	8.0	8.3	8.2	8.1	8.1
pH_{FOX} (field peroxide test)*	pH Units	6.3	6.5	6.3	6.1	6.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test						
Our Reference:	UNITS	132766-101	132766-102	132766-103	132766-104	132766-105
Your Reference	----------	BH121	BH122	BH122	BH122	BH122
Depth	----------	2	0.1	0.5	1	1.5
Date Sampled		12/08/2015	12/08/2015	12/08/2015	12/08/2015	12/08/2015
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_F (field pH test)*	pH Units	7.7	8.0	8.0	8.5	8.5
pH_{FOX} (field peroxide test)*	pH Units	6.0	6.3	5.9	6.5	6.3
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

sPOCAS field test		
Our Reference:	UNITS	132766-106
Your Reference	----------	BH122
Depth	----------	2
Date Sampled		12/08/2015
Type of sample		Soil
pH_F (field pH test)*	pH Units	8.2
pH_{FOX} (field peroxide test)*	pH Units	6.1
Reaction Rate*	-	Slight

Method ID	Methodology Summary
Inorg-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.

Report Comments:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Asbestos was authorised by Approved Signatory: Not applicable for this job

INS: Insufficient sample for this test
NA: Test not required
<: Less than

PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than

NT: Not tested
NA: Test not required
LCS: Laboratory Control Sample

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.

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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-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.

CHAIN OF CUSTODY

Douglas Partners
Geotechnics | Environment | Groundwater

Client: Douglas Partners	**Project Number** 84677.01	**To:**	Envirolab Services
Contact Person: Matt West	**Project Name:** Kurnell	**Contact Person:**	Aileen Hie
Project Mgr: Ray Blinman	**PO No.:**	**Address:**	12 Ashley Street
	lab Quote No. :		Chatswood NSW 2068
Address: 96 Hermitage Road	**Date results required:** Standard	**Phone:**	02 9910 6200
West Ryde NSW 2114	**Or choose:** standard	**Fax:**	02 9910 6201
	Note: Inform lab in advance if urgent turnaround is required - surcharges apply	**Email:**	ahie@envirolab.com.au
Phone: 9809 0666 **Mob:** 0412 985 938	**Report format:** esdat / PDF / Excel	**Laboratory Report No:**	
Email: Matt.West@douglaspartners.com.au	**Comments:**	**Lab Comments:**	

Sample information						Tests Required										Comments
Lab Sample ID	Field Sample ID	Depth	Date sampled	Container Type	Type of sample	ASS Screening									Combo	Provide as much information about the sample as you can
1	BH101	0.5	12-13/08/2015	plastic	SOIL	x										
2	BH101	1	12-13/08/2015	plastic	SOIL	x										
3	BH101	1.5	12-13/08/2015	plastic	SOIL	x										
4	BH101	2	12-13/08/2015	plastic	SOIL	x										
5	BH102	0.1	12-13/08/2015	plastic	SOIL	x										
6	BH102	0.5	12-13/08/2015	plastic	SOIL	x										
7	BH102	1	12-13/08/2015	plastic	SOIL	x										
8	BH102	1.5	12-13/08/2015	plastic	SOIL	x										
9	BH102	2	12-13/08/2015	plastic	SOIL	x										
10	BH103	0.1	12-13/08/2015	plastic	SOIL	x										
11	BH103	0.5	12-13/08/2015	plastic	SOIL	x										
12	BH103	1	12-13/08/2015	plastic	SOIL	x										
13	BH103	1.5	12-13/08/2015	plastic	SOIL	x										
14	BH103	2	12-13/08/2015	plastic	SOIL	x										
15	BH104	0.1	12-13/08/2015	plastic	SOIL	x										
16	BH104	0.5	12-13/08/2015	plastic	SOIL	x										
17	BH104	1	12-13/08/2015	plastic	SOIL	x										
18	BH104	1.5	12-13/08/2015	plastic	SOIL	x										
19	BH104	2	12-13/08/2015	plastic	SOIL	x										
20	BH105	0.1	12-13/08/2015	plastic	SOIL	x										
21	BH105	0.5	12-13/08/2015	plastic	SOIL	x										
22	BH105	1	12-13/08/2015	plastic	SOIL	x										
23	BH105	1.5	12-13/08/2015	plastic	SOIL	x										
24	BH106	0.5	12-13/08/2015	plastic	SOIL	x										
25	BH106	1	12-13/08/2015	plastic	SOIL	x										
26	BH106	1.5	12-13/08/2015	plastic	SOIL	x										
27	BH106	2	12-13/08/2015	plastic	SOIL	x										
28	BH107	0.1	12-13/08/2015	plastic	SOIL	x										
29	BH107	0.5	12-13/08/2015	plastic	SOIL	x										
30	BH107	1	12-13/08/2015	plastic	SOIL	x										
31	BH107	1.5	12-13/08/2015	plastic	SOIL	x										
32	BH107	2	12-13/08/2015	plastic	SOIL	x										
33	BH108	0.1	12-13/08/2015	plastic	SOIL	x										
34	BH108	0.5	12-13/08/2015	plastic	SOIL	x										
35	BH108	1	12-13/08/2015	plastic	SOIL	x										
36	BH108	1.5	12-13/08/2015	plastic	SOIL	x										
37	BH108	2	12-13/08/2015	plastic	SOIL	x										
38	BH109	0.1	12-13/08/2015	plastic	SOIL	x										
39	BH109	0.5	12-13/08/2015	plastic	SOIL	x										
40	BH109	1	12-13/08/2015	plastic	SOIL	x										
41	BH109	1.5	12-13/08/2015	plastic	SOIL	x										
42	BH109	2	12-13/08/2015	plastic	SOIL	x										
43	BH110	0.1	12-13/08/2015	plastic	SOIL	x										
44	BH110	0.5	12-13/08/2015	plastic	SOIL	x										
45	BH110	1	12-13/08/2015	plastic	SOIL	x										
46	BH110	1.5	12-13/08/2015	plastic	SOIL	x										
47	BH110	2	12-13/08/2015	plastic	SOIL	x										
48	BH111	0.1	12-13/08/2015	plastic	SOIL	x										
49	BH111	0.5	12-13/08/2015	plastic	SOIL	x										
50	BH111	1	12-13/08/2015	plastic	SOIL	x										

