Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Groundwater Sampling

Newcastle Art Gallery
Proposed Alterations & Additions
1 Laman Street, Newcastle

Prepared for
Newcastle City Council

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

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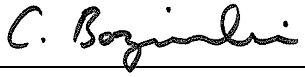
Reviewer		4 February 2021

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Report on Groundwater Sampling
Newcastle Art Gallery
1 Laman Street, Newcastle

1. Introduction

This report presents the results of groundwater sampling and testing undertaken for the proposed redevelopment of the Newcastle Region Art Gallery at Lots 10 to 15 DP 1122031, Lot 1 DP 63100, Lot 1 DP 516670 and Part Lot 18 Section G DP 978941, 1 Laman Street, Cooks Hill, NSW. The assessment was carried out at the request of Mr Matthew Bennett of Newcastle City Council (NCC) and was undertaken with reference to Douglas Partners Pty Ltd (DP) proposal NCL200612.P.001.Rev1 dated 9 October 2020.

It is understood that the proposed development includes the expansion of the current art gallery buildings over the majority of the site footprint, comprising a two-storey structure with a proposed café, court areas, gallery/function areas, gallery shop, theatre, retail section, stores and relocated dock. The initial 2011 design for the proposed development indicated that excavations were limited to footings, lift pits and installation of services. The results of previous site investigations (refer to Section 4 below) indicated that localised groundwater hydrocarbon and VOC impact was present on-site. The site was considered to be suitable for the proposed redevelopment in relation to site contamination subject to appropriate management of impacted soils, no basements or similar structures, and no extraction of groundwater for beneficial use.

Recent design alterations have been made for the proposed development which now include a reduced floor level (i.e. RL 7.4 AHD) requiring excavations of approximately 0.6m below previous (2011) design levels. Refer to Drawings DA-A-SK100, DA-A-SK101 and DA-A-SK202 in Appendix D for details.

Additional groundwater sampling and testing was therefore conducted to assess current groundwater conditions and confirm the suitability of the site for the revised design (i.e. reduced floor level) with respect to vapour intrusion risks.

The current assessment comprised the following:

- Brief review of previous investigations including the preliminary soil vapour intrusion assessment;
- Gauging of water levels in existing groundwater wells (8) to confirm the current depth to groundwater;
- Screening of groundwater well headspace and groundwater headspace for volatile organic compounds using a Photoionisation Detector (PID);
- Sampling and testing of groundwater from existing wells (7 shallow) for TRH, BTEXN, VOC and metals;
- Comparison of results to previous groundwater monitoring, current NEPM (2013) Groundwater HSLs for vapour intrusion (Tier 1 assessment) and current ANZG (2018) guidelines for slightly to moderately disturbed systems;
- Preparation of this report presenting the results and comparison to current guidelines.

For the purpose of this assessment NCC supplied updated drawings for the art gallery redevelopment. Drawings DA-A-SK100, DA-A-SK101 and DA-A-SK202 can be found in Appendix D.

The assessment was undertaken with reference to NSW EPA "Guidelines for Consultants Reporting on Contaminated Sites" (NSW EPA, 2020) and the National Environment Protection (Site Contamination) Measure (NEPC, 2013).

2. Site Identification

The Art Gallery site is identified as Lots 10 to 15 DP 1122031, Lot 1 DP 63100, Lot 1 DP 516670 and Part Lot 18 Section G DP 978941, 1 Laman Street, Cooks Hill, New South Wales and is shown on Drawing 1, Appendix D. The site comprises an irregular shaped area of approximately 4172 m^2 which currently includes the Newcastle Region Art Gallery, car parking and landscaped areas and part of the Newcastle library. Sampling of groundwater was conducted on existing wells within the site.

3. Geology and Hydrogeology

The 1:100,000 scale Newcastle Regional Coalfields Geology Sheet indicates that the site is underlain by Cainozoic aged Quaternary deposits, which generally comprise gravel, sand, silt and clay. The sheet also indicates subsurface conditions to the east of the site are underlain by the Late Permian aged Lambton subgroup within the Newcastle Coal Measures, which generally comprises sandstone, siltstone, claystone, coal and tuff.

The regional groundwater flow regime is generally expected to be towards Throsby Basin, (Hunter River) which is approximately 470 m north of the site and is considered to be the nearest sensitive receptor. It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

Site observations indicate that some cut/fill has occurred on-site during construction of the current art gallery buildings. Site slopes in the vicinity of the site generally fall to the southwest to north. The elevation of the site is approximately 8 m AHD. Surface water and stormwater collected from the site and surrounding sites is likely to eventually discharge to the Hunter River.

4. Background

The following relevant previous investigations have been conducted within the site:

- Phase 1 Environmental Site Assessment (EIS, 2007):
- Targeted Contamination Investigation (DP, 2011a);
- Additional Contamination Assessment (DP, 2011);
- Preliminary Soil Vapour Intrusion Assessment (DP 2012a);
- Additional Groundwater and Preliminary Soil Vapour Intrusion Investigation (DP, 2012);

In summary, previous investigations comprised the following:

- Desktop review and site history review;
- Soil sampling and testing;
- Installation of groundwater monitoring wells;
- Groundwater sampling and testing;
- Laboratory testing of selected soil and groundwater sample for a range of potential organic and inorganic contaminants;
- Interpretation of the results of laboratory testing in the context of field work observations, local geology and hydrogeology, and history of the site.

Relevant information from the previous reports is summarised below:

- Subsurface conditions comprised filling over clays and sands. Fill materials were variable and comprised a range of materials including coal, bricks and cobbles, with some asbestos, heavy metals and PAH impacts;
- Hydrocarbon odours were observed during drilling at two bore locations (i.e. Bores 201 and 107-D), where a slight hydrocarbon odour was observed in the vicinity of the water table;
- Some exceedances of the groundwater criteria were found for pH (most wells), Arsenic (Bores 105 and 107-D), Copper (Bores 1, 201, 202, 203-U, 203-D and 204-D), Nickel (Bores 105 and 201) and Zinc (Bores 1, 105 and 203-D);
- Low chain hydrocarbons and Xylene were identified in groundwater from Bore 105; however, concentrations were within the adopted trigger values;
- Several volatile organic compounds (VOC's) were detected in groundwater in Bores 105 and 107-U, with a single detection also identified in Bores 201, 203-U and 203-D. VOC concentrations were found to be within the adopted trigger values;
- No free phase hydrocarbon impact was identified on site;
- Groundwater was observed in all bores (except Bore 206) at depths of 3.07 m to 6.2 m during drilling and at RL 3.82 AHD to 4.96 AHD at the gauging event on 20 December 2011, with a groundwater flow direction towards the north-west;
- Subsurface gas monitoring indicated volatile hydrocarbon impact in Bore 105 and 107-U;
- Hydrocarbon concentrations were generally observed to be reducing. Soil gas monitoring also suggested that biodegradation of organics due to natural attenuation was occurring on-site;
- Groundwater at the site was not considered to present an unacceptable vapour inhalation risk to the future occupants of the site based on the vapour intrusion model.

Based on the results of the assessment, active remediation of groundwater was not considered necessary. The site was considered suitable for the proposed landuse and development subject to the following:

- Appropriate management of impacted soils (i.e. asbestos, heavy metals and PAH);
- Redevelopment does not include any basement or similar structures;
- Extraction of groundwater for beneficial use is not undertaken.

5. Field Work

5.1 Sampling Rationale

Additional sampling and testing on groundwater was conducted from existing wells to assess current groundwater quality and potential risks of vapour intrusion due to the previously identified volatile hydrocarbon impacts.

A total of five groundwater wells (previously installed by DP) were identified within the site for monitoring for the current assessment (Well 1, 105, 107-U, 107-D and 202).

It is noted that former monitoring wells 201, 203-U, 203-D, 204-U and 204-D were missing during the current investigation. These wells are thought to have been covered during recent construction and landscape work conducted at the site.

Three additional wells were identified within the site (not installed by DP). These wells were named Wells 107B, 203B and 203C as shown on Drawing 1 in Appendix D. The wells were not constructed with class 18 PVC and details associated with well installation were not known (i.e. drilling method, well, construction details including depth and location of the well screen etc). Groundwater samples were also collected from these well for completeness, however, any results should be qualified due to the absence of well details.

A total of eight wells were gauged for the current assessment. Sampling and testing was conducted on the following seven groundwater wells - 1, 105, 107-U, 202 107B, 203B and 203C).

5.2 Methods

The field work was undertaken on 2 December 2020 and comprised the following:

- Brief review of previous investigations including the preliminary soil vapour intrusion assessment;
- Gauging of water levels in existing groundwater wells (8) to confirm the current depth to groundwater;
- Screening of groundwater well headspace and groundwater headspace using a Photoionisation Detector (PID);
- Visual assessment of groundwater using new Clearview disposable bailers to assess for the presence of hydrocarbon impact;
- Purging groundwater from wells using disposable bailers until steady state parameters were achieved;
- Field measurement of groundwater pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), oxidation-reduction potential (ORP) and temperature using a hand-held calibrated meter;
- Sampling and testing of groundwater from seven existing wells for TRH, BTEXN, VOC and metals;
- Despatch of samples to a National Association of Testing Authorities, Australia (NATA) accredited laboratory for analysis;
- Comparison of results to current NEPM (2013) Groundwater HSLs for vapour intrusion (Tier 1 assessment) and current ANZG (2018) guidelines for slightly to moderately disturbed systems;

- Preparation of this report presenting the results and comparison to current guidelines.

Groundwater samples were collected under strict QA/QC protocols. All sampling data was recorded on DP chain of custody (COC) sheets , and the general sampling procedure comprised:

- Decontamination of all sampling equipment using a 3% solution of phosphate free detergent (Liquinox) and tap water prior to collecting each sample;
- The use of disposable gloves for each sampling event;
- Transfer of samples into laboratory-prepared jars bottles, and capping immediately;
- Collection of 10% replicate samples for QA/QC purposes;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample date;
- Placement of the sample bottles into a cooled, insulated and sealed container for transport to the laboratory within recommended holding times;
- Use of COC documentation ensuring that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory. Copies of completed forms are contained in Appendix C.

