Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Baseline Groundwater Investigation

Kariong Sand & Soil Supplies Facility
90 Gindurra Road, Somersby

Prepared for
Davis Earthmoving & Quarrying Pty Ltd

Project 83636.00
July 2020

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	83636.00	Document No.	R.001.Rev1
Document title	Report on Baseline Groundwater Investigation Kariong Sand & Soil Supplies Facility		
Site address	90 Gindurra Road, Somersby		
Report prepared for	Davis Earthmoving & Quarrying Pty Ltd		
File name	83636.00.R.001.Rev1.Baseline Groundwater Report.FINAL		

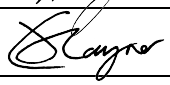
Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Brent Kerry	Dean Woods	10 July 2019
Revision 1	Brent Kerry	Dean Woods	8 July 2020

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Davis Earthmoving & Quarrying Pty Ltd
Revision 0	1	1	DP Archives
Revision 1	1	0	Davis Earthmoving & Quarrying Pty Ltd
Revision 1	1	1	DP Archives

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

	Signature		Date
Author			8 July 2020
Reviewer		For Dean Woods	8 July 2020

bsi. ISO 9001 Quality Management
FS 604853

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Report on Baseline Groundwater Investigation
Kariong Sand & Soil Supplies Facility
90 Gindurra Road, Somersby

1. Introduction

This report presents the methodology and results of a baseline groundwater investigation (BGI) undertaken by Douglas Partners Pty Ltd (DP) for a proposed new construction and demolition waste recycling facility at 90 Gindurra Road, Somersby. The investigation was commissioned by Jackson Environment and Planning Pty Ltd on behalf of Davis Earthmoving & Quarrying Pty Ltd (DEQ) and was undertaken with reference to DP proposal CCT190157.P.001.Rev0 dated 15 May 2019.

The objective of the BGI was to establish the nature and extent of groundwater flows in the locality of the proposed recycling facility, with reference to the Department of Industry recommendations (Ref OUT19/1319, dated 26 March 2019) and NSW Planning and Environment request (Ref SSD 8660, dated 29 March 2019).

2. Scope of Work

The scope of work for the BGI comprised the following:

- Collation and interpretation of data from topographical, geological and hydrogeological maps to assess the environmental setting and update the site historical information;
- Preparation of a conceptual site model to identify sources, pathways and receptors of potential contamination as well as confirm the analysis suite described below;
- A site walkover with the nominated Site Representative (Mr Eric Davis) to assess site access and proposed monitoring well locations;
- Installation of three new groundwater monitoring wells (i.e. Wells 1 to 3), with reference to industry standards, that aimed to intercept shallow groundwater seepage conditions at the site. Installation of the monitoring wells were limited to accessible locations (i.e. not obstructed by existing vegetation), and with respect to the recommendations of the Department of Industry (i.e. one up-gradient of the site and two down-gradient (south-west and south) of the site);
- An initial groundwater monitoring event (GME) at new well locations (i.e. Wells 1 to 3) comprising:
    - All well locations were surveyed using a differential GPS;
    - Gauging relative groundwater depths and elevations;
    - Low-flow purging of groundwater and measuring field parameters (pH, total dissolved solids (TDS), dissolved oxygen (DO) and reduction oxidation potential (Redox)) prior to the collection of groundwater samples; and

- Submit groundwater samples to Envirolab Services Pty Ltd (NATA accredited laboratory) for analysis of the following analytical suite:
  - Metals (As, Ba, Be, Bo, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Th, Va and Zn);
  - Petroleum Hydrocarbons (total recoverable hydrocarbons (TRH), benzene, toluene, ethyl benzene, xylene (BTEX) and polycyclic aromatic hydrocarbons (PAH));
  - Organochlorine Pesticides (OCP);
  - Cation / Anions (Ca, K, Na, Mg, OH, CO_3, HCO_3, alkalinity, SO_4 and Cl);
  - Nutrients (tot-N, NO_2, NO_3, NH_3, tot-P and PO_4).
- Preparation of this report outlining the works undertaken and the findings of the BGI.

Specifics of the work completed are presented in the Sections 9 and 10 of this report.

3. Site Description and Activities

The proposed new construction and demolition waste recycling facility is to be located (in the northern portion) at part of the property identified as Lot 4 in Deposited Plan 227279. The larger property has a street address of 90 Gindurra Road, Somersby, and is located near the intersection of Gindurra Road and Debenham Road South.

The following is a brief summary of relevant site conditions:

- The site was formerly operated as Kariong Landscape Supplies;
- Construction activities had commenced on-site for a new industrial shed (i.e. clearing and topsoil stripping) in the north-east portion of the site; and
- Remaining portions of the site appeared to be relatively unutilised, vegetated with a mix of bushland (probably mostly regrowth) with numerous material stockpiles and suspected fill materials positioned around the site. The site was generally accessed via cleared tracks.

4. Physical Setting

4.1 Topography and Hydrology

Review of topographic mapping indicates that site surface levels range between approximately 214 m AHD in the north corner, down to approximately 200 m AHD in the south-west corner. Typically, surface levels slope down to the south and west at gradients ranging between of 1% and 10%, with some suspected localised modifications to the natural site topography as a result of historical earthwork (e.g. placement of fill) activities.

An intermittent tributary of Piles Creek is mapped as being located approximately 500 m south of the site. It is suspected that Piles Creek is the nearest ecological receptor for groundwater migrating from the site.

A review of historic aerial photographs indicated that the majority of the site was cleared from bushland and appeared to have a rural use (circa 1975), and then was subject to earthwork activities (e.g. materials and fill stockpiled across the site circa 2002) possibly consistent with the identified Kariong Landscape Supplies usage.

4.2 Rainfall and Climate

No site-specific temperature, evaporation or rainfall data is available; however, the data provided in Table 1 is average climate data from the Ourimbah (Dog Trap Road) weather station, which is located approximately 4.4 km from the site. In summary, the climate data generally identifies higher than average rainfall in summer, autumn and early winter, with drier winter and spring conditions.

Table 1: Average Climate Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Rainfall (mm)	140.3	190.7	170.9	120.8	107.4	131.1	60.7	76.4	64.7	92.2	108.7	103.5
Mean Evaporation (mm)	142.6	114.8	105.4	78	55.8	48	52.7	74.4	102	124	129	145.7

Note: Evaporation data sourced from Peat Ridge AWS – Located approximately 14.2 km from the site.

It should be noted that the field work was completed during a period of wetter than average conditions. In addition, given the time-lag in rainfall reaching the groundwater table, the period of monitoring (in June) was considered to be appropriate for assessing the site conditions.

4.3 Geology and Soil Landscape

Reference to the local geological mapping indicates that the site is generally underlain by Hawkesbury Sandstone which typically comprises medium to very coarse-grained quartz sandstone, minor laminated mudstone and siltstone lenses. Hawkesbury Sandstone typically weathers to form sandy, residual soils.

Reference to the local soil landscape mapping indicates that the site is located within the Sydney Town erosional soil landscape area. This soil landscape group is described as undulating to rolling low hills on the Hawkesbury Sandstone plateau.

Limitations to development associated with the soil landscape are listed as very high erosion hazard, permanent waterlogging (localised), highly permeable, strongly acid soil with very low fertility.

4.4 Acid Sulfate Soils

Reference to the local acid sulfate soil mapping indicates that the investigation area generally has no mapped risk of acid sulfate soils. The risk mapping is consistent with the site topography and the encountered subsurface conditions.

4.5 Groundwater

Given the site's topography and geology it was considered likely that permanent groundwater would be present at least several metres below the existing ground surface within the sandstone bedrock. Shallower seepage may be present at the interface of localised permeability boundaries such as at the interface of the soil and weathered rock profile. This shallower seepage was targeted for this BGI as this groundwater regime has the higher risk of being impacted by site or local activities.

A search for registered groundwater bores in the Water NSW groundwater bore database [Note: this function has been taken up by NSW Office of Water] indicated that there were approximately five registered groundwater bores within a 500 m radius of the site. All five bore were located to the east of the site (suspected to be up-gradient / across from the site) and had a mix of authorised purposes comprising domestic, stock and irrigation. The bores were installed to depths of typically greater than 35 m. A copy of the search results is provided in Appendix B.

Based on the information available, it is considered that the tributary of Pile Creek and possibly the nearby groundwater bores would be the nearest groundwater receptors.

5. Previous Investigations and Client Supplied Information

5.1 Stage 1 Preliminary Site Investigation 2018

Clearsafe Environmental Solutions (CES) completed a preliminary site contamination investigation for the proposed construction and demolition recycling facility in March 2018. The report was entitled *Stage 1 Preliminary Site Investigation, 90 Gindurra Road, Somersby NSW 2250,* dated March 2018 (CES 2018).

The scope of the investigation comprised a desktop review of the site's past land uses together with a site walkover inspection and a limited sampling regime to assess for evidence of contamination or prior contaminating activities. The review identified that the site appeared to have previously been used for storing and screening soil and sand, which was then sold for landscaping. The review also identified four potential areas of environmental concern, that were investigated as part of the CES 2018 investigation. The limited sampling and testing programme was limited to existing site soils below current ground levels (i.e. excluded stockpiled materials).

In summary, CES concluded that the site is unlikely to pose a significant contamination risk with regards to chemical contamination, however asbestos-containing-material (ACM) was identified on ground surfaces within the north-eastern and central sections of the site. Several recommendations were made by CES, with respect to management of potential contamination issues and development of the site.

No assessment or comment on groundwater conditions were provided in the CES 2018 report.

6. Preliminary Conceptual Site Model

A conceptual site model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM provides the framework for identifying how the site could became contaminated and how potential receptors may be exposed to contamination either in the future *i.e.* it enables an assessment of the potential source – pathway – receptor linkages.

This CSM is limited to the identified potential contamination source (i.e. proposed Kariong Sand & Soil Supplies Facility) and exposure pathways associated with the identified likely receptor (i.e. tributary of Pile Creek and possibly the nearby groundwater bores).

6.1 Potential Contamination Source and Contaminants of Concern

Table 2 summarises the identified potential source of contamination and associated contaminants of concern which may be impacting the proposed Kariong Sand & Soil Supplies Facility.

Table 2: Identified Potential Contamination Sources and Contaminants of Concern

Potential Contamination Source/Activity	Description of Potential Contaminating Activity	Primary Potential Contaminants of Concern
Proposed new construction and demolition waste recycling facility	Processing and storage of construction and demolition waste	Various; however, the contamination suite was limited to primary potential contaminants of concern: pH, EC, metals, petroleum hydrocarbons, pesticides, cations / anions and nutrients.

For the purpose of developing a conceptual site model, the potential source of contamination investigated is summarised as:

- S1 - Processing and storage of construction and demolition waste.

6.2 Potential Receptors of Concern

The potential receptors of concern for the identified potential contamination source are limited to the following:

- R1 - Site users (i.e. site staff);
- R2 - Surface water (i.e. tributary of Pile Creek);
- R3 - Groundwater;
- R4 - Terrestrial ecology; and

- R5 - Property (i.e. buildings current and future).

6.3 Potential Contamination Migration Pathways

The pathways by which the potential sources of contamination could reach potential receptors are described below:

- P1 - Ingestion and dermal contact;
- P2 - Surface run off;
- P3 - Leaching and migration of groundwater; and
- P4 - Direct contact with terrestrial wildlife and plant material.

6.4 Conceptual Site Model

A conceptual site model (CSM) is presented in Table 3. It is a representation of site information regarding the potential contamination source and associated exposure pathways and potential receptors identified from site historical information and walkover. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future *i.e.* it enables an assessment of the potential source – pathway – receptor linkages.