ENVIROLAB GROUP

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 132766

Date Received: 14/8/15
Time Received: 16:30
Received by: JYH
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

132766

51	BH111	1.5	12-13/08/2015	plastic	SOIL	x												
52	BH111	2	12-13/08/2015	plastic	SOIL	x												
53	BH112	0.1	12-13/08/2015	plastic	SOIL	x												
54	BH112	0.5	12-13/08/2015	plastic	SOIL	x												
55	BH112	1	12-13/08/2015	plastic	SOIL	x												
56	BH112	1.5	12-13/08/2015	plastic	SOIL	x												
57	BH112	2	12-13/08/2015	plastic	SOIL	x												
58	BH113	0.1	12-13/08/2015	plastic	SOIL	x												
59	BH113	0.5	12-13/08/2015	plastic	SOIL	x												
60	BH113	1	12-13/08/2015	plastic	SOIL	x												
61	BH113	1.5	12-13/08/2015	plastic	SOIL	x												
62	BH113	2	12-13/08/2015	plastic	SOIL	x												
63	BH114	0.1	12-13/08/2015	plastic	SOIL	x												
64	BH114	0.5	12-13/08/2015	plastic	SOIL	x												
65	BH114	1	12-13/08/2015	plastic	SOIL	x												
66	BH114	1.5	12-13/08/2015	plastic	SOIL	x												
67	BH114	2	12-13/08/2015	plastic	SOIL	x												
68	BH115	0.1	12-13/08/2015	plastic	SOIL	x												
69	BH115	0.5	12-13/08/2015	plastic	SOIL	x												
70	BH115	1	12-13/08/2015	plastic	SOIL	x												
71	BH115	1.5	12-13/08/2015	plastic	SOIL	x												
72	BH115	2	12-13/08/2015	plastic	SOIL	x												
73	BH116	0.5	12-13/08/2015	plastic	SOIL	x												
74	BH116	1	12-13/08/2015	plastic	SOIL	x												
75	BH116	1.5	12-13/08/2015	plastic	SOIL	x												
76	BH116	2	12-13/08/2015	plastic	SOIL	x												
77	BH117	0.1	12-13/08/2015	plastic	SOIL	x												
78	BH117	0.5	12-13/08/2015	plastic	SOIL	x												
79	BH117	1	12-13/08/2015	plastic	SOIL	x												
80	BH117	1.5	12-13/08/2015	plastic	SOIL	x												
81	BH117	2	12-13/08/2015	plastic	SOIL	x												
82	BH118	0.1	12-13/08/2015	plastic	SOIL	x												
83	BH118	0.5	12-13/08/2015	plastic	SOIL	x												
84	BH118	1	12-13/08/2015	plastic	SOIL	x												
85	BH118	1.5	12-13/08/2015	plastic	SOIL	x												
86	BH118	2	12-13/08/2015	plastic	SOIL	x												
87	BH119	0.1	12-13/08/2015	plastic	SOIL	x												
88	BH119	0.5	12-13/08/2015	plastic	SOIL	x												
89	BH119	1	12-13/08/2015	plastic	SOIL	x												
90	BH119	1.5	12-13/08/2015	plastic	SOIL	x												
91	BH119	2	12-13/08/2015	plastic	SOIL	x												
92	BH120	0.1	12-13/08/2015	plastic	SOIL	x												
93	BH120	0.5	12-13/08/2015	plastic	SOIL	x												
94	BH120	1	12-13/08/2015	plastic	SOIL	x												
95	BH120	1.5	12-13/08/2015	plastic	SOIL	x												
96	BH120	2	12-13/08/2015	plastic	SOIL	x												
97	BH121	0.1	12-13/08/2015	plastic	SOIL	x												
98	BH121	0.5	12-13/08/2015	plastic	SOIL	x												
99	BH121	1	12-13/08/2015	plastic	SOIL	x												
100	BH121	1.5	12-13/08/2015	plastic	SOIL	x												
101	BH121	2	12-13/08/2015	plastic	SOIL	x												
102	BH122	0.1	12-13/08/2015	plastic	SOIL	x												
103	BH122	0.5	12-13/08/2015	plastic	SOIL	x												
104	BH122	1	12-13/08/2015	plastic	SOIL	x												
105	BH122	1.5	12-13/08/2015	plastic	SOIL	x												
106	BH122	2	12-13/08/2015	plastic	SOIL	x												