The process of obtaining samples and their transportation, storage and delivery to laboratories for analysis was documented on a DP standard COC form. Gauging, groundwater purging, and sampling were undertaken by an environmental engineer from DP.

A list of the procedures used and other information on quality assurance and quality control, including analysis of replicate samples, is found in Appendix C.

5.3 Data Quality Objectives (DQOs)

Table 1 summarises data quality objectives (DQOs) and the procedures designed to enable achievement of the DQOs.

Table 1: Data Quality Objectives

DQO	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation
Data completeness	Analysis of appropriate determinants and sampling locations based on site history, on-site observations and previous analysis
Data comparability	Use of NATA certified laboratory, use of consistent sampling technique
Precision and accuracy for sampling and analysis	Achievement of 50% RPD for replicate analysis, acceptable levels for laboratory QC criteria

5.4 Field Work Results

Groundwater levels (measured prior to purging) and field parameters (measured following purging) on 2 December 2020 within the current and former monitoring wells are presented in Table 2. The results of the previous groundwater sampling event (DP, 2012) are also provided for comparison purposes.

Table 2: Groundwater level and field parameters measured on 7 November 2011 and 2 December 2020

Well ID	Easting	Northing	Date Sampled	RL TOC (AHD)	Depth to Groundwater Below TOC (m)	RL GW Head (AHD)	PID Well Headspace (2) (ppm)	PID GW Headspace (2) (ppm)	Thickness of Free Product (1) (mm)	pH	EC (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Temp. (°C)	Volume Purged (L)	Comments
1 (5)	385293	6355841	7/11/2011	8.591	3.979	4.61	-	<1	ND	5.6	0.651	175	-	-	-	-	
			2/12/2020	8.591	4.200	4.39	<1	<1	ND	5.7	0.423	102	0.0	>1000	20.8	6	Brown, very turbid, moderate organic odour
105 (5)	385299	6355858	7/11/2011	8.411	3.877	4.53	-	30	ND	5.6	0.668	-10	-	-	-	-	
			2/12/2020	8.388	4.090	4.30	2.4	13.1	ND	6.0	0.528	43	1.8	210	20.5	5	Light brown, moderately turbid, no obvious odour. After purging dry, grey, mildly turbid, slight hydrocarbon odour.
107-U (5)	385262	6355834	7/11/2011	8.141	3.657	4.48	-	<1	ND	5.7	0.809	-10	-	-	-	-	
			2/12/2020	8.141	3.865	4.28	<1	<1	ND	5.5	0.531	55	0.0	>1000	20.6	8	Brown, very turbid, possible organic odour, some organics present
107B (3)	385266	6355834.06	2/12/2020	8.270	3.905	4.365	<1	7.8	ND	6.1	0.53	51	0.0	>1000	20.6	12	Brown, very turbid, strong organic odour, organics present in groundwater
107-D (5)	385262	6355835	7/11/2011	8.187	4.090	4.10	-	<1	ND	6.0	2.35	-235	-	-	-	-	
			2/12/2020	8.160	4.265	3.90	<1		ND	-	-	-	-	-	-	-	Not sampled
201	385289	6355871	7/11/2011	9.585	5.398	4.19	-	<1	ND	6.0	0.569	237	-	-	-	-	
			WELL UNABLE TO BE LOCATED DURING 2020 FIELDWORK														
202 (5)	385301	6355850	7/11/2011	8.364	3.800	4.56	-	<1	ND	5.8	0.584	211	-	-	-	-	
			2/12/2020	8.5	4.005	4.50	3.1	<1	ND	6.2	0.358	130	7.4	>1000	20.9	12	Brown, very turbid, no obvious odour
203-U	385312	6355895	20/12/2011	7.669	3.178	4.49	-	<1	ND	6.4	0.415	232	-	-	-	-	
			WELL UNABLE TO BE LOCATED DURING 2020 FIELDWORK														
203B (3)	385312	6355883.39	2/12/2020	7.641	3.455	4.19	<1	<1	ND	6.6	0.358	102	0.0	>1000	20.0	15	Brown, very turbid, no obvious odour
203C (3)	385311	6355885.3	2/12/2020	7.640	3.440	4.20	<1	<1	ND	6.9	0.39	52	0.0	>1000	20.1	17	Brown, very turbid, no obvious odour, silt observed in groundwater
203-D	385311.3	6355895	20/12/2011	7.694	2.735	4.96	<1	<1	ND	5.5	0.34	111	-	-	-	-	
			WELL UNABLE TO BE LOCATED DURING 2020 FIELDWORK														
204-U	385256.6	6355887	20/12/2011	9.862	5.953	4.91	<1	<1	ND	6.4	0.712	241	-	-	-	-	
			WELL UNABLE TO BE LOCATED DURING 2020 FIELDWORK														
204-D	385256	6355888	20/12/2011	9.739	5.920	3.82	<1	<1	ND	5.8	0.897	-224	-	-	-	-	
			WELL UNABLE TO BE LOCATED DURING 2020 FIELDWORK														

Notes to Table:
AHD - Australian Height Datum
DO - Dissolved Oxygen
EC - Electrical Conductivity
GW - Groundwater
NTU - Nephelometric Turbidity Units
ORP - Oxidation Reduction Potential
PID - Photoionisation Detector
ppm - parts per million
TOC - top of PVC casing
(1) - minimum limit of detection for oil-water interface meter 1 mm
(2) - minimum limit of detection for PID 1 ppm
(3) - Additional Well (not present in 2011 monitoring)
(4) - Well Missing in 2020
(5) Well Present During 2020 Field Work

The general groundwater flow direction based on measured water levels on 2 December 2020 is to the north-west which is consistent with previous monitoring in 2011.

The measured parameters for the current investigation indicate slightly acidic (i.e. pH 5.5 to 6.9), fresh (i.e. Electrical Conductivity (EC) 0.358 to 0.531 mS/cm) and generally oxidative conditions (i.e. positive Oxidative Reduction Potential (Eh)).

It is noted that three of the existing well covers (observed to be damaged) were replaced during the current round of monitoring.

5.5 Contaminant Observations

There were no observations of gross contamination within the wells. A slight hydrocarbon odour was observed in well 105 during purging, with a strong organic odour observed in wells 107-U, 107-B and 1 during purging. No floating product was detected using the oil water interface meter (accurate to 1 mm). All groundwater well headspace readings detected with the PID were <1 ppm with the exception of wells 202 (3.1 ppm) and 105 (2.4 ppm). Groundwater headspace readings <1 ppm were detected with the PID following groundwater purging in all wells with the exception of 07B (7.8 ppm) and 105 (13.1 ppm).

6. Laboratory Testing

6.1 Analytical Programme

Laboratory testing was undertaken by Envirolab Services Pty Ltd (Envirolab), a National Association of Testing Authorities, Australia (NATA) registered laboratory. Analytical Methods used are shown on the laboratory sheets in Appendix C.

A total of 7 groundwater samples (plus one QA/QC sample) were selected to assess groundwater conditions.

The samples were analysed for the following potential contaminants/analytes:

- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethyl Benzene, Xylene, Naphthalene (BTEXN);
- Volatile Organic Compounds (VOC);
- Metals: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Zinc (Zn).

Quality Control/Quality Assurance (QA/QC) testing comprised one replicate (sample D1/JRK), the results of which are provided in Appendix C.

6.2 Analytical Results

The results of chemical analysis of groundwater samples are presented in the laboratory report sheets (Appendix B) and are summarised in Table 3 below, alongside the results of the previous groundwater assessment (DP, 2012).

Table 3: Laboratory Results for Groundwater Samples (Current Investigation)