Table 3: Conceptual Site Model

Potential Source	Pathway	Receptor
S1 - Processing and storage of construction and demolition waste.	P1 – Ingestion and dermal contact	R1 – Site users
	P2 – Surface run off	R1 – Site users
	P3 - Leaching and migration of groundwater	R2 - Surface water (i.e. tributary of Pile Creek) R3 - Groundwater R4 - Terrestrial ecology
	P4 – Direct contact with terrestrial wildlife and plant material	R4 – Terrestrial ecology R5 – Property

The scope of the current investigation was limited to groundwater for the purposes of a baseline study as requested by the client.

7. Data Quality Objectives

The investigation has been devised with reference to with the seven-step data quality objective (DQO) process, which is provided in Appendix B, Schedule B2 of the National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 (NEPC 2013). The DQO process is outlined as follows:

- Stating the Problem;
- Identifying the Decision;
- Identifying Inputs to the Decision;
- Defining the Boundary of the Assessment;
- Developing a Decision Rule;
- Specifying Acceptable Limits on Decision Errors; and
- Optimising the Design for Obtaining Data.

The DQOs have been addressed within the report as shown in Table 4.

Table 4: Data Quality Objectives

Data Quality Objective	Report Section Where Addressed
State the Problem	S1 Introduction
Identify the Decision	S11 Discussion of Results S12 Conclusions and Recommendations
Identify Inputs to the Decision	S1 Introduction S3 Site Description and Activities S4 Physical Setting S5 Previous Investigations and Client Supplied Information S6 Preliminary Conceptual Site Model S8 Comparative Groundwater Investigation Levels S9 Field Work S10 Laboratory Testing
Define the Boundary of the Assessment	S1 Introduction Drawing 1 - Appendix A
Develop a Decision Rule	S8 Comparative Groundwater Investigation Levels
Specify Acceptable Limits on Decision Errors	S9 Field Work S10 Laboratory Testing Quality Assurance / Quality Control for Groundwater Sampling - Appendix F
Optimise the Design for Obtaining Data	S2 Scope of Works S9 Field Work Quality Assurance / Quality Control for Groundwater Sampling - Appendix F

8. Comparative Groundwater Investigation Levels

The Groundwater Investigation Levels (GIL) applied in the current investigation has initially considered humans and terrestrial ecology to be potential receptors to potential contamination from the site. Analytical results were assessed (as a Tier 1 assessment) primarily against the GIL of Schedule B1, *National Environment Protection (Assessment of Site Contamination) Measure* 1999, as amended 2013 (NEPC, 2013).

The ANZECC & ARMCANZ (2000) guidelines were revised and replaced in 2018 with the Australian and New Zealand Governments (ANZG), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2018 (ANZG, 2018). The criteria adopted are consistent with the default guideline values presented in ANZG (2018).

Further consideration could be given to the adoption of other comparative levels such as those for Primary Industries (i.e. irrigation waters); however, adoption of these would require consideration of site-specific factors at the nearby rural properties (which was beyond the scope of the current investigation). The adopted GIL are listed in the analytical results Table D1 in Appendix D and are presented for comparative purposes only.

9. Field Work

9.1 Programme

Field work for the BGI was undertaken between 31 May and 20 June 2019, and is summarised in Table 5.

Table 5: Field Work Programme

Date(s)	Description of Field Work Completed	Additional Comments
31 May 2019	A site walkover to assess site access and proposed monitoring well locations.	The proposed well locations set-out with the client and were limited to locations accessible to a 4WD-mounted drilling rig.
7 June 2019	Drill Bores 2 and 3. Installation of monitoring Wells 2 and 3.	Logs prepared for each borehole recording the subsurface locations encountered and the well installation details.
12 June 2019	Dip and develop Wells 2 and 3.	
14 June 2019	Drill Bore 1. Installation and development of monitoring Well 1.	Log prepared for each borehole recording the subsurface locations encountered and the well installation details.
20 June 2019	Monitoring of groundwater Wells 1, 2 and 3.	Well locations were surveyed using a differential GPS unit.

Copies of the borehole logs and calibration records are provided in Appendix C.

The approximate locations of the groundwater monitoring wells are presented in Drawing 1 in Appendix A.

9.2 Methodology

9.2.1 Borehole Drilling, Well Design and Installation

The boreholes were drilled using a using a truck-mounted drilling rig fitted with 120 mm diameter solid flight augers. The bores (designated Bores 1 to 3) were drilled to depths ranging between 3.5 m and 8.3 m. The subsurface conditions encountered in the bores were logged by an experienced engineer who also collected representative samples for strata identification purposes.

Groundwater wells constructed of 50 mm diameter flush threaded Class 18 PVC were installed in Bores 1 to 3 with reference to current industry standards.

A filter pack was installed in the bore annulus consisting of 5/2 graded and washed gravel above the top of the machine slotted PVC screen. The slotted screen was installed to a depth and geological profile consistent with the expected groundwater levels (above the encountered groundwater level with a 2.5 m to 3 m screen length).

A bentonite seal (typically 0.5 – 1 m thick) was placed above the filter pack. The wells were completed with lockable metal monument covers extending approximately 1 m above the ground surface. A torque cap was installed at the top of each well as part of groundwater well installation activities. Each well was developed by removing approximately five well volumes or until the well was dry. Construction details of the individual wells are provided on the borehole logs (Appendix C). Drilling and well installation was undertaken to minimise the risk of cross contamination. The monitoring wells were surveyed using a differential GPS unit to calculate the relative elevation of each well location.

A summary of the groundwater monitoring well construction details is provided in Table 6.

Table 6: Groundwater Monitoring Well Construction Details

Well ID	Surface RL (m AHD)	Date Drilled	Initial Groundwater Observations (m bgl)	Screen Range (m bgl)	Gravel Pack Range (m bgl)	Total Well Depth (m bgl)	Stabilised Groundwater Observations (m bgl)
1	213.32	14/06/2019	6.6 (seepage)	5.3 – 8.3	1.5 – 8.3	8.3	7.26
2	199.04	07/06/2019	2.0 (seepage)	1.0 – 3.5	0.5 – 3.5	3.5	1.15
3	206.44	07/06/2019	6.4 m (minor seepage)	5.0 – 8.0	1.0 – 8.0	8.0	5.04

Notes:
AHD = Australian Height Datum
m bgl = metres below ground level

9.2.2 Groundwater and Surface Sampling

For the groundwater monitoring programme, prior to sampling, an interface probe was used to measure the groundwater level and the possible presence of non-aqueous phase liquid (i.e. floating product). Groundwater was then purged using a low-flow sampling techniques *i.e.* until stabilised groundwater parameters were recorded.

All sampling activities were completed by suitability trained and experienced professional.

Field parameters (pH, temperature, dissolved oxygen, electric conductivity, and redox) were determined in a flow cell for each well/location using a calibrated field water quality meter (*i.e.* YSI ProDSS model). Samples from wells were then collected using the low-flow sampling kit into laboratory prepared containers for analysis.

Groundwater samples scheduled for metal analysis were filtered in the field (using a new 0.45 micron filter). Sample containers were labelled with individual and unique identification, including project number, sample location; and the bottles were placed into an ice-cooled, insulated and sealed container while on site.

Envirolab, accredited by NATA, was employed to conduct the sample analysis. The laboratory is required to carry out in-house QC procedures.

9.3 Subsurface Conditions

A log of subsurface conditions encountered in each of the Bores 1 to 3 is presented in Appendix C. These should be read in conjunction with the accompanying explanatory notes in Appendix C, which define the descriptive terms and classification methods used in the report. However, the following summary is provided:

- Topsoil and Silty Sand: Fine to medium grained grey-brown silty sand soil was encountered in all bores to relatively shallow depths (0.35 m to 0.5 m below ground level (bgl)); and
- Weathered Sandstone: Fine to medium grained generally light grey-brown to dark red-brown weathered sandstone with iron cemented bands were encountered in all bores to the termination depth of the bores (3.5 m to 8.5 m bgl).

Groundwater seepage inflows were observed in all bores during the course of drilling at depths ranging between approximately 2.0 m and 6.6 m below existing ground levels. Stabilised depths of groundwater were measured in the wells and ranged between 1.15 m (Well 2) and 7.25 m (Well 1). It should be noted that groundwater levels are variable and affected by factors such as soil permeability and recent weather conditions.

Interpolated groundwater equipotential contours are shown on Drawing 1, Appendix A. The groundwater contours are based on the stabilised gauging results recorded during the 20 June 2019 monitoring event.

10. Laboratory Testing

10.1 Groundwater Laboratory Program

As part of the groundwater monitoring event (20 June 2019) groundwater samples (plus additional quality control samples) were analysed for selected potential contaminants comprising:

- Metals (Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Th, Va and Zn);

- Petroleum Hydrocarbons (TRH, BTEX and PAH);
- Pesticides (OCP only);
- Cation / Anions (Ca, K, Na, Mg, OH, CO_3, HCO_3, alkalinity, SO_4 and Cl); and
- Nutrients (tot-N, NO_2, NO_3, NH_3, tot-P and PO_4).

The results of initial (baseline) monitoring and chemical analysis are summarised in Table D1 in Appendix D.

The laboratory certificates are contained within Appendix E, together with the chain of custody dispatch sheets. Results of the QA/QC are discussed in Appendix F. Based on a review of the field and laboratory QA/QC results, it is considered that the laboratory test data obtained are reliable and useable for this assessment.

10.2 Groundwater Results

The field monitoring and laboratory test results are summarised in Table D1 in Appendix D.

11. Discussion of Results

11.1 Field Monitoring Results

The following comments are provided:

- The stabilised depth to groundwater ranged between 1.15 m (bgl) at Well 2 and 7.25 m bgl at Well 1 in June 2019. Interpolation of the reported groundwater elevations (for relative elevations refer to Table D1, Appendix D and Drawing 1, Appendix B) based on the June 2019 monitoring indicates that the groundwater piezometric surface (or groundwater gradient) appears to slope down to the south-west and west, broadly following the site topography;
- Non-aqueous phase liquid (NAPL) was not identified during gauging of groundwater levels or purging of the monitoring wells on site. Furthermore, no odours potentially indicating volatile organic compound contamination were noted in the bores;
- Groundwater was generally moderately to strongly acidic, with groundwater pH results ranging between pH 4.3 and pH 5.6. Groundwater collected from all wells exceeded the pH trigger values for fresh and drinking water. It should be noted, however, that acidic groundwater conditions are generally considered to be representative of local background conditions and do not necessarily indicate the presence of groundwater contamination; and
- Relatively low groundwater salinity levels, ranging between 216 µS/cm and 420 µS/cm, were encountered in all wells and these may be consistent with local groundwater salinity conditions.

11.2 Cation and Anion Laboratory Results

Groundwater samples were analysed for a suite of major anions and cations comprising Ca, K, Na, Mg, OH, CO_3, HCO_3, alkalinity, SO_4 and Cl.

The following comments are provided:

- Groundwater in the investigation area is considered to be sodium and chlorine dominant, with the possible exception of Well 2 where a slightly more balanced (i.e. not dominated by one cation and anion) was reported;
- The increased proportion of Ca and SO_4 in Well 2 may be influenced by the former site activities which appeared to include the stockpiling of building materials (evidence by the nearby stockpiles of concrete); and
- All groundwater samples reported low alkalinity levels which are considered to be generally representative of background conditions with the Hawkesbury Sandstone formation.