Relinquished by: Douglas Partners	**Sample Receipt**	***Lab use only:***
Courier (by whom) HUNTER EXPRESS	**Received by (Company):** JLB	**Samples Received: Cool or Ambient (circle one)**
Condition of Sample at dispatch Cool or Ambient (circle)	**Print Name:** Kevin Wong	**Temperature Received at:** (if applicable)
Temperature (if Applicable):	**Date & Time:** 14/8/15 16:50	**Transported by: Hand delivered / courier**
Print Name: MATTHEW WEST	**Signature:**	
Date & Time: #########		
Signature:		

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

SAMPLE RECEIPT ADVICE

Client:

Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde NSW 2114

ph: 02 9809 0666
Fax: 02 9809 4095

Attention: Matt West, Ray Blinman

Sample log in details:

Your reference:	**84677.01, Kurnell**
Envirolab Reference:	**132766**
Date received:	14/08/15
Date results expected to be reported:	**21/08/15**

Samples received in appropriate condition for analysis:	YES
No. of samples provided	106 soils
Turnaround time requested:	Standard
Temperature on receipt (°C)	5.9
Cooling Method:	None
Sampling Date Provided:	YES

Comments:

If there is sufficient sample after testing, samples will be held for the following time frames from date of receipt of samples:
Water samples - 1 month
Soil and other solid samples - 2 months
Samples collected in canisters - 1 week. Canisters will then be cleaned.
All other samples are not retained after analysis
If you require samples to be retained for longer periods then retention fees will apply as per our pricelist.

Contact details:

Please direct any queries to Aileen Hie or Jacinta Hurst
ph: 02 9910 6200 fax: 02 9910 6201
email: ahie@envirolabservices.com.au or jhurst@envirolabservices.com.au

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

CERTIFICATE OF ANALYSIS 132766-A

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Matt West, Ray Blinman

Sample log in details:

Your Reference:	**84677.01, Kurnell**		
No. of samples:	106 soils		
Date samples received / completed instructions received	14/08/15	/	26/08/15

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: / Issue Date:	1/09/15	/	1/09/15
Date of Preliminary Report:	Not Issued		

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

Results Approved By:

Jacinta Hurst
Laboratory Manager

sPOCAS Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- ----------	132766-A-4 BH101 2 12/08/2015 Soil	132766-A-18 BH104 1.5 12/08/2015 Soil	132766-A-22 BH105 1 12/08/2015 Soil	132766-A-30 BH107 1 12/08/2015 Soil	132766-A-35 BH108 1 12/08/2015 Soil
Date prepared	-	31/08/2015	31/08/2015	31/08/2015	31/08/2015	31/08/2015
Date analysed	-	31/08/2015	31/08/2015	31/08/2015	31/08/2015	31/08/2015
pH $_{kcl}$	pH units	7.6	9.4	6.0	6.6	6.6
TAA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	4.6	7.2	4.9	5.3	5.6
TPA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
ANC_E	% $CaCO_3$	<0.05	0.47	<0.05	<0.05	<0.05
a-ANC_E	moles H^+/t	<5	95	<5	<5	<5
s-ANC_E	%w/w S	<0.05	0.15	<0.05	<0.05	<0.05
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	0.02	<0.005	<0.005	<0.005	<0.005
S_{POS}	%w/w	0.01	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+/t	9	<5	<5	<5	<5
Ca_{KCl}	%w/w	0.11	0.07	0.01	0.03	0.02
Ca_P	%w/w	0.14	0.17	0.02	0.04	0.02
Ca_A	%w/w	0.024	0.10	<0.005	0.006	<0.005
Mg_{KCl}	%w/w	0.005	<0.005	<0.005	<0.005	<0.005
Mg_P	%w/w	<0.005	0.006	<0.005	<0.005	<0.005
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<10	<10	<10	<10	<10
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
a-Net Acidity without ANCE	moles H^+/t	NA	<10	NA	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	<0.75	NA	NA	NA