								Field ID:	1		105		107-U		107B	107-D	201	202		203-U	203B	D1/JRK (203B)	203C	203-D	204-U	204-D
								Sample Date:	7/11/2011	2/12/2020	8/11/2011	2/12/2020	9/11/2011	2/12/2020	2/12/2020	20/12/2011	10/11/2011	11/11/2011	2/12/2020	20/12/2011	2/12/2020	2/12/2020	2/12/2020	2/12/2020	20/12/2011	20/12/2011	20/12/2011
			ANZG (2018) Freshwater 95% Toxicant DGVs	ANZG (2018) Marine Water 95% Toxicant DGVs	NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion Sand | Silt | Clay																						
ChemName	Units	PQL			2-4m	4-8m	>8m																				
Field Parameters																											
Groundwater Headspace	ppm	NA							<1	<1	144	13.1	<1	<1	7.8	<1	<1	1.2	<1	<1	<1	-	<1	<1	3.2	<1
pH (field)	pH Units	NA	7.0-8.5						5.9	5.7	5.9	6.0	5.9	5.5	6.1	5.9	6.2	6.1	6.2	6.5	6.6	-	6.9	5.8	6.3	6.2
Electrical Conductivity	µs/cm	NA							650	423	700	528	740	531	530	2600	620	590	358	440	358	-	390	350	790	770
Metals (Dissolved)																											
Arsenic	µg/L	1							<1	<1	4	<1	2	9	3	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	µg/L	0.1	0.2	5.6					0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium (III+VI)	µg/L	1							<1	<1	<1	1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	2	1
Copper	µg/L	1	1.4	1.3					2	15	1	4	1	3	2	<1	4	4	4	3	3	14	3	2	7	1
Lead	µg/L	1	3.4	4.4					<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mercury	µg/L	0.05	0.6	0.4					<0.1	<0.05	<0.1	<0.05	<0.1	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	µg/L	1	11	70					2	5	21	24	3	1	4	4	180	2	<1	2	<1	1	<1	1	2	2
Zinc	µg/L	1	8	15					15	18	13	140	47	9	14	30	72	21	10	18	7	9	6	10	26	22
TRH																											
C6-C9	µg/L	10							<10	<10	**320**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10-C14	µg/L	50							<50	<50	**520**	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15-C28	µg/L	100							<100	**130**	<100	<100	<100	<100	**130**	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29-C36	µg/L	100							<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C6-C10	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
C6-C10 (F1 minus BTEX)	µg/L	10			NL|6000	NL|6000	NL|7000		-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
C10-C16	µg/L	50							-	**120**	-	<50	-	<50	**130**	-	-	-	<50	-	<50	<50	<50	-	-	-
C10-C16 (F2 minus Naphthalene)	µg/L	50			NL	NL	NL		-	**120**	-	<50	-	<50	**130**	-	-	-	<50	-	<50	<50	<50	-	-	-
C16-C34 (F3)	µg/L	100							-	<100	-	<100	-	<100	<100	-	-	-	<100	-	<100	<100	<100	-	-	-
C34-C40 (F4)	µg/L	100							-	<100	-	<100	-	<100	<100	-	-	-	<100	-	<100	<100	<100	-	-	-
BTEXN																											
Benzene	µg/L	1	950	700	6000|30000	6000|30000	30000|35		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	1	180	180	NL	NL	NL		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	µg/L	1	80	80	NL	NL	NL		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Xylene (m & p)	µg/L	2		75					<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	1	350						<1	<1	**27**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	1	16	70	NL	NL	NL		-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
VOCs in Water																											
1,1,1,2-tetrachloroethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,1,1-trichloroethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,1,2,2-tetrachloroethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,1,2-trichloroethane	µg/L	1	6500	1900					-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,1-dichloroethane	µg/L	1							<1	<1	<1	<1	**3**	**2**	**2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-dichloroethene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,1-dichloropropene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2,3-trichlorobenzene	µg/L	1	10						-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2,3-trichloropropane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2,4-trichlorobenzene	µg/L	1	170	80					-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2,4-trimethylbenzene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2-dibromo-3-chloropropane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2-dibromoethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2-dichlorobenzene	µg/L	1	160						-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2-dichloroethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,2-dichloropropane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,3,5-trimethylbenzene	µg/L	1							<1	<1	**24**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-dichlorobenzene	µg/L	1	260						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3-dichloropropane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
1,4-dichlorobenzene	µg/L	1	60						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
2,2-dichloropropane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
2-chlorotoluene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
4-chlorotoluene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Bromobenzene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Bromochloromethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Bromodichloromethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Bromoform	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Bromomethane	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
Carbon tetrachloride	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Chlorobenzene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Chlorodibromomethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Chloroethane	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
Chloroform	µg/L	1							<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloromethane	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
cis-1,2-dichloroethene	µg/L	1							<1	<1	<1	<1	**2**	**1**	**1**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
cis-1,3-dichloropropene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Cyclohexane	µg/L	1							<1	<1	**5**	<1	**1**	<1	<1	**2**	<1	<1	<1	**7**	<1	<1	<1	**8**	<1	**1**
Dibromomethane	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Dichlorodifluoromethane	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
Hexachlorobutadiene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Isopropylbenzene	µg/L	1							<1	<1	**3**	**2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
n-butylbenzene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
n-propylbenzene	µg/L	1							<1	<1	**2**	**2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
p-isopropyltoluene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
sec-butylbenzene	µg/L	1							<1	<1	**2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Styrene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Trichloroethene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
tert-butylbenzene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Tetrachloroethene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
trans-1,2-dichloroethene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
trans-1,3-dichloropropene	µg/L	1							-	<1	-	<1	-	<1	<1	-	-	-	<1	-	<1	<1	<1	-	-	-
Trichlorofluoromethane	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
Vinyl chloride	µg/L	10							-	<10	-	<10	-	<10	<10	-	-	-	<10	-	<10	<10	<10	-	-	-
PAHs																											
Total PAH	mg/L	.0016/0.016							<0.016	-	<0.016	-	<0.016	-	-	<0.0016	<0.016	<0.016	-	<0.0016	-	-	-	<0.0018	<0.0016	<0.0016
Naphthalene	mg/L	.0001/0.00	16	70					<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Acenaphthene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Fluorene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	0.0001	-	-	-	0.0003	<0.0001	<0.0001
Phenanthrene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Anthracene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Fluoranthene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Pyrene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Benzo[a]anthracene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Chrysene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Benzo[b,k]fluoranthene	mg/L	0002/0.002							<0.002	-	<0.002	-	<0.002	-	-	<0.0002	<0.002	<0.002	-	<0.0002	-	-	-	<0.0002	<0.0002	<0.0002
Benzo[a]pyrene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Indeno[123-cd]pyrene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Dibenzo[ah]anthracene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001
Benzo[ghi]perylene	mg/L	0001/0.001							<0.001	-	<0.001	-	<0.001	-	-	<0.0001	<0.001	<0.001	-	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001

7. Assessment of Contamination (Current Investigation)

7.1 Assessment Criteria

Results of the chemical analyses were compared to the following current recommended guidelines:

- NEPC (2013) – National Environmental Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) [NEPM];
- ANZG (2018) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

The NEPM 2013 guidelines were used to assess the potential contamination from TRH, BTEX and VOCs. Groundwater Health Screening Levels (HSLs) have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via inhalation and direct contact pathways.

The ANZG (2018) Guidelines for Fresh and Marine Water Quality were used to assess groundwater quality. The protection of slightly to moderately disturbed aquatic ecosystem guidelines (marine) are considered to be relevant to the site assessment due to the proximity of the site to Throsby Basin and the Hunter River (i.e. receiving waters). The receiving waters are considered to be a 'slightly to moderately disturbed system'.

7.2 Assessment of Contamination – Groundwater

Laboratory analysis results of collected groundwater samples from the current investigation indicated the following exceedances of the ANZG (2018) Trigger Values for Slightly to Moderately Disturbed Ecosystems:

- pH in all monitoring wells;
- Copper (Cu) in all monitoring wells;
- Nickel (Ni) in well 105;
- Zinc (Zn) in monitoring wells 1, 105, 107B, 107-U and 202.

The concentrations of metals were generally commensurate with the former monitoring round, with only minor increases or decreases.

Concentrations of low chain hydrocarbons (i.e. TRH, C_6 – C_{14}) were detected in well 105 in the DP 2012 investigation. Low chain hydrocarbons, however, were not detected during the current laboratory testing (indicating a reduction in low chain hydrocarbon concentrations in well 105). Detectable concentrations of TRH C_{10} – C_{16} and C_{15} – C_{28} were observed (slightly above laboratory detection limits) in monitoring wells 1 and 107B during the current investigation.

Ethylbenzene and Xylene concentrations were also detected in wells 105 and 107-U in the previous investigation, with the results being within acceptable criteria. BTEX concentrations were below the detectable laboratory limit for all monitoring wells during the current investigation.

Minor concentrations of VOCs were also detected previously (DP, 2012) within Bores 105, 107-U, 107-D (Chloroform only), 102 (1,2 – dichlorobenzene only), 203-U (Chloroform only) and 203-D (Chloroform only). Detectable concentrations of VOCs were also observed during the current investigation in wells 105 (Isopropylbenzene, n-propylbenzene), 107-U (1,1-dichloroethane, Cis-1,2-dichloroethane) and 107B (1,1-dichloroethane, Cis-1,2-dichloroethane). The minor VOC concentrations in the current assessment were similar to, or slightly below, the concentrations found in 2011.

8. Discussion/Comments

The results of the current investigation indicate the following:

- The groundwater table was observed to be slightly lower than pervious monitoring (i.e. 0.2 m lower than levels in 2011). The groundwater flow direction (i.e. north-west) was commensurate with 2011 groundwater monitoring;
- Groundwater levels within the site ranged from about RL4 AHD to RL5 AHD. A revised floor level of RL7.4 AHD is proposed, which is 2.4 m to 3.4 m above the measured water table;
- There were no observations of gross contamination in the wells monitored (i.e. no floating product was detected in groundwater wells and no slicks / staining were observed in groundwater);
- pH, EC and ORP were all similar to 2011 monitoring;
- Metals in groundwater were generally commensurate with previous testing. Heavy metal concentrations were generally similar in upgradient and downgradient wells and are therefore likely to be associated with background local groundwater quality;
- Slight hydrocarbon odours were observed in well 105 after purging and well recovery;
- There was a reduction in volatile (low chain) petroleum hydrocarbon concentrations in well 105, however, minor medium chain hydrocarbon concentrations were detected in wells 1 and 107B;
- Hydrocarbon concentrations detected in wells 1 and 107B were within HSL D commercial / industrial guidelines for groundwater vapour intrusion (NEPC, 2013);
- Trace VOC concentrations were identified in wells 105, 107-U and 107B which were commensurate with or slightly below 2011 concentrations.

Based on the results of the current assessment and previous investigations, active remediation of groundwater is not considered to be necessary. The site is considered to be suitable for the proposed landuse and revised redevelopment (i.e. additional excavations of approximately 0.6m to RL 7.4 AHD), provided there is no extraction or beneficial reuse of groundwater.

The results of monitoring generally indicate that volatile impacts to groundwater are relatively low and appear to be reducing at the locations monitored. It is noted, however, that the source of volatile impacts within the site is unknown. If deeper basement construction is considered at levels of lower than RL7.4 AHD, additional direct soil vapour sampling/testing and assessment is recommended to determine site suitability and the potential for adverse human health or environmental.

9. References

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10. Limitations

Douglas Partners (DP) has prepared this report for this project at 1 Laman Street, Newcastle in accordance with DP's proposal NCL200612.P.001.Rev1 dated 9 October 2020 and acceptance received from Matthew Bennett of Newcastle City Council dated 10 November 2020. The work was carried out under DP's Conditions of Engagement and Newcastle City Council Contract No 2021/154Q, dated 29 October 2020).

This report is provided for the exclusive use of Newcastle City Council 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.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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.