11.3 Inorganic and Organic Results

Samples were analysed for a suite of inorganic and metal elements, with the results summarised in Table D1. The results were compared to generic GIL presented in NEPM 2013 for comparison purposes only. The following comments are provided:

- All groundwater samples detected dissolved Pb and/or Zn concentrations that exceeded the adopted comparative freshwater GIL. The marginal zinc exceedances reported in all wells are likely to be consistent with background conditions with the Hawkesbury Sandstone formation and do not necessarily indicate a potential source of zinc impact within the site. The detectable lead concentration reported in Well 2 (only) is considered to be marginally elevated (i.e. 0.004 mg/L compared to a freshwater GIL of 0.0034 mg/L) and in comparison to the possible background concentrations reported in Wells 1 and 3. Lead concentrations in Well 2 may be representative of some possible groundwater impact caused by past site activities, possibly through a process of dissolution of metals caused by acidic groundwater conditions. It should be noted; however, that the lead concentrations in Well 2 were significantly less than the comparative drinking water GIL. Follow-up groundwater monitoring would be required to confirm the repeatability of this initial monitoring result; and
- All groundwater samples reported non-detectable concentrations of potential organic contaminants.

12. Conclusions and Recommendations

DP has undertaken a BGI to provide an initial assessment of the nature and extent of groundwater flows in the locality of the proposed recycling facility at 90 Gindurra Road, Somersby.

Based on the data collected, the following conclusions are provided:

- Three groundwater monitoring wells (Wells 1 to 3) were installed to assess baseline groundwater conditions at the site. The wells were positioned with reference to the recommendations of the Department of Industry and were limited to accessible locations within the site boundary;

- Groundwater seepage was encountered within the weathered Hawkesbury Sandstone formation, with stabilised depths to groundwater ranging between 1.15 m (bgl) at Well 2 and 7.25 m bgl in Well 1 in June 2019. The measured groundwater elevations infer a groundwater gradient and potentially a groundwater flow to the south-west and west;
- Groundwater at the site was assessed to be generally fresh (low salinity levels) and moderately to highly acidic which is considered to be consistent with local background groundwater conditions;
- No signs of obvious contamination were observed in the groundwater at the borehole locations monitored; and
- Generally low concentrations of potential contaminants were detected within the wells; however, some detectable concentrations of zinc and/or lead were reported that exceeded the comparative freshwater GIL. The zinc concentrations are likely to be consistent with background conditions with the Hawkesbury Sandstone formation and do not necessarily indicate a potential source of zinc impact within the site. The marginally elevated concentration of lead combined with the increased proportion of Ca and SO_4 in Well 2 may indicate that former site activities have had some impact on site groundwater conditions. It should be noted; however, that the lead concentration in Well 2 was significantly less than the comparative drinking water GIL. Follow-up groundwater monitoring would be required to confirm the repeatability of this initial monitoring result.

It is recommended that a groundwater monitoring and management plan is prepared for the proposed development. The plan should be prepared with respect to the recommendations of Department of Industry and it is anticipated that the existing monitoring wells will be incorporated into the future groundwater monitoring programme.

13. References

NEPC, 2013, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (amended 2013), National Environment Protection Council (NEPC).

ANZG, 2018, Australian and New Zealand Governments (ANZG), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2018.

CES 2018, *Stage 1 Preliminary Site Investigation, 90 Gindurra Road, Somersby NSW 2250,* dated March 2018, Clearsafe Environmental Solutions Pty Ltd.

14. Limitations

Douglas Partners (DP) has prepared this report for this project at 90 Gindurra Road, Somersby in accordance with DP's proposal CCT190157 dated 15 May 2019 and acceptance received from Davis Earthmoving & Quarrying Pty Ltd dated 31 May 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Davis Earthmoving & Quarrying Pty Ltd and Jackson Environment & Planning 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 report 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.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above), or to parts of the site being inaccessible and not available for inspection/sampling, or to vegetation preventing visual inspection and reasonable access.

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 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

Drawings 1 – Test Location Plan and Interpolated Groundwater Contours

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.

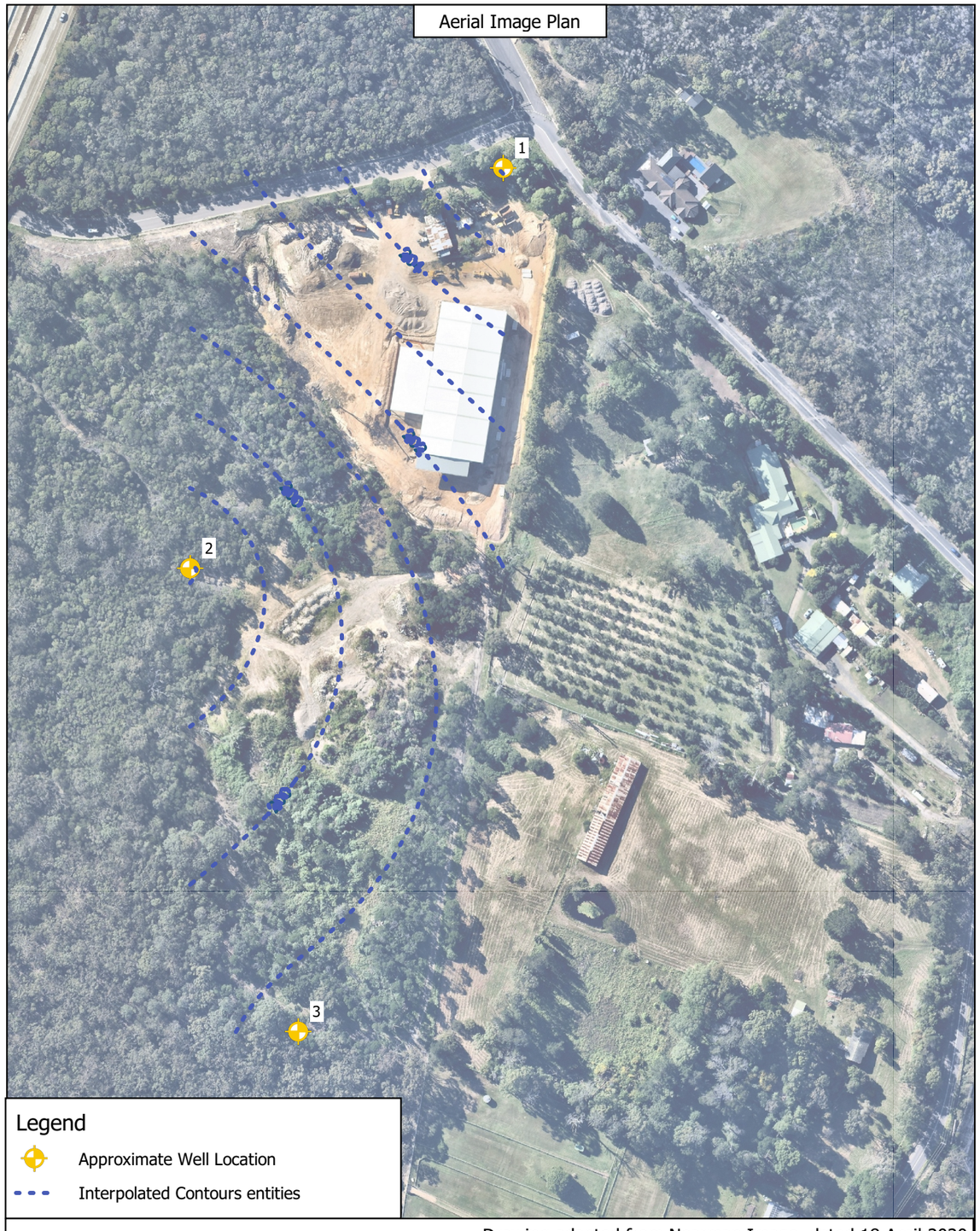
Information for Contractual Purposes

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.

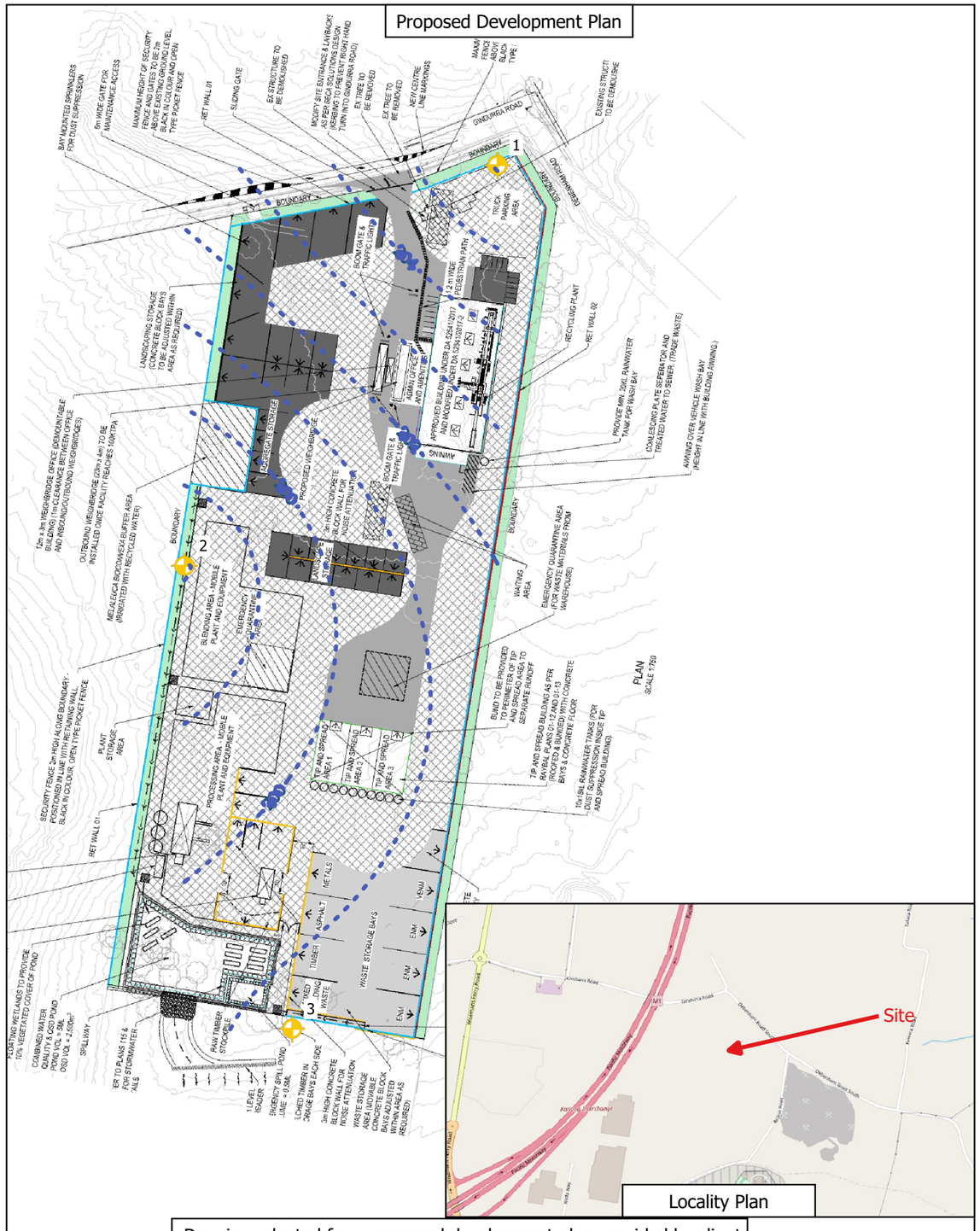
Aerial Image Plan



Drawing adapted from Nearmap Image, dated 18 April 2020

70 0 70 140 210 280 m

Proposed Development Plan



Drawing adapted from proposed development plan provided by client

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Davis Earthmoving & Quarrying		
	OFFICE: Central Coast	DRAWN BY: BJK	
	SCALE: As Shown	DATE: 06/07/2020	