sPOCAS Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- ----------	132766-A-56 BH112 1.5 12/08/2015 Soil	132766-A-60 BH113 1 12/08/2015 Soil	132766-A-65 BH114 1 12/08/2015 Soil	132766-A-75 BH116 1.5 12/08/2015 Soil	132766-A-99 BH121 1 12/08/2015 Soil
Date prepared	-	31/08/2015	31/08/2015	31/08/2015	31/08/2015	31/08/2015
Date analysed	-	31/08/2015	31/08/2015	31/08/2015	31/08/2015	31/08/2015
pH $_{kcl}$	pH units	6.6	6.5	7.5	7.2	7.3
TAA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	5.7	5.6	6.0	5.7	5.7
TPA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
ANC_E	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANC_E	moles H^+/t	<5	<5	<5	<5	<5
s-ANC_E	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S_{POS}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+/t	<5	<5	<5	<5	<5
Ca_{KCl}	%w/w	0.008	0.008	0.05	0.03	0.04
Ca_P	%w/w	0.008	0.009	0.06	0.05	0.05
Ca_A	%w/w	<0.005	<0.005	0.014	0.014	0.010
Mg_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_P	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<10	<10	<10	<10	<10
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
a-Net Acidity without ANCE	moles H^+/t	NA	NA	NA	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	NA	NA	NA	NA

Method ID	Methodology Summary
Inorg-064	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

Client Reference: 84677.01, Kurnell

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			31/08/2015	132766-A-4	31/08/2015 || 31/08/2015	LCS-1	31/08/2015
Date analysed	-			31/08/2015	132766-A-4	31/08/2015 || 31/08/2015	LCS-1	31/08/2015
pH kcl	pH units		Inorg-064	[NT]	132766-A-4	7.6 || 7.7 || RPD: 1	LCS-1	93%
TAA pH 6.5	moles H^+/t	5	Inorg-064	<5	132766-A-4	<5 || <5	LCS-1	97%
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	132766-A-4	<0.01 || <0.01	[NR]	[NR]
pH ox	pH units		Inorg-064	[NT]	132766-A-4	4.6 || 4.7 || RPD: 2	LCS-1	104%
TPA pH 6.5	moles H^+/t	5	Inorg-064	<5	132766-A-4	<5 || <5	LCS-1	90%
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	132766-A-4	<0.01 || <0.01	[NR]	[NR]
TSA pH 6.5	moles H^+/t	5	Inorg-064	<5	132766-A-4	<5 || <5	LCS-1	89%
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	132766-A-4	<0.01 || <0.01	[NR]	[NR]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	132766-A-4	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	5	Inorg-064	<5	132766-A-4	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	132766-A-4	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	132766-A-4	<0.005 || <0.005	LCS-1	111%
S_P	%w/w	0.005	Inorg-064	<0.005	132766-A-4	0.02 || 0.02 || RPD: 0	LCS-1	91%
S_{POS}	%w/w	0.005	Inorg-064	<0.005	132766-A-4	0.01 || 0.01 || RPD: 0	LCS-1	86%
a-S_{POS}	moles H^+/t	5	Inorg-064	<5	132766-A-4	9 || 9 || RPD: 0	LCS-1	86%
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	132766-A-4	0.11 || 0.09 || RPD: 20	LCS-1	99%
Ca_P	%w/w	0.005	Inorg-064	<0.005	132766-A-4	0.14 || 0.13 || RPD: 7	[NR]	[NR]
Ca_A	%w/w	0.005	Inorg-064	<0.005	132766-A-4	0.024 || 0.038 || RPD: 45	[NR]	[NR]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	132766-A-4	0.005 || <0.005	LCS-1	103%
Mg_P	%w/w	0.005	Inorg-064	<0.005	132766-A-4	<0.005 || <0.005	[NR]	[NR]
Mg_A	%w/w	0.005	Inorg-064	<0.005	132766-A-4	<0.005 || <0.005	[NR]	[NR]
S_{HCl}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NR]	[NR]
S_{NAS}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NR]	[NR]
a-S_{NAS}	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NR]	[NR]
s-S_{NAS}	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NR]	[NR]
Fineness Factor	-	1.5	Inorg-064	<1.5	132766-A-4	1.5 || 1.5 || RPD: 0	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	Inorg-064	<10	132766-A-4	<10 || <10	LCS-1	86%
Liming rate	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	132766-A-4	<0.75 || <0.75	LCS-1	86%

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
a-Net Acidity without ANCE	moles H^+/t	10	Inorg-064	<10	132766-A-4	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	132766-A-4	NA || NA	[NR]	[NR]

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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.

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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-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.