Douglas Partners Pty Ltd

Appendix A

About This Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs – Previous Assessment (49737.00) (Bores 1 to 7)
Borehole Logs – Previous Assessment (49737.01) (Bores 101 to 107)
Borehole Logs – Previous Assessment (49737.02) (Bores 107D, 201, 202, 203-D, 203-U, 204-D, 204-U)

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

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).

Symbols & Abbreviations

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

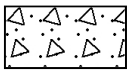
Symbols & Abbreviations

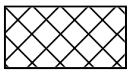
Graphic Symbols for Soil and Rock

General

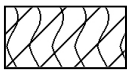

Asphalt

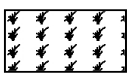

Road base

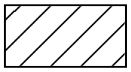

Concrete

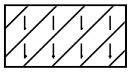

Filling

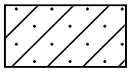
Soils


Topsoil

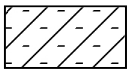

Peat

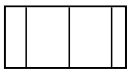

Clay

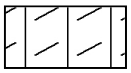

Silty clay

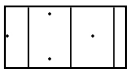

Sandy clay

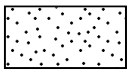

Gravelly clay

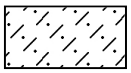

Shaly clay

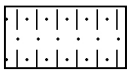

Silt


Clayey silt


Sandy silt

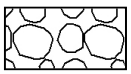

Sand

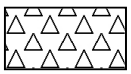

Clayey sand


Silty sand


Gravel

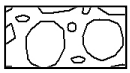

Sandy gravel


Cobbles, boulders

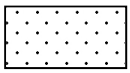

Talus

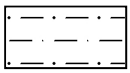
Sedimentary Rocks

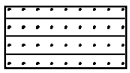

Boulder conglomerate

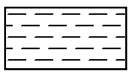

Conglomerate


Conglomeratic sandstone

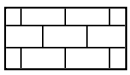

Sandstone


Siltstone

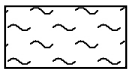

Laminite

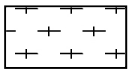

Mudstone, claystone, shale

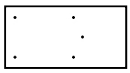

Coal


Limestone

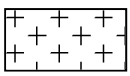
Metamorphic Rocks

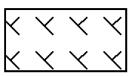

Slate, phyllite, schist

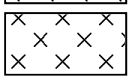

Gneiss

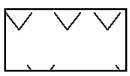

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.62 AHD
EASTING: 372193.274
NORTHING: 1354815.254
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 49737
DATE: 21/3/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.04	FILLING: Asphalt		D,PID	0.1		<1ppm		Well cover flushed with ground surface, end cap at 0.03m
	0.4	FILLING: Generally comprising grey/orange silty sand fill with trace clay and subangular gravel, damp		D,PID	0.3		<1ppm		From 0.0m to 0.12m, concrete
	0.6	From 0.2m, grey, trace shells, brick fragments and coal		A,PID	0.5		<1ppm		
		FILLING: Generally comprising grey mottled orange ash and brick fragment filling, trace gravel humid to damp		A,PID	0.85		<1ppm		
	1.0			pp	1.1		110-120kPa		From 0.12m to 2.2m, bentonite plug
		FILLING: Generally comprising dark grey silty clay filling with trace to some subangular, fine grained gravel, M>Wp		A,PID,pp	1.45		<1ppm, 100-110kPa		
		CLAY: Stiff, grey clay with some silt, M>Wp		A,PID,pp	1.95		<1ppm, 100-120kPa		
		From 2.2m, very stiff, dark grey, silt content decreasing		A,PID,pp	2.5		3ppm, 280-320kPa		
		From 2.7m, stiff to very stiff		pp	2.95		170-200kPa		
				A,PID,pp	3.45		<1ppm, 180-220kPa		From 2.2 to 4.8m, 5/2mm washed gravel screen
				pp	3.95		170-200kPa	▼	From 3.0m to 6m, 50mm diameter Class 18 machine slotted PVC screen
	4.1			A,PID,pp	4.15		<1ppm, 50-70kPa		
	4.2	SANDY CLAY: Firm, dark grey fine grained sandy clay, with trace silt, M>Wp		A,PID,pp	4.45		<1ppm, 110-120kPa		
		CLAY: Stiff, dark grey clay with trace silt, M>Wp							
	4.8	SILTY SAND: Grey, fine grained silty sand with trace clay, slight hydrocarbon odour, saturated							
		From 4.8m, strata collapsing		A,PID	5.5		510ppm		4.8m to 6.0m, collapsed strata
	6.0	Bore discontinued at 6.0m, limit of investigation							End cap

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66

TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil

WATER OBSERVATIONS: Free groundwater observed at 4.1m during drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.98 AHD
EASTING: 372190.061
NORTHING: 1354825.012
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 49737
DATE: 21/3/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising dark grey silty sand filling with trace gravel and shell fragments, slight hydrocarbon odour, damp		D,PID	0.05		80ppm		
				A,PID	0.45		550ppm		
	0.7								
	0.85	FILLING: Generally comprising grey silty sand filling, some gravel, trace brick fragments and shell fragments, humid		A,PID	0.8		60ppm		
				A,PID	0.9		<1ppm		
	1.1	FILLING: Generally comprising dark grey ash filling with trace gravel and sand, humid		A,PID	1.45		<1ppm		
	1.7	FILLING: Generally comprising dark grey silty clay filling with trace fine grained gravel and sand, M>Wp		A,PID,pp	1.8		<1ppm, 310-330kPa		
		CLAY: Very stiff, grey clay, M>Wp							
	2.5	Bore discontinued at 2.5m, limit of investigation		A,PID,pp	2.45		<1ppm, 310-350kPa		

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66

TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: Bore started in fill platform batter, approx 0.25m above surrounding ground level

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: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 9.06 AHD
EASTING: 372197.655
NORTHING: 1354841.698
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 49737
DATE: 21/3/2011
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
9	0	FILLING: Generally comprising dark grey silty sand with trace gravel, shell fragments, rootlets, damp		D,PID	0.05		<1ppm		
				A,PID	0.45		<1ppm		
		From 0.6m, grey, some gravel, trace brick fragments and ceramic plating fragments							
8	1			A,PID	0.95		<1ppm		1
	1.3	SAND: Generally comprising grey/brown fine grained sand, damp		A,PID	1.45		<1ppm		
7	2			A,PID	1.95		<1ppm		2
				A,PID	2.45		<1ppm		
		From 2.6m, trace cemented sand nodules							
6	3			A,PID	2.95		<1ppm		3
5	4								4
4	5							▼	5
	5.5	SAND: Light grey, fine to medium grained sand, slight hydrocarbon odour, saturated		A,PID	5.7		<1ppm		
3	6								6
	6.0	Bore discontinued at 6.0m, limit of investigation							
2	7								7
1	8								8
0	9								9

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil
WATER OBSERVATIONS: Free groundwater observed at 5.0m during drilling
REMARKS: Bore started in fill platform batter, approx 0.5m above surrounding ground level

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: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.48 AHD
EASTING: 372205.686
NORTHING: 1354889.761
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 49737
DATE: 21/3/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.02	FILLING: Asphalt		D,PID	0.1		<1ppm		
	0.13	FILLING: Generally comprising orange subrounded gravel filling with some clay and sand, humid to damp (quarried conglomerate?)		A,PID	0.25		<1ppm		
				A,PID	0.5		<1ppm		
	0.65	FILLING: Generally comprising grey/yellow medium grained sand filling, damp		A,PID	0.95		<1ppm		
	1.1	FILLING: Generally comprising silty fine to medium grained sand filling with trace gravel, brick fragments and ceramic tile fragments, damp		A,PID	1.45		<1ppm		
	1.25	At 0.85m, brick encountered							
	1.65	FILLING: Generally comprising orange bricks		A,PID	1.95		<1ppm		
	2.0	FILLING: Generally comprising brown/grey fine to medium grained sand filling, trace gravel and brick fragments, damp							
		SILTY SAND: Grey, fine to medium grained silty sand, damp							
		Bore discontinued at 2.0m, limit of investigation							

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66

TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: Bore drilled in loading dock ramp, approx 0.65m above surrounding ground level

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: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.39 AHD
EASTING: 372162.202
NORTHING: 1354816.56
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 49737
DATE: 21/3/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	FILLING: Asphalt		D,PID	0.15		<1ppm		
	0.2	FILLING: Generally comprising orange grey subrounded gravel filling with some clay and sand (quarry conglomerate?), humid to damp		A,PID	0.3		<1ppm		
	1.05	FILLING: Generally comprising dark grey ash filling with trace sand, gravel, glass, ceramic tile fragments and brick fragments, humid From 0.6m increase in sand and clay content, trace coal		A,PID	0.95		<1ppm		
		SILTY SAND: Grey/brown, fine to medium grained silty sand filling, damp		A,PID	1.4		<1ppm		
		From 1.65m, grey mottled orange, trace cemented sand nodules		A,PID	1.95		<1ppm		
		From 3.2m, grey, no cemented sand nodules observed, some clay, trace sandy clay nodules						▼	
				A,PID	5.9		<1ppm		
	6.0	Bore discontinued at 6.0m, limit of investigation							

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil
WATER OBSERVATIONS: Free groundwater observed at 4.1m during drilling
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.32 AHD
EASTING: 372170.721
NORTHING: 1354804.376
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 49737
DATE: 21/3/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.02	FILLING: Asphalt		D,PID	0.05		<1ppm		
	0.1	FILLING: Generally comprising grey/orange subrounded gravel filling with some sand, trace clay, humid		A,PID	0.45		<1ppm		
	1	FILLING: Generally comprising grey ash filling, with some sand, trace gravel, glass, brick fragments, humid From 1.1m, trace sandy clay nodules		A,PID	0.95		<1ppm		
				A,PID	1.45		<1ppm		
	1.6	FILLING: Generally comprising dark grey silty clay filling with trace gravel, M<Wp							
	2 2.0	SILTY CLAY: Hard dark grey silty clay, M<Wp		A,PID	1.95		<1ppm		
	2.5	Bore discontinued at 2.5m, limit of investigation		A,PID,pp	2.45		<1ppm, >400kPa		