TITLE: **Test Location Plan and Interpolated Groundwater Contours**
Baseline Groundwater Quality Assessment
90 Gindurra Road, Somersby

N

PROJECT No:	83636.00
DRAWING No:	1
REVISION:	2

Appendix B

Licensed Groundwater Bores


GW203273
GW104403
GW052457
GW061380
GW051146
GW029909
GW031934
GW056702
GW100594
GW100273
GW072923
GW026412
GW056846
GW104881
GW051977
Pacific Motorway
Old Pacific Highway
Wisemans Ferry Rd
Somersby Falls Rd

WaterNSW
Work Summary

GW104881

Licence: 20WA204163
Licence Status: CURRENT

Authorised Purpose (s): STOCK,DOMESTIC
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore
Work Status: New Bore
Construct.Method: Rotary Air
Owner Type: Private

Commenced Date:
Completion Date: 10/04/2003
Final Depth: 108.30 m
Drilled Depth: 108.30 m

Contractor Name: INTERTEC DRILLING SERVICES
Driller: Colin Leslie Barden
Assistant Driller:

Property: IVERS 32 Acacia Rd SOMERSBY 2250 NSW
GWMA: 606 - MANGROVE MOUNTAIN
GW Zone: 008 - MOONEY MOONEY AND MULLET CREEKS GROUNDWATER SOURCE
Standing Water Level (m): 31.000
Salinity Description:
Yield (L/s): 0.400

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTHUMBERLAND	GOSFO	LT A DP 420575
Licensed:	NORTHUMBERLAND	GOSFORD	Whole Lot A//420575

Region: 10 - Sydney South Coast
River Basin: 212 - HAWKESBURY RIVER
Area/District:
CMA Map: 9131-2S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6300826.000
Easting: 341991.000
Latitude: 33°25'13.1"S
Longitude: 151°18'01.9"E

GS Map: -
MGA Zone: 56
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	11.70	210			Down Hole Hammer
1		Hole	Hole	11.70	108.30	156			Down Hole Hammer
1	1	Casing	Steel	-0.40	11.60	168	158		Driven into Hole
1	1	Casing	Pvc Class 9	0.40	59.60	140			Suspended in Clamps, Screwed and Glued
1	1	Opening	Slots - Diagonal	22.00	24.00	140		0	PVC Class 9, SL: 100.0mm, A: 10.00mm
1	1	Opening		24.00	26.00	140		0	

			Slots - Diagonal						PVC Class 9, SL: 100.0mm, A: 10.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
20.30	24.30	4.00	Unknown			0.10	30.00		57.80
66.80	67.40	0.60	Unknown			0.10	72.00		89.20
105.00	106.00	1.00	Unknown	31.00		0.20	108.30		105.00

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	9.00	9.00	FILL	Fill	
9.00	18.30	9.30	SANDSTONE LT/BROWN	Sandstone	
18.30	19.30	1.00	CLAY GREY	Clay	
19.30	36.30	17.00	SANDSTONE/IRONSTONE BANDS	Sandstone	
36.30	39.80	3.50	QUARTZ	Invalid Code	
39.80	57.30	17.50	SANDSTONE GREY	Sandstone	
57.30	58.80	1.50	CLAY	Clay	
58.80	88.50	29.70	SANDSTONE GREY	Sandstone	
88.50	96.30	7.80	SANDSTONE DARK GREY	Sandstone	
96.30	108.30	12.00	SANDSTONE GREY	Sandstone	

***** End of GW104881 *****

WaterNSW
Work Summary

GW031934

Licence:
Licence Status:
Authorised Purpose (s):
Intended Purpose(s): DOMESTIC

Work Type: Bore open thru rock
Work Status:
Construct.Method: Rotary
Owner Type: Private

Commenced Date:
Completion Date: 01/02/1970
Final Depth: 35.00 m
Drilled Depth: 35.10 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property:
GWMA:
GW Zone:
Standing Water Level (m):
Salinity Description: Good
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	NORTHUMBERLAND	GOSFO	204
Licensed:			

Region: 10 - Sydney South Coast
CMA Map: 9131-2S
River Basin: 212 - HAWKESBURY RIVER
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6301373.000
Easting: 341987.000
Latitude: 33°24'55.3"S
Longitude: 151°18'02.1"E

GS Map: -
MGA Zone: 56
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	P.V.C.	-0.20	5.80	127			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.80	30.40	7.60	Consolidated	5.70		0.15			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Soil	Soil	
0.30	5.79	5.49	Sandstone Soft	Sandstone	
5.79	35.05	29.26	Sandstone Water Supply	Sandstone	
0.30	5.79	5.49	Clay Interlayere	Clay	

***** End of GW031934 *****

WaterNSW
Work Summary

GW026412

Licence:
Licence Status:
Authorised Purpose (s):
Intended Purpose(s): IRRIGATION

Work Type: Bore
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date:
Final Depth: 43.80 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property:
GWMA:
GW Zone:
Standing Water Level (m):
Salinity Description: 0-500 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:			
Licensed:	NORTHUMBERLAND	GOSFO	204

Region: 10 - Sydney South Coast
River Basin: 212 - HAWKESBURY RIVER
Area/District:
CMA Map: 9131-2S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6301127.000
Easting: 341991.000
Latitude: 33°25'03.3"S
Longitude: 151°18'02.1"E

GS Map: -
MGA Zone: 56
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing		0.00	4.20	152			

***** End of GW026412 *****

Appendix C

Borehole Logs

Calibration Records

Field Groundwater Sampling Form

BOREHOLE LOG

CLIENT: Davis Earthmoving & Quarrying Pty Ltd
PROJECT: Kariong Sand & Soil Supplies Facility
LOCATION: 90 Gindurra Road, Somersby

SURFACE LEVEL: 213.32 AHD
EASTING: 341925
NORTHING: 6301441
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 83636.00
DATE: 14/6/2019
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
213	0.2	TOPSOIL: Silty SAND SM: fine to medium grained, brown, dry to moist, with trace rootlets		D	0.1				From 0m to 0.5m, concrete
				D	0.3				
	0.5	Silty SAND: fine to medium grained, light brown silty SAND, dry - From 0.3m, some ironstone gravels							
	1	SANDSTONE: fine to medium grained, light grey/brown mottled red/brown, extremely to highly weathered		D	1.0				From 0.5m to 1.5m, bentonite
212									
	2	- At 2.2m to 2.3m, soft band							
211									
	3								
210									
		- At 3.6m to 3.7m, soft band - From 3.7m, harder							
	4								
209									
	5								From 1.5m to 8.3m, gravel
208		- At 5.4m to 6.0m, soft band							
	6								
207									
		- At 6.6m, seepage						▽	
	7	- At 7.1m to 7.3m, soft band						▼ 20-06-19	From 5.3m to 8.3m, 50mm Ø machine slotted PVC
206									
	8								
205	8.3	Bore discontinued at 8.3m- limit of investigation							At 8.3m, end cap
	9								
204									

RIG: FICO FG101 **DRILLER:** FICO **LOGGED:** BJK **CASING:**
TYPE OF BORING: 100mm Ø Spiral Flight Auger
WATER OBSERVATIONS: Seepage at 6.6m depth
REMARKS: Well completed with a lockable monument cover at 0.8m height

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: Davis Earthmoving & Quarrying Pty Ltd
PROJECT: Kariong Sand & Soil Supplies Facility
LOCATION: 90 Gindurra Road, Somersby

SURFACE LEVEL: 199.04 AHD
EASTING: 341777
NORTHING: 6301251
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 83636.00
DATE: 7 - 14/6/2019
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
199	0.4	TOPSOIL: Silty SAND SM: fine to medium grained, grey-brown, low plasticity silt, with root inclusions, moist							From 0m to 0.5m, bentonite
198	1	SANDSTONE: fine to medium grained, yellow-orange, dry to moist, extremely weathered (weakly to moderately cemented) - From 0.7m, becoming pale yellow-white, dry		D	0.6			20-06-19	
		- From 1.3m, slightly softer							
197	2	- From 2.0m, water seepage						▽	From 0.5m to 3.5m, gravel From 1.0m to 3.5m, 50mm Ø machine slotted PVC
196	3	- From 2.7m, increased resistance, inferred highly weathered rock to extremely weathered							
	3.5	Bore discontinued at 3.5m- limit of investigation							At 3.5m, end cap
195	4								
194	5								
193	6								
192	7								
191	8								
190	9								

RIG: FICO FG101 **DRILLER:** FICO **LOGGED:** MVB **CASING:**
TYPE OF BORING: 100mm Ø Spiral Flight Auger
WATER OBSERVATIONS: Seepage at 2.0m depth
REMARKS: Well completed with a lockable monument cover at 0.9m height

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: Davis Earthmoving & Quarrying Pty Ltd
PROJECT: Kariong Sand & Soil Supplies Facility
LOCATION: 90 Gindurra Road, Somersby

SURFACE LEVEL: 206.44 AHD
EASTING: 341828
NORTHING: 6301031
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 83636.00
DATE: 7 - 14/6/2019
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
206	0.35	TOPSOIL: Silty SAND SM: fine to medium grained, grey-brown, low plasticity silt, with root inclusions, moist							From 0m to 0.4m, concrete
		SANDSTONE: fine to medium grained, brown-orange, extremely to highly weathered		D	0.5				From 0.5m to 1.0m, bentonite
		- From 0.6m to 1.2m, becoming brown with some ironstone gravel inclusions							
205									
		- From 2.0m, becoming red, extremely weathered, softer		D	2.1				
204		- From approximately 2.3m to approximately 2.4m, clay band							
		- From 2.6m to 3.2m, increased resistance, inferred highly weathered, ironstone sand		D	2.8				
203									From 1.0m to 8.0m, gravel
202									
201		- From 5.2m, becoming pale yellow-white/orange						20-06-19	
200		- From 6.4m, soft clay, approximately 100mm thick (possible minor seepage band)							From 5.0m to 8.0m, 50mm Ø machine slotted PVC
199									
198	8.0	Bore discontinued at 8.0m- limit of investigation							At 8.0m, end cap
197									

RIG: FICO FG101 **DRILLER:** FICO **LOGGED:** MVB **CASING:**

TYPE OF BORING: 100mm Ø Spiral Flight Auger

WATER OBSERVATIONS: Possible minor seepage at 6.4m depth

REMARKS: Well completed with a lockable monument cover at 0.9m height

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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Sampling Methods

Douglas Partners

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.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. 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	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

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
Friable	Fr	-

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	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

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;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it 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 Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

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 occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

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 stronger. 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

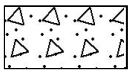
Symbols & Abbreviations

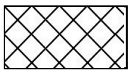
Graphic Symbols for Soil and Rock

General

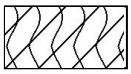

Asphalt

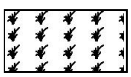

Road base

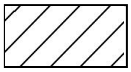

Concrete

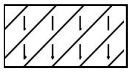

Filling

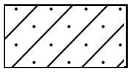
Soils


Topsoil

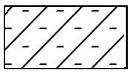

Peat

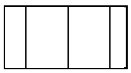

Clay

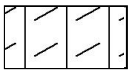

Silty clay

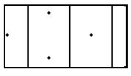

Sandy clay

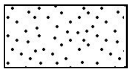

Gravelly clay

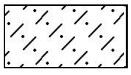

Shaly clay

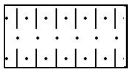

Silt


Clayey silt


Sandy silt

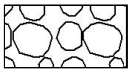

Sand

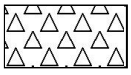

Clayey sand


Silty sand


Gravel

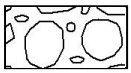

Sandy gravel


Cobbles, boulders

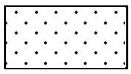

Talus

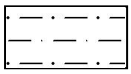
Sedimentary Rocks

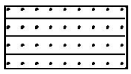

Boulder conglomerate

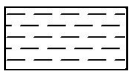

Conglomerate


Conglomeratic sandstone

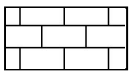

Sandstone


Siltstone

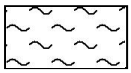

Laminite

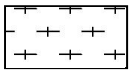

Mudstone, claystone, shale

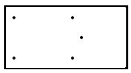

Coal


Limestone

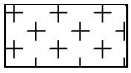
Metamorphic Rocks

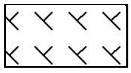

Slate, phyllite, schist

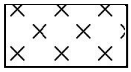

Gneiss

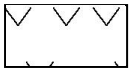

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

AES
sensing safety

Calibration & Service Report
Water Quality Meter

Company:	Active Environmental Solutions Hire	Manufacturer:	Geotech	Serial #:	5188
Address:	Unit 16, 191 Parramatta Road AUBURN NSW 2144	Instrument/Model:	51350021	Cable Length:	4.5m
Phone:	02 9716 5966 | Fax: 02 9716 5988	Client Company:		Client Email:	
Email:	hire@aesoultions.com.au	Client Name:		Client Phone:	

Equipment Check

Geopump Peristaltic Pump

Customer:		**Manufacturer:**	Geotech
Contact:	Milenko	**Instrument:**	Peristaltic Pump
Order:		**Serial #:**	5188
		Head Serial #:	D18003975
		Cable length:	4.5m

Item	Test	Pass	Comments
Battery	12 Voltage	✓	Voltage above 13 V
	Fuses	✓	
	Capacity	✓	
Pump	Decontaminated	✓	
	Condition	✓	
	Operation	✓	
	0.5 m Silicon Tubing	✓	New Tubing
Charger	Condition	✓	
Hard Case	Condition	✓	
Instrument Test	Operation checked	✓	
Instruction manual	Included	✓	

Comments

2 batteries sent.

This is to certify that the above instrument has been checked and is in good working order.

Checked By: Milenko Sisic

Check Date: 18/06/2019 Due for Check: 18/12/2019

Calibration & Service Report
Water Quality Meter

Company:	Active Environmental Solutions Hire	Manufacturer:	YSI	Serial #:	18K100442
Address:	Unit 16, 191 Parramatta Road AUBURN NSW 2144	Instrument/Model:	WQM Professional Plus w/ Quatro Cable	Cable Length:	1m
Phone:	02 9716 5966 | Fax: 02 9716 5988	Client Company:		Client Email:	
Email:	hire@aesoultions.com.au	Client Name:		Client Phone:	

Item	Test	Pass	Comments
Battery	2 x Alkaline C-cells	✓	Voltage reading above 2.9V
	Battery Saver	✓	Automatically turns off after 60 minutes if not used
Connections	Condition	✓	Good, clean
Cable	Condition	✓	Clean, no tears
Display	Operation	✓	
Firmware	Version	✓	4.0.0
Keypad	Operational	✓	
Display	Screen	✓	
Unit	Condition, seals and O-rings	✓	
Monitor housing	Condition	✓	
pH			
Condition		✓	Good, clean
pH millivolts for pH7 calibration range 0 mV ± 50 mV		✓	
pH 4 mV range + 165 to + 180 from 7 buffer mV value		✓	
pH slope		✓	55 to 60 mV/pH; ideal 59mV
Response time < 90 seconds		✓	
Calibrated and conforms to manufacturer's specifications		✓	
ORP			
Condition		✓	Good, clean
Response time < 90 seconds		✓	
within ± 80mv of reference Zobell Reading		✓	
Calibrated and conforms to manufacturer's specifications		✓	Variance range ± 20mV
Conductivity			
Condition		✓	Good, clean
Temperature		✓	°C
Conductivity cell constant 5.0 ± 1.0 in GLP file		✓	
Clean sensor reads less than 3 uS/cm in dry air		✓	
Calibrated and conforms to manufacturer's specifications		✓	µs/cm
Dissolved Oxygen			
Condition		✓	Good, clean
DO sensor in use		✓	Polarographic
1.25 mil PE membrane (yellow membrane):		✓	
DO Sensor Value		✓	(min 4.31 uA - max 8.00 uA) Avg 6.15 uA
Calibrated and conforms to manufacturer's specifications		✓	ppm

				Instrument Readings		
Parameter	Standards	Reference	Calibration Point	Before	After	Units
Temperature	Center 370 Thermometer	Room Temp.	19.3	N/A	19.4	°C
pH	pH 4.00	321062	4.01	3.98	4.01	pH
pH	pH 7.00	321423	7.00	6.97	7.00	pH
Conductivity	2760 µs/cm at 25°C	321761	2760	2771	2760	µs/cm
ORP (Ref. check only)	Zobell A & B	326918 & 326693	237.2	234.1	237.2	mV
Zero Dissolved Oxygen	NaSO3 in distilled water	283762	0.0	-0.6	0.0	%
100% Dissolved Oxygen	100% Air Saturation	Fresh Air	100.0	101.0	100.0	%

Calibrated By: Milenko Sisic

Calibration Date: 18/06/2019 Calibration Due: 18/12/2019

Douglas Partners
Geotechnics | Environment | Groundwater

GROUNDWATER SAMPLING FORM

Project: Kariong Sand & Soil Supplies Facility	**Project No:** 83636.00
Client: Davis Earthmoving & Quarrying Pty Ltd	
Location: 90 Gindurra Road, Somersby	
Sampling Method: Low-Flow - Peristaltic Pump (QA)	

Bore No.	1		2		3
Purging Date	20/6/19		20/6/19		20/6
Bore Casing Diameter (mm)	50		50		50
SWL (m below top of casing)	7.925		1.88		5.845
Height of Casing (m above GL*)	0.67		0.73		0.81
SWL (m below GL*)	7.255		1.15		5.035
Total Bore Depth (m below GL*)	~8.3		~3.5		~8
Well Volume (L) **[which for 50mm casing is 2L approx. per metre depth]					
Purged Volume (L) (≈ well vol x 3)	~3L		~4L		~4L
Sampling Date	20/6/19		20/6/19		20/6/19
Sampling Time	13:00		14:45		14:00
Temperature (°C)	17.6/17.3		15.1/14.8		16.7/16.6/16.9
pH (record to one decimal place)	5.11/5.6		4.28/4.32		4.8/4.78/4.65
EC (µS/cm) 402	415/415		415/420		294/247/216
Dissolved Oxygen (% Sat)	32.6/19.5		35.5/37.7		25.8/29.5/29.5
Dissolved Oxygen (mg/L)	3.07/1.9/1.9		3.57/3.77		2.54/2.84/2.84
Turbidity (NTU)	-/-		-/-		-
Redox (mV)	146/82/82		181/184		150/141/154
TDS (mg/L)	-		-		-
Odour	Clear/Od		Low mod		Clear/"
Colour	None		light brown		None "
Recharge Rate	OK/Poor		OK		OK/Poor
Observations	-		-		-
Notes:	Dry				
Supervisor:	BJK		**Date:**		20/6/19

Water quality meter calibration details (please tick calibration liquids used): AES Hire - YSI

Meter ID							
Buffer (pH 4)	☐	Use-by Date		Conductivity Standard (2.76 mS/cm)	☐	Use-by Date	
Buffer (pH 6.88)	☐	Use-by Date		Total Dissolved Solids Standard (2 parts per thousand)	☐	Use-by Date	
Buffer (pH 9)	☐	Use-by Date		Rapid Cal Solution	☐	Use-by Date	

*GL – denotes ground level **Well Volume = πr^2 x depth of water, where r is internal casing radius