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil
WATER OBSERVATIONS: No free groundwater observed during drilling
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Region Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.57 AHD
EASTING: 372177.911
NORTHING: 1354818.693
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 49737
DATE: 21/3/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	FILLING: Asphalt		D,PID	0.15		<1ppm		
		FILLING: Generally comprising dark grey silty sand filling with some ash, trace brick fragments, humid to damp		A,PID	0.5		<1ppm		
		From 0.2m, increase in ash content		A,PID	0.95		<1ppm		
		From 1.5m, some clay nodules, decrease in ash content		A,PID	1.45		<1ppm		
	2.0	SILTY CLAY: Grey silty clay, M≥Wp		A,PID	1.95		<1ppm		
	2.5	Bore discontinued at 2.5m, limit of investigation		A,PID	2.45		<1ppm		

RIG: 4WD Truck Mounted Drilling Rig **DRILLER:** Foody **LOGGED:** Peade **SURVEY DATUM:** ISG66
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment **CASING:** Nil
WATER OBSERVATIONS: No free groundwater observed during drilling
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 9.75 AHD
EASTING: 385281.94
NORTHING: 6355862.34
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 49737.01
DATE: 27/7/2011
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
9	0	FILLING: Generally comprising brown woodchips filling with some silt, sand and rootlets, moist to wet		D,PID	0.05		<1ppm		
	0.25	FILLING: Generally comprising grey/brown silty sand filling with trace gravel, glass and rootlets, wet From 0.4m, grey		A,PID	0.3		<1ppm		
	0.5	FILLING: Generally comprising orange sandy gravel filling with some clay, moist		A	0.6				
	0.7	FILLING: Generally comprising dark grey sandy silt filling, trace brick fragments and charcoal, moist From 0.85m, no brick fragments encountered (possibly natural)		A,PID	0.75		<1ppm		
	1								1
	1.45	SAND: Light grey, fine grained sand, damp to moist		A	1.5				
8	1.7	Bore discontinued at 1.7m, limit of investigation							
	2								2
7									

RIG: Hand Tools **DRILLER:** Prowse **LOGGED:** Prowse **CASING:** Nil
TYPE OF BORING: 75mm diameter hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SURVEY DATUM: MGA94

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: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 10.33 AHD
EASTING: 385252.86
NORTHING: 6355881.62
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 49737.01
DATE: 27/7/2011
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
10	0.2	FILLING: Generally comprising dark grey silty sand/sandy silt filling with some woodchips and rootlets, moist		D,PID	0.05		<1ppm		
	0.4	FILLING: Generally comprising grey/brown, fine to medium grained sand (possibly beach sand), moist		A,PID	0.25		<1ppm		
	1	SAND: Grey/brown, fine to medium grained sand, moist to wet		A,PID	0.8		<1ppm		1
9	2			A,PID	2.0		<1ppm		2
8	2.5	Bore discontinued at 2.5m, limit of investigation							

RIG: Hand Tools **DRILLER:** Prowse **LOGGED:** Prowse **CASING:** Nil

TYPE OF BORING: 75mm diameter hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bore started in garden bed ~0.4m above surrounding ground surface

SURVEY DATUM: MGA94

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: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 9.87 AHD
EASTING: 385260.79
NORTHING: 6355886.71
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 49737.01
DATE: 27/7/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising dark grey silty clay/clayey silt filling with some sand, abundant rootlets, moist to wet (M>Wp)		D,PID	0.05		<1ppm		
	0.2	FILLING: (Possibly natural), generally comprising grey/brown, fine to medium grained sand filling, moist to wet							
	0.4	SAND: Light grey, fine grained sand, damp to moist							
	0.65	Bore discontinued at 0.65m, limit of investigation							
9	1								1
8	2								2
7									

RIG: Hand Tools **DRILLER:** Prowse **LOGGED:** Prowse **CASING:** Nil

TYPE OF BORING: 75mm diameter hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SURVEY DATUM: MGA94

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: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 7.73 AHD
EASTING: 385310.53
NORTHING: 6355884.76
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 49737.01
DATE: 26/7/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
7	0.06	FILLING: Asphalt							
		FILLING: Generally comprising orange sandy gravel/gravelly sand with trace clay, humid		D,PID	0.1		<1ppm		
	0.3	FILLING: Generally comprising grey/brown silty, fine to medium grained sand with some subrounded to subangular gravel and brick fragments, trace glass, humid to damp		A,PID	0.4		<1ppm		
		At 0.8m, fibro fragment encountered (~20mm x 10mm)							
		At 0.9m, shell encountered							
	1								1
	1.1	SAND: Brown, fine to medium grained sand with trace to some silt, damp		A,PID	1.15		<1ppm		
6				A,PID	1.5		<1ppm		
	2								2
5									

RIG: 4WD truck mounted drill rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** Nil

TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS:

SURVEY DATUM: MGA94

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: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 7.73 AHD
EASTING: 385310.53
NORTHING: 6355884.76
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 49737.01
DATE: 26/7/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SAND: Brown, fine to medium grained sand with trace to some silt, damp *(continued)*							
	3.2	SAND: Light grey, fine grained sand, moist to wet		A,PID	3.4		<1ppm		
4	4	From 4.0m, saturated		A,PID	4.2		<1ppm	▼	4
	4.35	Bore discontinued at 4.35m, limit of investigation							
3									
	5								5
2									

RIG: 4WD truck mounted drill rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** Nil
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment
WATER OBSERVATIONS: Free groundwater observed at 4.0m
REMARKS:

SURVEY DATUM: MGA94

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: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.44 AHD
EASTING: 385299.14
NORTHING: 6355858.31
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 49737.01
DATE: 26/7/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	FILLING: Asphalt							Well cover flush with ground surface, end cap at 0.02m From 0.0 to 0.12m, concrete
		FILLING: Generally comprising orange subrounded to subangular gravelly fine to medium grained sand filling with trace clay, humid		D,PID	0.1		<1ppm		
	0.25	FILLING: Generally comprising grey/brown, fine to coarse grained sand filling with some subrounded to subangular gravel, trace clay and silt, damp							
8				A,PID	0.45		<1ppm		
	0.75	CLAY: Firm, dark grey clay with some silt, trace fine to medium grained sand, M>Wp							
		From 0.75m to 1.0m, possible slight hydrocarbon odour		A,PID,pp	0.9		<1ppm, 60-90kPa		
	1	From 1.0m, grey, sand content increasing, silt content decreasing			1.0				1 From 0.12 to 2.0m, bentonite plug
		From 1.25m, stiff		S,PID,pp			2,2,4 N = 6 <1ppm, 100-120kPa		
7					1.45				
	2								2
6		From 2.5m, very stiff to hard			2.5				
				S,PID,pp			5,7,9 N = 16 <1ppm, >400kPa		
					2.95				

RIG: 4WD truck mounted drilling rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** Nil

TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS:

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.44 AHD
EASTING: 385299.14
NORTHING: 6355858.31
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 49737.01
DATE: 26/7/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
5	3.0	CLAY: Very stiff to hard, dark grey clay with some silt, trace fine to medium grained sand, M>Wp							
	3.5	CLAYEY SAND: Dense, light grey clayey, fine grained sand, wet to saturated, moderate to strong hydrocarbon odour		A,PID	3.85		1099ppm		From 2.0 to 5.3m, 5/2mm washed gravel filter From 2.3 to 5.3m, 50mm diameter Class 18 machine slotted PVC Screen
4	4	From 4.0m, saturated, slight hydrocarbon odour			4.0			▼	4
				S,PID			13,17,29 N = 46 <1ppm		
					4.45				
5	5	From 5.0m, reduction in clay content							5
									End Cap
3		From 5.5m, medium dense to dense			5.5				
				S,PID			7,15,14 N = 29 <1ppm		
	5.75	SAND: Medium dense to dense, light grey, fine to medium grained sand, saturated, slight hydrocarbon odour							
	5.95	Bore discontinued at 5.95m, limit of investigation			5.95				

RIG: 4WD truck mounted drilling rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** Nil
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment
WATER OBSERVATIONS: Free groundwater observed at 4.0m
REMARKS:

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.39 AHD
EASTING: 385276.8
NORTHING: 6355834.39
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 49737.01
DATE: 26/7/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
8	0.03	FILLING: Asphalt							
		FILLING: Generally comprising orange, medium grained sandy gravel filling with trace clay, humid		D,PID	0.07		<1ppm		
	0.3	FILLING: Generally comprising dark grey/black, medium grained sand and ash filling, humid		A,PID	0.35		<1ppm		
		From 0.6m, trace clay							
				A,PID	0.85		<1ppm		
	1				1.0				1
				S,PID,pp			6,9,10 N = 19 <1ppm, >400kPa		
7	1.25	SANDY CLAY: Very stiff to hard, grey/brown, medium grained sandy clay with trace silt, M<Wp							
					1.45				
		From 1.5m, sand content decreasing, silt content increasing							
	2								2
6									

RIG: 4WD truck mounted drilling rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** Nil
TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment
WATER OBSERVATIONS: Free groundwater observed at 4.0m
REMARKS:

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.39 AHD
EASTING: 385276.8
NORTHING: 6355834.39
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 49737.01
DATE: 26/7/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
5		SANDY CLAY: Very stiff to hard, grey/brown, medium grained sandy clay with trace silt, M<Wp *(continued)*							
		From 3.3m, dark grey, M>Wp		A,pp	3.4		>400Pa		
4	4.0	CLAYEY SAND: Dark grey clayey, fine grained sand, saturated		A,PID	4.1		<1ppm	▼	4
	4.5	Bore discontinued at 4.5m, limit of investigation							
3	5								5