Appendix D

Table D1 – Summary of Analytical Testing in Groundwater

Douglas Partners
Geotechnics / Environment / Groundwater

Table D1: Summary of Analytical Testing in Groundwater

								Well ID	Well 1	Well 2	Well 3
								Sampled Date	20/06/2019	20/06/2019	20/06/2019
								Lab Report Number	220121	220121	220121
				NEPM 2013 Table 1A(4) Commercial / Industrial Land use HSL D GW for Vapour Intrusion, Sand			NEPM 2013 Table 1C GILs, Fresh Waters (ANZG 2018)	NEPM 2013 Table 1C GILs, Drinking Water (NHRMC 2018)			
Chem_Group	**ChemName**	**Units**	**PQL**	**2-4m**	**4-8m**	**>8m**					
Field Parameters	Groundwater Depth	mbgl	-						7.255	1.15	5.035
	Groundwater Elevation	mAHD	-						206.073	197.895	201.414
	Temperature	°C	-						17.3	14.8	16.9
	pH	-	-				6.5-8.5	6.5-8.5	5.6	4.3	4.7
	Electrical Conductivity	µS/cm	-						415	420	216
	Dissolved Oxygen	mg/L	-						1.9	3.8	2.8
	Redox Potential	mV	-						82	184	154
Metals	Arsenic (Filtered)	mg/L	0.001					0.01	<0.001	<0.001	<0.001
	Barium (Filtered)	mg/L	0.001					2	0.02	0.032	0.01
	Beryllium (Filtered)	mg/L	0.0005					0.06	<0.0005	<0.001	<0.001
	Boron (Filtered)	mg/L	0.02				0.37	4	0.03	0.04	0.02
	Cadmium (Filtered)	mg/L	0.0001				0.0002	0.002	<0.0001	<0.001	<0.001
	Calcium (Filtered)	mg/L	0.5						5.7	15	5.2
	Chromium (III+VI) (Filtered)	mg/L	0.001						<0.001	<0.001	<0.001
	Cobalt (Filtered)	mg/L	0.001						0.11	0.13	0.044
	Copper (Filtered)	mg/L	0.001				0.0014	2	0.001	0.001	<0.001
	Lead (Filtered)	mg/L	0.001				0.0034	0.01	<0.001	0.004	<0.001
	Magnesium (Filtered)	mg/L	0.5						6.2	10	4.0
	Manganese (Filtered)	mg/L	0.005				1.9	0.5	0.68	0.53	0.15
	Mercury (Filtered)	mg/L	0.00005				0.00006	0.001	<0.00005	<0.00005	<0.00005
	Molybdenum (Filtered)	mg/L	0.001					0.05	<0.001	<0.001	<0.001
	Nickel (Filtered)	mg/L	0.001				0.011	0.02	0.006	0.003	0.002
	Phosphorus	mg/L	0.05						<0.05	<0.05	<0.05
	Potassium (Filtered)	mg/L	0.5						6.1	3.9	4.3
	Selenium (Filtered)	mg/L	0.001				0.005	0.01	<0.001	<0.001	<0.001
	Thorium-Dissolved	mg/L	0.0005						<0.0005	<0.0005	<0.0005
	Vanadium (Filtered)	mg/L	0.001						<0.001	<0.001	<0.001
	Zinc (Filtered)	mg/L	0.001				0.008		0.013	0.01	0.015
TPH	C10-C16	mg/L	0.05						<0.050	<0.050	<0.050
	C16-C34	mg/L	0.1						<0.100	<0.100	<0.100
	C34-C40	mg/L	0.1						<0.100	<0.100	<0.100
	F2-NAPHTHALENE	mg/L	0.05	NL	NL	NL			<0.050	<0.050	<0.050
	C6 - C9	mg/L	0.01						<0.010	<0.010	<0.010
	C10 - C14	mg/L	0.05						<0.050	<0.050	<0.050
	C15 - C28	mg/L	0.1						<0.100	<0.100	<0.100
	C29-C36	mg/L	0.1						<0.100	<0.100	<0.100
	C6-C10 less BTEX (F1)	mg/L	0.01	6	6	7			<0.010	<0.010	<0.01
	C6-C10	mg/L	0.01						<0.010	<0.010	<0.01
BTEX	Benzene	mg/L	0.001	5	5	5	0.95	0.001	<0.001	<0.001	<0.001
	Ethylbenzene	mg/L	0.001	NL	NL	NL		0.3	<0.001	<0.001	<0.001
	Toluene	mg/L	0.001	NL	NL	NL		0.8	<0.001	<0.001	<0.001
	Xylene (m & p)	mg/L	0.002						<0.002	<0.002	<0.002
	Xylene (o)	mg/L	0.001				0.35		<0.001	<0.001	<0.001
PAHs	Total Positive PAHs	mg/L							0	0	0
	Acenaphthene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Acenaphthylene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Anthracene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Benz(a)anthracene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Benzo(a) pyrene	mg/L	0.0001					0.00001	<0.0001	<0.0001	<0.0001
	Benzo(a)pyrene TEQ	mg/L	0.0005						<0.0005	<0.0005	<0.0005
	Benzo(b)&(k)fluoranthene	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Benzo(g,h,i)perylene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Chrysene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Dibenz(a,h)anthracene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Fluoranthene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Fluorene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Indeno(1,2,3-c,d)pyrene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Naphthalene	mg/L	0.0002	NL	NL	NL	0.016		<0.0002	<0.0002	<0.0002
	Phenanthrene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
	Pyrene	mg/L	0.0001						<0.0001	<0.0001	<0.0001
Organochlorine Pesticides	4,4-DDE	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	a-BHC	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Aldrin	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	b-BHC	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Chlordane (cis)	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Chlordane (trans)	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	d-BHC	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	DDD	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	DDT	mg/L	0.0002				0.000006	0.009	<0.0002	<0.0002	<0.0002
	Dieldrin	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Endosulfan I	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Endosulfan II	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Endosulfan sulphate	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Endrin	mg/L	0.0002				0.00001		<0.0002	<0.0002	<0.0002
	Endrin aldehyde	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	g-BHC (Lindane)	mg/L	0.0002				0.0002	0.01	<0.0002	<0.0002	<0.0002
	Heptachlor	mg/L	0.0002				0.00001		<0.0002	<0.0002	<0.0002
	Heptachlor epoxide	mg/L	0.0002					0.0003	<0.0002	<0.0002	<0.0002
	Hexachlorobenzene	mg/L	0.0002						<0.0002	<0.0002	<0.0002
	Methoxychlor	mg/L	0.0002						<0.0002	<0.0002	<0.0002
Inorganics	Alkalinity (Hydroxide) as CaCO3	mg/L	5						<5	<5	<5
	Alkalinity (total) as CaCO3	mg/L	5						27	<5	6
	Ammonia	mg/L	0.005				0.9		0.075	0.088	0.012
	Alkalinity (Bicarbonate as CaCO3)	mg/L	5						27	<5	6
	Chloride	mg/L	1						110	82	61
	Ionic Balance	%							-6	0	-5
	Nitrate (as N)	mg/L	0.005						0.95	0.53	0.12
	Phosphate (as P)	mg/L	0.005						<0.005	<0.005	<0.005
	Sodium (Filtered)	mg/L	0.5						55	49	23
	Sulphate	mg/L	1					500	3	74	2
Organic	Alkalinity (Carbonate)	mg/L	5						<5	<5	<5

Notes:
PQL - practical quantitation limit

Appendix E

Laboratory Certificates
And Chain of Custody Documentation

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

CERTIFICATE OF ANALYSIS 220121

Client Details

Client	Douglas Partners Tuggerah
Attention	Brent Kerry
Address	Unit 5, 3 Teamster Close, Tuggerah, NSW, 2259

Sample Details

Your Reference	**83636.00, Somersby Baseline**
Number of Samples	5 Water
Date samples received	21/06/2019
Date completed instructions received	21/06/2019

Analysis Details

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

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

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

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

Report Details

Date results requested by	28/06/2019
Date of Issue	28/06/2019

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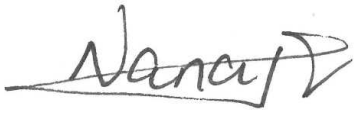
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Giovanni Agosti, Group Technical Manager
Jaimie Loa-Kum-Cheung, Metals Supervisor
Nick Sarlamis, Inorganics Supervisor
Steven Luong, Organics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

vTRH(C6-C10)/BTEXN in Water						
Our Reference		220121-1	220121-2	220121-3	220121-4	220121-5
Your Reference	UNITS	Well 1	Well 2	Well 3	QA1	RB1
Date Sampled		20/06/2019	20/06/2019	20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	26/06/2019	26/06/2019	26/06/2019	26/06/2019	26/06/2019
Date analysed	-	27/06/2019	27/06/2019	27/06/2019	27/06/2019	27/06/2019
TRH C_6 - C_9	µg/L	<10	<10	<10	<10	<10
TRH C_6 - C_{10}	µg/L	<10	<10	<10	<10	<10
TRH C_6 - C_{10} less BTEX (F1)	µg/L	<10	<10	<10	<10	<10
Benzene	µg/L	<1	<1	<1	<1	<1
Toluene	µg/L	<1	<1	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2	<2	<2
o-xylene	µg/L	<1	<1	<1	<1	<1
Naphthalene	µg/L	<1	<1	<1	<1	<1
Surrogate Dibromofluoromethane	%	124	123	124	125	123
Surrogate toluene-d8	%	95	94	95	95	94
Surrogate 4-BFB	%	84	85	85	83	82

svTRH (C10-C40) in Water						
Our Reference		220121-1	220121-2	220121-3	220121-4	220121-5
Your Reference	UNITS	Well 1	Well 2	Well 3	QA1	RB1
Date Sampled		20/06/2019	20/06/2019	20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	26/06/2019	26/06/2019	26/06/2019	26/06/2019	26/06/2019
Date analysed	-	27/06/2019	27/06/2019	27/06/2019	27/06/2019	27/06/2019
TRH C_{10} - C_{14}	µg/L	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	µg/L	<100	<100	<100	<100	<100
TRH C_{29} - C_{36}	µg/L	<100	<100	<100	<100	<100
TRH >C_{10} - C_{16}	µg/L	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	<50	<50	<50	<50	<50
TRH >C_{16} - C_{34}	µg/L	<100	<100	<100	<100	<100
TRH >C_{34} - C_{40}	µg/L	<100	<100	<100	<100	<100
Surrogate o-Terphenyl	%	92	74	100	65	85

PAHs in Water - Low Level						
Our Reference		220121-1	220121-2	220121-3	220121-4	220121-5
Your Reference	UNITS	Well 1	Well 2	Well 3	QA1	RB1
Date Sampled		20/06/2019	20/06/2019	20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	26/06/2019	26/06/2019	26/06/2019	26/06/2019	26/06/2019
Date analysed	-	27/06/2019	27/06/2019	27/06/2019	27/06/2019	27/06/2019
Naphthalene	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaphthylene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Total +ve PAH's	µg/L	NIL (+)VE	NIL (+)VE	NIL (+)VE	NIL (+)VE	NIL (+)VE
Surrogate p-Terphenyl-d14	%	97	74	92	64	95

OCP in water				
Our Reference	UNITS	220121-1	220121-2	220121-3
Your Reference		Well 1	Well 2	Well 3
Date Sampled		20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water
Date extracted	-	26/06/2019	26/06/2019	26/06/2019
Date analysed	-	26/06/2019	26/06/2019	26/06/2019
HCB	µg/L	<0.2	<0.2	<0.2
alpha-BHC	µg/L	<0.2	<0.2	<0.2
gamma-BHC	µg/L	<0.2	<0.2	<0.2
beta-BHC	µg/L	<0.2	<0.2	<0.2
Heptachlor	µg/L	<0.2	<0.2	<0.2
delta-BHC	µg/L	<0.2	<0.2	<0.2
Aldrin	µg/L	<0.2	<0.2	<0.2
Heptachlor Epoxide	µg/L	<0.2	<0.2	<0.2
gamma-Chlordane	µg/L	<0.2	<0.2	<0.2
alpha-Chlordane	µg/L	<0.2	<0.2	<0.2
Endosulfan I	µg/L	<0.2	<0.2	<0.2
pp-DDE	µg/L	<0.2	<0.2	<0.2
Dieldrin	µg/L	<0.2	<0.2	<0.2
Endrin	µg/L	<0.2	<0.2	<0.2
pp-DDD	µg/L	<0.2	<0.2	<0.2
Endosulfan II	µg/L	<0.2	<0.2	<0.2
pp-DDT	µg/L	<0.2	<0.2	<0.2
Endrin Aldehyde	µg/L	<0.2	<0.2	<0.2
Endosulfan Sulphate	µg/L	<0.2	<0.2	<0.2
Methoxychlor	µg/L	<0.2	<0.2	<0.2
Surrogate TCMX	%	89	71	90

HM in water - dissolved						
Our Reference		220121-1	220121-2	220121-3	220121-4	220121-5
Your Reference	UNITS	Well 1	Well 2	Well 3	QA1	RB1
Date Sampled		20/06/2019	20/06/2019	20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	24/06/2019	24/06/2019	24/06/2019	24/06/2019	24/06/2019
Date analysed	-	24/06/2019	24/06/2019	24/06/2019	24/06/2019	24/06/2019
Arsenic-Dissolved	µg/L	<1	<1	<1	<1	<1
Barium-Dissolved	µg/L	20	32	10	32	<1
Beryllium-Dissolved	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Boron-Dissolved	µg/L	30	40	20	50	<20
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	<1	<1
Cobalt-Dissolved	µg/L	110	130	44	150	<1
Copper-Dissolved	µg/L	1	1	<1	2	<1
Lead-Dissolved	µg/L	<1	4	<1	6	<1
Manganese-Dissolved	µg/L	680	530	150	610	<5
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum-Dissolved	µg/L	<1	<1	<1	<1	<1
Nickel-Dissolved	µg/L	6	3	2	4	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Thorium-Dissolved	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Vanadium-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	13	10	15	16	<1

Metals in Waters - Total				
Our Reference		220121-1	220121-2	220121-3
Your Reference	UNITS	Well 1	Well 2	Well 3
Date Sampled		20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water
Date prepared	-	26/06/2019	26/06/2019	26/06/2019
Date analysed	-	26/06/2019	26/06/2019	26/06/2019
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05

Ion Balance				
Our Reference		220121-1	220121-2	220121-3
Your Reference	UNITS	Well 1	Well 2	Well 3
Date Sampled		20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water
Date prepared	-	21/06/2019	21/06/2019	21/06/2019
Date analysed	-	21/06/2019	21/06/2019	21/06/2019
Calcium - Dissolved	mg/L	5.7	15	5.2
Potassium - Dissolved	mg/L	6.1	3.9	4.3
Sodium - Dissolved	mg/L	55	49	23
Magnesium - Dissolved	mg/L	6.2	10	4.0
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	27	<5	6
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	27	<5	6
Sulphate, SO4	mg/L	3	74	2
Chloride, Cl	mg/L	110	82	61
Ionic Balance	%	-6.0	0	-5.0

Miscellaneous Inorganics				
Our Reference		220121-1	220121-2	220121-3
Your Reference	UNITS	Well 1	Well 2	Well 3
Date Sampled		20/06/2019	20/06/2019	20/06/2019
Type of sample		Water	Water	Water
Date prepared	-	21/06/2019	21/06/2019	21/06/2019
Date analysed	-	21/06/2019	21/06/2019	21/06/2019
Nitrate as N in water	mg/L	0.095	0.53	0.12
Ammonia as N in water	mg/L	0.075	0.088	0.012
Phosphate as P in water	mg/L	<0.005	<0.005	<0.005

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 10% ie total anions = total cations +/-10%.
Inorg-055	Nitrate - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a KCl extraction.
Inorg-060	Phosphate determined colourimetrically based on EPA365.1 and APHA latest edition 4500 P E. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-013	Water samples are analysed directly by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
Date analysed	-			27/06/2019	[NT]	[NT]	[NT]	[NT]	27/06/2019	[NT]
TRH C_6 - C_9	µg/L	10	Org-016	<10	[NT]	[NT]	[NT]	[NT]	95	[NT]
TRH C_6 - C_{10}	µg/L	10	Org-016	<10	[NT]	[NT]	[NT]	[NT]	95	[NT]
Benzene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Toluene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Ethylbenzene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	89	[NT]
m+p-xylene	µg/L	2	Org-016	<2	[NT]	[NT]	[NT]	[NT]	93	[NT]
o-xylene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Naphthalene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-016	110	[NT]	[NT]	[NT]	[NT]	102	[NT]
Surrogate toluene-d8	%		Org-016	97	[NT]	[NT]	[NT]	[NT]	96	[NT]
Surrogate 4-BFB	%		Org-016	85	[NT]	[NT]	[NT]	[NT]	110	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	[NT]
Date extracted	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
Date analysed	-			27/06/2019	[NT]	[NT]	[NT]	[NT]	27/06/2019	[NT]
TRH C_{10} - C_{14}	µg/L	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	108	[NT]
TRH C_{15} - C_{28}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	108	[NT]
TRH C_{29} - C_{36}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	117	[NT]
TRH >C_{10} - C_{16}	µg/L	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	108	[NT]
TRH >C_{16} - C_{34}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	108	[NT]
TRH >C_{34} - C_{40}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	117	[NT]
Surrogate o-Terphenyl	%		Org-003	76	[NT]	[NT]	[NT]	[NT]	76	[NT]

QUALITY CONTROL: PAHs in Water - Low Level						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	[NT]
Date extracted	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
Date analysed	-			27/06/2019	[NT]	[NT]	[NT]	[NT]	27/06/2019	[NT]
Naphthalene	µg/L	0.2	Org-012	<0.2	[NT]	[NT]	[NT]	[NT]	112	[NT]
Acenaphthylene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Acenaphthene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluorene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	92	[NT]
Phenanthrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	86	[NT]
Anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluoranthene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	78	[NT]
Pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	84	[NT]
Benzo(a)anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chrysene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	82	[NT]
Benzo(b,j+k)fluoranthene	µg/L	0.2	Org-012	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(a)pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	80	[NT]
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibenzo(a,h)anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(g,h,i)perylene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	117	[NT]	[NT]	[NT]	[NT]	91	[NT]

QUALITY CONTROL: OCP in water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
Date analysed	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
HCB	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
alpha-BHC	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	72	[NT]
gamma-BHC	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
beta-BHC	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	77	[NT]
Heptachlor	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	70	[NT]
delta-BHC	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aldrin	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	71	[NT]
Heptachlor Epoxide	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	75	[NT]
gamma-Chlordane	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
alpha-Chlordane	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endosulfan I	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pp-DDE	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	74	[NT]
Dieldrin	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	80	[NT]
Endrin	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	71	[NT]
pp-DDD	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	69	[NT]
Endosulfan II	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pp-DDT	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endrin Aldehyde	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endosulfan Sulphate	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	77	[NT]
Methoxychlor	µg/L	0.2	Org-005	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate TCMX	%		Org-005	84	[NT]	[NT]	[NT]	[NT]	78	[NT]

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	220121-2
Date prepared	-			24/06/2019	1	24/06/2019	24/06/2019		24/06/2019	24/06/2019
Date analysed	-			24/06/2019	1	24/06/2019	24/06/2019		24/06/2019	24/06/2019
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		97	[NT]
Barium-Dissolved	µg/L	1	Metals-022	<1	1	20	[NT]		98	[NT]
Beryllium-Dissolved	µg/L	0.5	Metals-022	<0.5	1	<0.5	[NT]		94	[NT]
Boron-Dissolved	µg/L	20	Metals-022	<20	1	30	[NT]		102	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	[NT]		97	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		94	[NT]
Cobalt-Dissolved	µg/L	1	Metals-022	<1	1	110	[NT]		97	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	1	[NT]		99	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		99	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	680	[NT]		96	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	104	104
Molybdenum-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		91	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	6	[NT]		94	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		96	[NT]
Thorium-Dissolved	µg/L	0.5	Metals-022	<0.5	1	<0.5	[NT]		98	[NT]
Vanadium-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		91	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	13	[NT]		96	[NT]

QUALITY CONTROL: Metals in Waters - Total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
Date analysed	-			26/06/2019	[NT]	[NT]	[NT]	[NT]	26/06/2019	[NT]
Phosphorus - Total	mg/L	0.05	Metals-020	<0.05	[NT]	[NT]	[NT]	[NT]	103	[NT]

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			21/06/2019	[NT]	[NT]	[NT]	[NT]	21/06/2019	[NT]
Date analysed	-			21/06/2019	[NT]	[NT]	[NT]	[NT]	21/06/2019	[NT]
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	104	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	106	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	93	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	104	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	106	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	91	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			21/06/2019	[NT]	[NT]	[NT]	[NT]	21/06/2019	[NT]
Date analysed	-			21/06/2019	[NT]	[NT]	[NT]	[NT]	21/06/2019	[NT]
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	[NT]	[NT]	[NT]	[NT]	104	[NT]
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	[NT]	[NT]	[NT]	[NT]	101	[NT]
Phosphate as P in water	mg/L	0.005	Inorg-060	<0.005	[NT]	[NT]	[NT]	[NT]	115	[NT]

Result Definitions

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

Quality Control Definitions

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 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.

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

Measurement Uncertainty estimates are available for most tests upon request.

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

CHAIN OF CUSTODY

Douglas Partners
Geotechnics / Environment / Groundwater

Client: Douglas Partners	**Project Number** 83636.00	**To:**	Envirolab Services
Contact Person: Brent Kerry	**Project Name:** Somersby Baseline	**Contact Person:**	Aileen Hie
Project Mgr: Brent Kerry	**PO No.:**	**Address:**	12 Ashley Street
	lab Quote No. : 2016-2017 List		Chatswood NSW 2068
Address: 5/3 Teanster Cl	**Date results required:** Standard TAT	**Phone:**	02 9910 6200
Tuggerah NSW 2259	*Note: Inform lab in advance if urgent turnaround is required - surcharges apply*	**Fax:**	02 9910 6201
		Email:	ahie@envirolab.com.au
Phone: 4351 1422 **Mob:**	**Report format:** Esdat/PDF / Excel	**Laboratory Report No:**	
Email: brent.kerry@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	Combo 8A	COMBO 3	Combo 3L	Ionic Balance	Nutrient Suite	OCP	Combo #5A	Scr Suite	Combustible Content %	Sulfur%	Combo	Provide as much information about the sample as you can
1	Well 1	-	20/06/2019	Bottles	discrete			X	X	X	X						All metal samples were field filtered
2	Well 2	-	20/06/2019	Bottles	discrete			X	X	X	X						
3	Well 3	-	20/06/2019	Bottles	discrete			X	X	X	X						Metals = As, Ba, Be, Bo, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Th, Va and Zn
4	QA1	-	20/06/2019	Bottles	discrete			X									
5	RB1	-	20/06/2019	Bottles	discrete			X									NO3, NH3, tot-P and PO4

ENVIROLAB GROUP

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

Job No: 220121
Date Received: 21/06/19
Time Received: 16:43
Received by: SB
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by: Douglas Partners	**Sample Receipt**	***Lab use only:***
Courier (by whom) TNT	**Received by (Company):** ELS Syd.	**Samples Received:** Cool or Ambient (circle one)
Condition of Sample at dispatch Cool or Ambient (circle) cool	**Print Name:** S. Bolton	**Temperature Received at:** 13.1 (if applicable)
Temperature (if Applicable):	**Date & Time:** 21/06/19 16:43	**Transported by:** Hand delivered / Courier
Print Name: Brent Kerry	**Signature:**	
Date & Time: 21/06/2019		
Signature:		

Report Comments

Total metals: no preserved sample was received, therefore analysis was conducted from the unpreserved sample bottle.
Note: there is a possibility some elements may be underestimated.

Appendix F

Quality Assurance / Quality Control for Groundwater Sampling

APPENDIX F

QUALITY ASSURANCE/QUALITY CONTROL FOR WATER SAMPLING

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Quality Assurance (QA) was maintained by:

- compliance with a Project Quality Plan written for the objectives of the study;
- using experienced staff to undertake the field supervision and sampling;
- following the DP operating procedures for sampling, field testing and decontamination as presented in Table F1;
- using NATA accredited laboratories for sample testing, that generally utilise standard laboratory methods of the US EPA, the APHA and NSW EPA.

Table F1: Field Procedures

Abbreviation	Procedure Name
FPM DECONT	Decontamination of Personnel and Equipment
FPM ENVID	Sample Identification, Handling, Transport and Storage of Contaminated Samples
FPM WATWELL	Installation of Hydrogeochemical Monitoring Wells
FPM WATSAMP	Water Sampling

(from Douglas Partners Field Procedures Manual)

Quality Control (QC) of the laboratory programme was achieved by the following means:

- intra-laboratory duplicate – a specific sample was split in the field, placed in separate containers and labelled with different sample numbers, and sent to the primary laboratory for analysis;
- field equipment rinsate – a specific rinsate water sample was taken in the field during field investigations and sent to the laboratory at the completion of sampling to ensure decontamination of sampling equipment was adequate. Field equipment rinsate samples were submitted for the groundwater sampling programme only.
- method blanks - the laboratory ran reagent blanks to confirm the equipment and standards used were uncontaminated;
- laboratory duplicates - the laboratory split samples internally and conducted tests on separate extracts;
- laboratory spikes - samples were spiked by the laboratory with a known concentration of contaminants and subsequently tested for percent recovery.

Discussion

A. Check Duplicate

The Relative Percent Difference (RPD) between duplicate results is used as a measure of laboratory reproducibility and is given by the following:-

$$\text{RPD} = \frac{\text{ABS (Duplicate result 1} - \text{Duplicate result 2)}}{\text{(Duplicate result 1} + \text{Duplicate result 2)/2}} \text{ x } 100$$

The RPD can have a value between 0% and 200%. An RPD data quality objective of up to 50% is generally considered to be acceptable for organic analysis, and 35% for inorganics (i.e. metals).

A summary of the results of the field groundwater duplicates QA/QC testing are provided in Table F2.