RIG: 4WD truck mounted drilling rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** Nil

TYPE OF BORING: 120mm diameter solid flight auger with v-bit attachment

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS:

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.17 AHD
EASTING: 385261.81
NORTHING: 6355833.66
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 49737.01
DATE: 27/7/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.03	FILLING: Asphalt							Well cover flush with ground surface, end cap at 0.02m
		FILLNIG: Generally comprising orange/grey sandy subrounded gravel filling with trace clay and subangular gravel, humid		D,PID	0.1		1ppm		From 0.0 to 0.15m, concrete
8	0.17	FILLING: Generally comprising grey sand and ash filling with trace glass, gravel, brick fragments and china plate fragments, damp		A,PID	0.25		1ppm		
				A,PID	0.95		1ppm		
	1				1.0				1
7				S,PID,pp			3,6,7 N = 13 <1ppm, >400kPa		From 0.15 to 2.1m, bentonite plug
	1.3	CLAY: Stiff to very stiff, grey mottled orange clay with trace fine to medium grained sand and organics, M>Wp			1.45				
	2	From 2.0m, trace to some silt							2
6					2.5				
				S,PID,pp			5,9,16 N = 25 >400kPa		
					2.95				

RIG: 4WD truck mounted drilling rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** HW to 6.2m
TYPE OF BORING: 120mm dia. SFA with v-bit attachment to 4.45m, 120mm external dia. HFA till 5.95m, rotary to 6.2m
WATER OBSERVATIONS: Free groundwater observed at 4.3m
REMARKS:

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Newcastle Regional Art Gallery Redevelopment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: 8.17 AHD
EASTING: 385261.81
NORTHING: 6355833.66
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 49737.01
DATE: 27/7/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		CLAY: Stiff to very stiff, grey mottled orange clay with trace fine to medium grained sand and organics, M>Wp *(continued)*							
				S	4.0		3,10,14 N = 24		From 2.1 to 5.6m, 5/2mm washed gravel filter
	4.3	SAND: Medium dense, light grey, fine grained sand with trace clay, slight hydrocarbon odour, saturated		A,PID	4.4		1ppm	▼	From 2.6 to 5.6m, 50mm diameter Class 18 machined slotted PVC Screen
		From 4.5m, no clay encountered			4.45				
				S,PID	5.5		1,3,9 N = 12 2ppm		End Cap
	5.95	Bore discontinued at 5.95m, limit of investigation			5.95				

RIG: 4WD truck mounted drilling rig **DRILLER:** Morris **LOGGED:** Prowse **CASING:** HW to 6.2m
TYPE OF BORING: 120mm dia. SFA with v-bit attachment to 4.45m, 120mm external dia. HFA till 5.95m, rotary to 6.2m
WATER OBSERVATIONS: Free groundwater observed at 4.3m
REMARKS:

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 49737.02
DATE: 31/10/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	FILLING: Generally comprising grey silty fine to medium grained sand fill, trace organics (leaf matter, twigs, gum nuts) and subrounded gravel, moist		D,PID	0.05		<1ppm		Well cover flush with ground surface
	0.3			D,PID	0.25		<1ppm		From 0.02m to 0.1m, concrete
		FILLING: Generally comprising grey, fine to medium grained sandy fill, clayey silt, moist		A,PID	0.5		<1ppm		
1					1.0		2,2,3 N = 5		1
	1.1	FILLING: Generally comprising grey silty fine to medium grained sand fill, trace brick (?) fragments and coal fines, moist							
	1.2			S,PID			<1ppm		
		FILLING: Generally comprising dark grey/black silty fine to medium grained sand fill, some coal gravel/fines and brick fragments, moist			1.45		(Sample recovery 250mm)		
2		SAND (FILLING?): Very loose, light/dark grey fine to medium grained sand, trace silt and coal fines(?), moist		A,PID	2.0		<1ppm		From 0.1m to 3.4m, bentonite plug 2
					2.5		0,1,2 N = 3		
	2.7	SAND (FILLING?): Very loose, brown/grey, fine to medium grained sand, trace to no coal fines		S,PID			<1ppm		
3					2.95		(Sample recovery 250mm)		3
				A,PID	3.5		<1ppm		
4		From 4.0m, slight hydrocarbon/sweet odour			4.0		2,3,5 N = 8		4
				S,PID			<1ppm		
		From 4.6m, trace sandy clay nodules			4.45				
5				A,PID	5.0		<1ppm		5
					5.5		1,3,5 N = 8	▼	From 3.4m to 7.2m, 5/2mm - graded washed gravel filter
		From 5.6m, light grey/yellow, fine to medium grained sand, saturated		S,PID			<1ppm		From 4.2m to 7.2m, 50mm diameter Class 18 machine slotted PVC screen
6					5.95		(Sample recovery 350mm)		6
				A,PID	6.5		<1ppm		
7					7.0		0,1,2 N = 3		7 At 7.2m, end cap
				S,PID			<1ppm		
	7.5	Bore discontinued at 7.5m, limit of investigation			7.45				
8									8
9									9

RIG: 4WD truck mounted rig **DRILLER:** Morris **LOGGED:** Peade **CASING:** Nil

TYPE OF BORING: 115mm diameter solid flight auger attachment

WATER OBSERVATIONS: Free groundwater observed at ~5.5m

REMARKS: Drilled area ~1.5m higher than surrounding ground level, casing from 0.01m

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 I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 49737.02
DATE: 31/10/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0	FILLING: Generally comprising grey fine to medium grained sand fill with some silt, trace organics, woodchips, abundant rootlets to 0.1m, humid/dry		D,PID	0.05		<1ppm		Well cover flush with ground surface
		From 0.1m, no woodchips		D,PID	0.25		<1ppm		From 0.02m to 0.1m, concrete
		From 0.3m, trace brick(?), glass fragments and sandy clay nodules		A,PID	0.5		<1ppm		
	1				1.0		3,4,5 N = 9		From 0.1m to 1.5m, bentonite plug
	1.2	CLAY: Stiff to very stiff, light grey mottled orange clay, M>Wp		S,PID,pp			<1ppm, ~220kPa (Sample recovery 250mm)		
					1.45				
	2			A,PID,pp	2.0		<1ppm, 150-200kPa		
		From 2.2m, dark grey mottled orange (very stiff to hard)			2.5				
				S,PID,pp			4,6,9 N = 15 <1ppm, 380-400kPa		
	3				2.95				
				A,PID	3.5		<1ppm		
	4				4.0				From 1.5m to 6.1m, 5/2mm - graded washed gravel filter
	4.2	SAND: Losse to medium dense, light grey/grey sand, trace clay, wet/saturated		S,PID			14,19,18 N = 37 <1ppm	▼	
					4.45				
	5			A,PID	5.0		<1ppm		From 3.2m to 6.2m, 50mm diameter Class 18 machine slotted PVC screen
					5.5				
				S,PID			3,4,6 N = 10 <1ppm		
	6				5.95				At 7.2m, end cap
	6.2	Bore discontinued at 6.2m, limit of investigation							
	7								
	8								
	9								

RIG: 4WD truck mounted rig **DRILLER:** Morris **LOGGED:** Peade **CASING:** Nil
TYPE OF BORING: 115mm diameter solid flight auger attachment
WATER OBSERVATIONS: Free groundwater observed at ~4.2m
REMARKS: In garden strip in line with trees, casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 107-D
PROJECT No: 49737.02
DATE: 15/12/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.01	ASPHALT		D,PID	0.1		<1ppm		Well cover flush with ground level From 0.02m to 0.1m, concrete
	0.2	FILLING: Generally comprising orange silty fine to medium grained sand fill, trace subrounded/subangular gravel, dry/humid		A,PID	0.25		<1ppm		
				A,PID	0.5		<1ppm		
	0.7	FILLING: Generally comprising grey silty fine to medium grained sand fill, trace fine angular gravel, dry/humid							
1				A,PID,pp	1.0		<1ppm, 230-240kPa 5,6,7 N = 13		
	1.3	FILLING: Generally comprising very stiff, dark grey mottled orange clay fill, trace coal fines/gravel and fine gravel, M>Wp From 1.0m, coal fines increasing		S,PID,pp			<1ppm, >200kPa		
					1.45				
2	2.0	FILLING: Generally comprising stiff to very stiff grey mottled orange clay fill, trace fine sand, trace coal fines, M>Wp							
		CLAY: Very stiff to hard, dark grey clay, M>Wp			2.5		6,8,12 N = 20		
				S,PID,pp			<1ppm, 480-510kPa		
3					2.95				
	3.5	CLAY: Very stiff to hard, grey sandy clay, M>Wp						▼	
4					4.0		6,14,20 N = 34		
	4.3	SAND: Medium dense to dense, light grey, fine to medium grained sand, trace clay, saturated		S,PID			<1ppm		
					4.45				
5									
					5.5		3,3,8 N = 11		
				S,PID			<1ppm		
6					5.95				
		From ~6.5m, trace dark coarse sand intermixed							From 0.1m to 12.8m, bentonite plug From 0m to 13.15m, 50mm diameter Class 18 PVC casing
7					7.0		5,6,7 N = 13		
	7.25	SAND: Medium dense, fine to medium grained sand, trace silt/clay, saturated		S			(no recovery)		
					7.45				
8									
	8.4	CLAY: Stiff to very stiff, grey clay, trace silt and fine to medium grained sand, M>Wp From 8.5m, sand content increasing			8.5		5,6,7 N = 13		
				S,PID,pp			<1ppm, 180-250kPa		
9					8.95				
					10.0				

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: 125mm diameter solid flight auger to 1.0m, TC bit attachment, from GL to 2.5m casing, from 2.5m wash boring