Table F2: Summary of Analytical Testing in Groundwater

				Well ID	Well 2	QA1	RPD (%)
				Sampled Date	20/06/2019	20/06/2019	
				Lab Report Number	220121	220121	
Chem_Group	**ChemName**	**Units**	**PQL**				
Field Parameters	Groundwater Depth	mbgl	-		1.15	1.15	-
	Groundwater Elevation	mAHD	-		197.895	197.895	-
	Temperature	°C	-		14.8	14.8	-
	pH	-	-		4.3	4.3	-
	Electrical Conductivity	µS/cm	-		420	420	-
	Dissolved Oxygen	mg/L	-		3.8	3.8	-
	Redox Potential	mV	-		184	184	-
Metals	Arsenic (Filtered)	mg/L	0.001		<0.001	<0.001	N/A
	Barium (Filtered)	mg/L	0.001		0.032	0.032	0
	Beryllium (Filtered)	mg/L	0.0005		<0.001	<0.001	N/A
	Boron (Filtered)	mg/L	0.02		0.04	0.05	22
	Cadmium (Filtered)	mg/L	0.0001		<0.001	<0.001	N/A
	Calcium (Filtered)	mg/L	0.5		15	-	-
	Chromium (III+VI) (Filtered)	mg/L	0.001		<0.001	<0.001	N/A
	Cobalt (Filtered)	mg/L	0.001		0.13	0.15	14
	Copper (Filtered)	mg/L	0.001		0.001	0.002	67
	Lead (Filtered)	mg/L	0.001		0.004	0.006	40
	Magnesium (Filtered)	mg/L	0.5		10	-	-
	Manganese (Filtered)	mg/L	0.005		0.53	0.61	14
	Mercury (Filtered)	mg/L	0.00005		<0.00005	<0.00005	N/A
	Molybdenum (Filtered)	mg/L	0.001		<0.001	<0.001	N/A
	Nickel (Filtered)	mg/L	0.001		0.003	0.004	29
	Phosphorus	mg/L	0.05		<0.05	-	-
	Potassium (Filtered)	mg/L	0.5		3.9	-	-
	Selenium (Filtered)	mg/L	0.001		<0.001	<0.001	N/A
	Thorium-Dissolved	mg/L	0.0005		<0.0005	<0.0005	N/A
	Vanadium (Filtered)	mg/L	0.001		<0.001	<0.001	N/A
	Zinc (Filtered)	mg/L	0.001		0.01	0.016	46
TPH	C10-C16	mg/L	0.05		<0.050	<0.050	N/A
	C16-C34	mg/L	0.1		<0.100	<0.100	N/A
	C34-C40	mg/L	0.1		<0.100	<0.100	N/A
	F2-NAPHTHALENE	mg/L	0.05		<0.050	<0.050	N/A
	C6 - C9	mg/L	0.01		<0.010	<0.010	N/A
	C10 - C14	mg/L	0.05		<0.050	<0.050	N/A
	C15 - C28	mg/L	0.1		<0.100	<0.100	N/A
	C29-C36	mg/L	0.1		<0.100	<0.100	N/A
	C6-C10 less BTEX (F1)	mg/L	0.01		<0.010	<0.01	N/A
	C6-C10	mg/L	0.01		<0.010	<0.01	N/A
BTEX	Benzene	mg/L	0.001		<0.001	<0.001	N/A
	Ethylbenzene	mg/L	0.001		<0.001	<0.001	N/A
	Toluene	mg/L	0.001		<0.001	<0.001	N/A
	Xylene (m & p)	mg/L	0.002		<0.002	<0.002	N/A
	Xylene (o)	mg/L	0.001		<0.001	<0.001	N/A
PAHs	Total Positive PAHs	mg/L			0	0	0
	Acenaphthene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Acenaphthylene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Anthracene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Benz(a)anthracene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Benzo(a) pyrene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Benzo(a)pyrene TEQ	mg/L	0.0005		<0.0005	<0.0005	N/A
	Benzo(b)&(k)fluoranthene	mg/L	0.0002		<0.0002	<0.0002	N/A
	Benzo(g,h,i)perylene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Chrysene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Dibenz(a,h)anthracene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Fluoranthene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Fluorene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Indeno(1,2,3-c,d)pyrene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Naphthalene	mg/L	0.0002		<0.0002	<0.0002	N/A
	Phenanthrene	mg/L	0.0001		<0.0001	<0.0001	N/A
	Pyrene	mg/L	0.0001		<0.0001	<0.0001	N/A

Notes:

PQL - practical quantitation limit

The RPD for individual contaminants ranged from 0% to 67%, with the majority of the duplicate samples reporting results within the acceptable limits. High RPD values for the copper, lead and zinc results are not consistent with the other inorganic and metal concentrations. The RPDs otherwise indicated a high level of precision or reproducibility and as such the results are considered acceptable.

B. Field Rinsate Blank

A field equipment rinsate sample was tested as part of field investigations to check the adequacy of field decontamination procedures. In cases where monitoring equipment was used, such as a interface probe; the equipment was decontaminated in accordance with filed procedure "FPM DECONT".

The field rinsate sample was tested for the same analytical suite as the primary samples. The results are reported are all below the laboratory practical quantitation limits.

It is considered unlikely that any significant cross-contamination occurred during the sampling based on the non-detect results reported combined with the decontamination procedures adopted. As such results were generally acceptable.

C. Sample Handling and Holding Times

A review of the laboratory certificate and chain of custody forms associated with the groundwater investigation indicates the following:

- samples were received chilled and generally in good order;
- samples received were appropriately preserved for all tests; and
- samples were received within recommended holding times.

D. Laboratory Method Blanks

A reagent blank is prepared and analysed at the beginning of every analytical run, following calibration of the analytical apparatus. Results for reagent blanks for groundwater analyses showed concentrations of all analytes to be below laboratory PQL. Results are included in the laboratory certificate in Appendix E.

E. Laboratory Duplicates

The RPD for the duplicate sample was limited to a single analyte due to the small number of samples. The results were below the laboratory practical quantification limits (PQL).

The RPD indicated an acceptable level of precision and reproducibility, and as such results were considered acceptable.

F. Laboratory Matrix Spike Recovery

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 to determine whether matrix interferences exist. Recoveries percentages were found to be within the laboratory acceptance limits, indicating that the extraction was effectively and appropriately completed.

CONCLUSIONS

In summary, no significant exceedances were found for any quality control testing and therefore the overall quality control results are considered acceptable.

The accuracy and precision of the groundwater testing procedures, as inferred by the QA/QC data is generally considered to be of sufficient standard to allow the data reported to be used to interpret site contamination conditions. Table F3 summarises data quality indicators (DQIs).

Table F3 - Data Quality Indicators

DQO	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation.
Data completeness	Sampling strategy and analysis of appropriate determinants based on site history and on-site observations.
Data comparability	Use of NATA certified laboratory, use of consistent sampling technique.
Representativeness	Target media sampled. Sample numbers recovered and analysed are considered to be representative of the target media and complying with DQOs. Samples were extracted and analysed within holding times.
Precision and accuracy for sampling and analysis	Achievement of 35-50% RPD for replicate analysis, acceptable levels for laboratory QC criteria.

Appendix G

Baseline Groundwater Report – Response to Comments

Baseline Groundwater Report – Response to comments

Agency	Requirement / comment	Response / where addressed.
SEARs	An investigation to identify any soil or ***water contamination*** on the site and proposed management measures.	Chapter 9, 10, 11, 12 & 13 Appendix D
	A description of water and soil resources, topography, ***hydrology***, water courses and riparian lands on or nearby the site.	Chapter 4
DPIE Adequacy Review Comments Feb 2020		
DPIE	The BGI report does not provide details of rainfall and climate, a conceptual site model, consideration of the proposed land use with potential receptors, an assessment of downstream groundwater beneficial uses against the ANZECC guideline considering a number of existing groundwater bores are located in site's vicinity.	Section 4.2 - Rainfall and Climate Section added. Section 4.5 – Nearby groundwater receptors discussed including nearby registered groundwater bores. Section 6 – Preliminary conceptual site model.
DPIE	Please clarify why groundwater investigation was carried out in dry season (i.e. winter) only.	See Section 4.2
DPIE	Please clarify why Borehole 3 was not located at the proposed OSD basin where excavation would be carried out.	Bore 3 was positioned as close as practicable to the proposed OSD given the limited site access and aiming to meet the objectives of the DPIE. The distribution provides a good indication of the groundwater levels and flow direction at the site.
DPIE	Reference has been made to Table D2 regarding groundwater elevation data. This table was not located in the report. Please revise the report to include Table D2.	Typo error was made referencing Table D2. It should have been referred as Table D1. The reference to Table D2 has been changed to Table D1. Table D1 includes groundwater elevation data.
DPIE	Borehole Log 3 form does not show the groundwater level (static and encountering level during drilling). Please update the report to include the standing water level for Well 3 or provide clarification as why this data has not been included. Where standing water level data was not obtained for Well 3, please detail as to how the interpolated groundwater contours were determined to include groundwater elevation data for Well 3.	Borehole logs have been updated to include groundwater observations during drilling and stabilised levels observed at the time of monitoring. Groundwater contours were interpolated based on the stabilised groundwater elevations. (See Appendix C)
DPIE	A detailed summary table of groundwater monitoring wells including but not limited to date drilled, depth groundwater encountered, screen range, gravel pack, total well depth and standing water levels must be provided in the BGI report.	This information is in the Borehole Logs provided in Appendix C of the BGI report. Table 6 (Section 9.2.1) is a summary of the requested details.

Agency	Requirement / comment	Response / where addressed.
DPIE	Please provide a breakdown of detectable CoPC at each borehole.	A summary table was provided as Table D1 in Appendix D. Table D1 identifies CoPC at each borehole that exceed adopted comparative guideline values. Laboratory Certificate of Analysis and Chain of Custody documentation is provided in provided in Appendix E of the BGI report. A discussion of the significant/detectable CoPC results is provided as Section 11 of the BGI report.
DPIE	Please provide justification for analysing one type of pesticide (Organochlorine Pesticides (OCP)) only.	BGI aimed to establish baseline groundwater conditions at the site. Other pesticides were not identified as principal CoPC. Given the expense of analysing for organic compounds, OCP is used as an indicator of whether organic pesticides maybe present.
DPIE	Please provide groundwater well development forms in the BGI report.	Field groundwater sampling form is provided in Appendix C of BGI.
DPIE	Groundwater monitoring wells have been installed to the northern (Well 1), western (Well 2) and southern (Well 3) boundaries of the proposed development, however not to the east. This data gap does not potentially adequately characterise the groundwater conditions across the site. Consideration should be given to monitor for potential off-site groundwater risks at the eastern site boundary, particularly given the proximity of the neighbouring residential property.	The objective of the BGI was to establish the nature and extent of groundwater flows in the locality of the proposed recycling facility, with reference to the Department of Industry (DoI) recommendations (Ref OUT19/1319, dated 26 March 2019) and NSW Planning and Environment request (Ref SSD 8660, dated 29 March 2019). DoI required the installation of three monitoring wells (i.e. one upgradient of the site and two down-gradient (south-west and south) of the site). The eastern boundary of the facility is "up gradient" of the site with respect to groundwater flow. Existing activities adjacent to the eastern site boundary were assessed as posing a relatively low risk of groundwater contamination. Furthermore, given there was no significant groundwater contamination issues identified in the down gradient wells, it is unlikely there would be any contamination sourced from beyond the eastern site boundary. An additional monitoring well can be installed after completion of construction activities and prior to commencement of operational activities if required by DPIE.
DPIE	Please provide details of the Quality Assurance and Quality Control procedures and decisions undertaken during the baseline assessment, ensuring the representativeness and integrity of samples, and the accuracy and reliability of analysis results.	Quality Assurance / Quality Control for Groundwater Sampling is provided in Appendix F of BGI report. Furthermore, the overall investigation data quality objective process has been provided as Section 7 of the BGI.