WATER OBSERVATIONS: Groundwater level in 170-U ~3.661m*

REMARKS: Slight odour from 4.0m-4.45m sample, casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 107-D
PROJECT No: 49737.02
DATE: 15/12/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	10.1	CLAYEY SAND: Dense grey clayey sand, saturated		S,PID	10.45		21,20,20 N = 40 <1ppm		
		From 10.7m, trace yellow mottling							
11					11.5				
	11.6	SAND: Very dense, light grey fine to medium grained sand, trace clay, saturated		S			22,31,30 N = 61		
12					11.95				
	12.5	SAND: Very dense yellow with trace light grey fine to medium grained sand, saturated							
13				S,PID	13.0		23,30,38 N = 68 <1ppm		
					13.45				
14	14.0	SANDY CLAY: Hard grey mottled yellow fine to medium grained sandy clay, M>Wp							
	14.5	SAND: Very dense light grey fine to medium grained sand, trace yellow mottling, saturated		S,PID	14.5		26,35,50 N = 85 <1ppm		
15					14.95				
	15.5	GRAVELLY SILTY CLAY: Very stiff to hard grey gravelly silty clay, trace yellow mottling (extremely weathered conglomerate) and medium to coarse grained sand, M>Wp							
16				S,PID,pp	16.0		8,10,15 N = 25 <1ppm, 300-400kPa		
					16.45				
17	17.0	SILTSTONE: Hard, grey mottled orange siltstone							
				S,PID	17.5		7,8,25 N = 33 <1ppm		
18	18.0	Bore discontinued at 18.0m, limit of investigation			17.95				
19									

Well Construction Details: From 12.7m to 16.15m, 5mm graded washed gravel filter; From 13.15m to 16.15m, 50mm diameter Class 18 machine slotted PVC screen; End Cap 16.15m

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: 125mm diameter solid flight auger to 1.0m, TC bit attachment, from GL to 2.5m casing, from 2.5m wash boring

WATER OBSERVATIONS: Groundwater level in 170-U ~3.661m*

REMARKS: Slight odour from 4.0m-4.45m sample, casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 203-D
PROJECT No: 49737.02
DATE: 28/10 - 2/12/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		ASPHALT							Well cover flush with ground level From 0.02m to 0.1m, concrete
	0.33	FILLING: Generally comprising brown/grey fine to medium grained sand fill, trace to some bricks/sandstone cobbles/boulders, trace angular gravel, humid/moist		D,PID	0.35		<1ppm		
				D,PID	0.5		<1ppm		
		From 0.8m, decreased brick and cobble content		D,PID/S	1.0		<1ppm 1,1,1 N = 2		
		Last sample at 1.5m, due to limited extent of reach		D,PID	1.45 1.5		<1ppm		
	2.2	End of pothole log							
		FILLING: Packing sand, brick fragments							
		SAND: Very loose, dark grey/brown/ light grey/yellow, fine to medium grained sand fill, trace silt damp to moist		S,PID	2.5		4,2,2 N = 4 <1ppm	07-12-11	
	3.0	SAND: Very loose, light grey/yellow fine to medium grained sand, saturated			2.95				
				S,PID	4.0		2,1,2 N = 3 <1ppm		From 0.1m to 7.4m, bentonite plug
	4.4	SAND: Very loose, grey fine to medium grained sand, trace to some clays, saturated			4.45				
				S,PID	5.5		8,11,13 N = 24 <1ppm		
		From 4.4m to 5.95m, change to medium dense light grey, trace clay			5.95				
	6.5	SAND: Very loose, grey/dark grey fine to medium grained sand, trace clay, saturated							
	7.0	SAND: Medium dense, light grey/yellow fine to medium grained sand, saturated		S,PID	7.0		1,0,1 N = 1 <1ppm		
		From 7.25m, clay content increasing (sand/clayey sand)			7.45				
				S,PID	8.5		6,5,10 N = 15 <1ppm		
					8.95				
					10.0				From 7.4m to 11.3m, 5mm graded washed gravel filter From 8.3m to 11.3m, 50mm

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: Potholed using sucker truck to ~2.2m (28.10.11) then backfilled. Then 125mm diameter solid flight auger to 1.0m, TC bit attachment, from FL t

WATER OBSERVATIONS: Groundwater level in well ~2.7m, (7/12/11)

REMARKS: Casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 203-D
PROJECT No: 49737.02
DATE: 28/10 - 2/12/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
									diameter Class 18 slotted PVC screen
	10.3	CLAY: Very stiff/hard, light grey mottled red residual clay, M>Wp		S,PID	10.45		7,9,30 N = 39 <1ppm		
	11.15	Bore discontinued at 11.15m, limit of investigation							End Cap at 11.3m

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: Potholed using sucker truck to ~2.2m (28.10.11) then backfilled. Then 125mm diameter solid flight auger to 1.0m, TC bit attachment, from FL t

WATER OBSERVATIONS: Groundwater level in well ~2.7m, (7/12/11)

REMARKS: Casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 203-U
PROJECT No: 49737.02
DATE: 7/12/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.33	ASPHALT							Well cover flush with ground level From 0.02m to 0.1m, concrete From 0.1m to 0.4m, backfill sand
		FILLING: Generally comprising brown/grey fine to medium grained sand fill, trace to some bricks/sandstone cobbles/boulders, trace angular gravel, humid/moist		D,PID	0.35		<1ppm		
				D,PID	0.5		<1ppm		
		From 0.8m, decreased brick and cobble content		D,PID/S	1.0		<1ppm 1,1,1 N = 2		From 0.4m to 2.0m, bentonite plug
		Last sample at 1.5m, due to limited extent of reach		D,PID	1.45 1.5		<1ppm		
	2.2	End of pothole log							
		FILLING: Packing sand, brick fragments			2.5				From 2m to 2.6m, 5mm graded washed gravel filter
		SAND: Very loose, dark grey/brown/ light grey/yellow, fine to medium grained sand, trace silt damp moist		S,PID			4,2,2 N = 4 <1ppm		
	3.0	SAND: Very loose, light grey/yellow fine to medium grained sand, saturated			2.95			▼	
					4.0				From 2.2m to 5.2m, 50mm diameter, Class 18 machine slotted PVC screen From 2.6m to 5.2m collapsed
				S,PID			2,1,2 N = 3 <1ppm		
	4.4	SAND: Very loose, grey fine to medium grained sand, trace to some clays, saturated			4.45				
	5.2	Bore discontinued at 5.2m, limit of investigation							

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: Potholed using sucker truck to ~2.2m (28.10.11) then backfilled. Then 125mm diameter solid flight auger to 1.0m, TC bit attachment, from FL t

WATER OBSERVATIONS: Free groundwater at 3.2m during drilling

REMARKS: Casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 204-D
PROJECT No: 49737.02
DATE: 8/12/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising dark grey fine to medium grained sand fill, trace to some clay, trace fine gravel from 0.25m/0.3m, trace rootlets and organics to 0.05m (leaf matter, grass), moist to wet		D	0.1		~1.2ppm		Well cover flush with ground level From 0.02m to 0.1m, concrete
	0.25 0.3			A,PID	0.25		<1ppm		
				A,PID	0.5		<1ppm		
		SAND/FILLING: Generally comprising grey fine to medium grained sand, trace fine gravel/coarse sand to 0.3m, moist							
	1	SAND: Loose, grey fine to medium grained sand, moist			1.0				
				S,PID			3,3,3 N = 6 <1ppm		
					1.45				
	2				2.5				
				S,PID			2,3,4 N = 7 <1ppm		
	3				2.95				
	4				4.0				
				S,PID			3,5,7 N = 12 <1ppm		From 0.1m to 8.5m, bentonite plug
		From 4.3m, medium dense darker grey fine to medium grained sand, wet			4.45				
	5	From 5.0m/5.1m, light grey/yellow fine to medium grained sand, wet to saturated							
					5.5				
				S,PID			11,14,14 N = 28 <1ppm	▼	
	6	From ~5.8m, trace orange mottling			5.95				
	7	7.0 From ~7.0m, dense			7.0				
		SAND: Dense grey fine to medium grained sand, trace clay, saturated		S,PID			14,18,18 N = 36 <1ppm		
					7.45				
	8				8.5				
		From ~8.5m, medium dense		S,PID			6,8,11 N = 19 <1ppm		From 8.5m to 9.0m, gravel filter
	9				8.95				
	9.7	CLAYEY SAND: Very loose grey fine to medium grained clayey sand, saturated			10.0				

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: 125mm diameter solid flight auger to 1.0m, TC bit attachment from GL to 2.5m casing, from 2.5m wash boring

WATER OBSERVATIONS: Groundwater level @ 5.9m below surrace in well 204-U

REMARKS: Rainy conditions previous/current day, casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 204-D
PROJECT No: 49737.02
DATE: 8/12/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		CLAYEY SAND: Very loose grey fine to medium grained clayey sand, saturated *(continued)*		S,PID			1,0,1 N = 1 <1ppm		From 8.5m to 12.0m, 5mm graded washed gravel filter From 9.0m to 12.0m, 50mm diameter Class 18 slotted PVC screen
11					10.95				
	11.3	CLAY (Residual): Stiff, light grey mottled red/orange clay, trace fine grained sand, M>Wp			11.5				
				S,PID			6,6,8 N = 14		
12	12.0	Bore discontinued at 12.0m, limit of investigation			11.95				End Cap at 12.0m
13									
14									
15									
16									
17									
18									
19									

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: 125mm diameter solid flight auger to 1.0m, TC bit attachment from GL to 2.5m casing, from 2.5m wash boring

WATER OBSERVATIONS: Groundwater level @ 5.9m below surrace in well 204-U

REMARKS: Rainy conditions previous/current day, casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

BOREHOLE LOG

CLIENT: Newcastle City Council
PROJECT: Additional Groundwater & Preliminary Vapour Intrusion Assessment
LOCATION: 1 Laman Street, Cooks Hill

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 204-U
PROJECT No: 49737.02
DATE: 7/12/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Generally comprising dark grey fine to medium grained sand, trace to some clay, trace fine gravel from 0.25m/0.3m, trace rootlets and organics to 0.05m (leaf matter, grass), moist to wet		D	0.1		~1.2ppm		Well cover flush with ground level From 0.02m to 0.1m concrete
	0.25 0.3			A,PID	0.25		<1ppm		
				A,PID	0.5		<1ppm		
		SAND/FILLING: Generally comprising grey fine to medium grained sand, trace fine gravel/coarse sand to 0.3m, moist		A,PID	0.99		<1ppm		
	1	SAND: Loose, grey fine to medium grained sand, moist		S,PID	1.0		3,3,3 N = 6		
					1.45		<1ppm		
	2				2.5				From 0.3m to 4.8m, bentonite plug
				S,PID			2,3,4 N = 7		
	3				2.95		<1ppm		
					4.0		3,5,7 N = 12		
	4	From 4.3m, medium dense darker grey fine to medium grained sand, wet			4.45		<1ppm		From 0.1m to 8.3m, backfill sand
	5	From 5.0m/5.1m, light grey/yellow fine to medium grained sand, wet to saturated			5.5		11,14,14 N = 28		From 4.8m to 5.5m, 5mm graded washed gravel filter End cap at 8.1m
		From ~5.8m, trace orange mottling		S,PID	5.95		<1ppm	▼	
	6								
	7	7.0 From ~7.0m, dense SAND: Dense grey fine to medium grained sand, trace clay, saturated							Collapsed strata from 5.5m to 8.1m
	8	8.1 Bore discontinued at 8.1m, limit of investigation							
	9								

RIG: Scout 4 **DRILLER:** Kerney-ennis **LOGGED:** Peade **CASING:** HW

TYPE OF BORING: 125mm diameter solid flight auger, TC bit attachment

WATER OBSERVATIONS: Free groundwater observed at 6.2m

REMARKS: Casing from ~0.01m

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

Appendix B

Laboratory Test Results (Report 257346)

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 257346

Client Details

Client	Douglas Partners Newcastle
Attention	Chris Bozinovski, Joshua Kramer
Address	Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310

Sample Details

Your Reference	**49737.04, Newcastle**
Number of Samples	8 Water
Date samples received	03/12/2020
Date completed instructions received	03/12/2020

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.

Report Details

Date results requested by	10/12/2020
Date of Issue	08/12/2020

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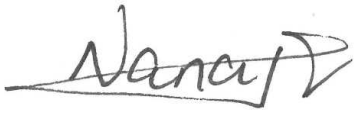
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Dragana Tomas, Senior Chemist
Hannah Nguyen, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

VOCs in water						
Our Reference		257346-1	257346-2	257346-3	257346-4	257346-5
Your Reference	UNITS	107-U	107B	1	202	105
Date Sampled		02/12/2020	02/12/2020	02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	04/12/2020	04/12/2020	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	07/12/2020	07/12/2020	07/12/2020	07/12/2020	07/12/2020
Dichlorodifluoromethane	µg/L	<10	<10	<10	<10	<10
Chloromethane	µg/L	<10	<10	<10	<10	<10
Vinyl Chloride	µg/L	<10	<10	<10	<10	<10
Bromomethane	µg/L	<10	<10	<10	<10	<10
Chloroethane	µg/L	<10	<10	<10	<10	<10
Trichlorofluoromethane	µg/L	<10	<10	<10	<10	<10
1,1-Dichloroethene	µg/L	<1	<1	<1	<1	<1
Trans-1,2-dichloroethene	µg/L	<1	<1	<1	<1	<1
1,1-dichloroethane	µg/L	2	2	<1	<1	<1
Cis-1,2-dichloroethene	µg/L	1	1	<1	<1	<1
Bromochloromethane	µg/L	<1	<1	<1	<1	<1
Chloroform	µg/L	<1	<1	<1	<1	<1
2,2-dichloropropane	µg/L	<1	<1	<1	<1	<1
1,2-dichloroethane	µg/L	<1	<1	<1	<1	<1
1,1,1-trichloroethane	µg/L	<1	<1	<1	<1	<1
1,1-dichloropropene	µg/L	<1	<1	<1	<1	<1
Cyclohexane	µg/L	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	<1	<1	<1	<1	<1
Benzene	µg/L	<1	<1	<1	<1	<1
Dibromomethane	µg/L	<1	<1	<1	<1	<1
1,2-dichloropropane	µg/L	<1	<1	<1	<1	<1
Trichloroethene	µg/L	<1	<1	<1	<1	<1
Bromodichloromethane	µg/L	<1	<1	<1	<1	<1
trans-1,3-dichloropropene	µg/L	<1	<1	<1	<1	<1
cis-1,3-dichloropropene	µg/L	<1	<1	<1	<1	<1
1,1,2-trichloroethane	µg/L	<1	<1	<1	<1	<1
Toluene	µg/L	<1	<1	<1	<1	<1
1,3-dichloropropane	µg/L	<1	<1	<1	<1	<1
Dibromochloromethane	µg/L	<1	<1	<1	<1	<1
1,2-dibromoethane	µg/L	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	<1	<1	<1	<1	<1
1,1,1,2-tetrachloroethane	µg/L	<1	<1	<1	<1	<1
Chlorobenzene	µg/L	<1	<1	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1	<1	<1

VOCs in water						
Our Reference		257346-1	257346-2	257346-3	257346-4	257346-5
Your Reference	UNITS	107-U	107B	1	202	105
Date Sampled		02/12/2020	02/12/2020	02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water	Water	Water
Bromoform	µg/L	<1	<1	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2	<2	<2
Styrene	µg/L	<1	<1	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<1	<1	<1	<1
o-xylene	µg/L	<1	<1	<1	<1	<1
1,2,3-trichloropropane	µg/L	<1	<1	<1	<1	<1
Isopropylbenzene	µg/L	<1	<1	<1	<1	2
Bromobenzene	µg/L	<1	<1	<1	<1	<1
n-propyl benzene	µg/L	<1	<1	<1	<1	2
2-chlorotoluene	µg/L	<1	<1	<1	<1	<1
4-chlorotoluene	µg/L	<1	<1	<1	<1	<1
1,3,5-trimethyl benzene	µg/L	<1	<1	<1	<1	<1
Tert-butyl benzene	µg/L	<1	<1	<1	<1	<1
1,2,4-trimethyl benzene	µg/L	<1	<1	<1	<1	<1
1,3-dichlorobenzene	µg/L	<1	<1	<1	<1	<1
Sec-butyl benzene	µg/L	<1	<1	<1	<1	<1
1,4-dichlorobenzene	µg/L	<1	<1	<1	<1	<1
4-isopropyl toluene	µg/L	<1	<1	<1	<1	<1
1,2-dichlorobenzene	µg/L	<1	<1	<1	<1	<1
n-butyl benzene	µg/L	<1	<1	<1	<1	<1
1,2-dibromo-3-chloropropane	µg/L	<1	<1	<1	<1	<1
1,2,4-trichlorobenzene	µg/L	<1	<1	<1	<1	<1
Hexachlorobutadiene	µg/L	<1	<1	<1	<1	<1
1,2,3-trichlorobenzene	µg/L	<1	<1	<1	<1	<1
Surrogate Dibromofluoromethane	%	103	104	107	105	107
Surrogate toluene-d8	%	99	102	100	99	99
Surrogate 4-BFB	%	117	115	115	117	116

VOCs in water				
Our Reference		257346-6	257346-7	257346-8
Your Reference	UNITS	203B	203C	D1/JRK
Date Sampled		02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water
Date extracted	-	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	07/12/2020	07/12/2020	07/12/2020
Dichlorodifluoromethane	µg/L	<10	<10	<10
Chloromethane	µg/L	<10	<10	<10
Vinyl Chloride	µg/L	<10	<10	<10
Bromomethane	µg/L	<10	<10	<10
Chloroethane	µg/L	<10	<10	<10
Trichlorofluoromethane	µg/L	<10	<10	<10
1,1-Dichloroethene	µg/L	<1	<1	<1
Trans-1,2-dichloroethene	µg/L	<1	<1	<1
1,1-dichloroethane	µg/L	<1	<1	<1
Cis-1,2-dichloroethene	µg/L	<1	<1	<1
Bromochloromethane	µg/L	<1	<1	<1
Chloroform	µg/L	<1	<1	<1
2,2-dichloropropane	µg/L	<1	<1	<1
1,2-dichloroethane	µg/L	<1	<1	<1
1,1,1-trichloroethane	µg/L	<1	<1	<1
1,1-dichloropropene	µg/L	<1	<1	<1
Cyclohexane	µg/L	<1	<1	<1
Carbon tetrachloride	µg/L	<1	<1	<1
Benzene	µg/L	<1	<1	<1
Dibromomethane	µg/L	<1	<1	<1
1,2-dichloropropane	µg/L	<1	<1	<1
Trichloroethene	µg/L	<1	<1	<1
Bromodichloromethane	µg/L	<1	<1	<1
trans-1,3-dichloropropene	µg/L	<1	<1	<1
cis-1,3-dichloropropene	µg/L	<1	<1	<1
1,1,2-trichloroethane	µg/L	<1	<1	<1
Toluene	µg/L	<1	<1	<1
1,3-dichloropropane	µg/L	<1	<1	<1
Dibromochloromethane	µg/L	<1	<1	<1
1,2-dibromoethane	µg/L	<1	<1	<1
Tetrachloroethene	µg/L	<1	<1	<1
1,1,1,2-tetrachloroethane	µg/L	<1	<1	<1
Chlorobenzene	µg/L	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1

VOCs in water				
Our Reference		257346-6	257346-7	257346-8
Your Reference	UNITS	203B	203C	D1/JRK
Date Sampled		02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water
Bromoform	µg/L	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2
Styrene	µg/L	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<1	<1
o-xylene	µg/L	<1	<1	<1
1,2,3-trichloropropane	µg/L	<1	<1	<1
Isopropylbenzene	µg/L	<1	<1	<1
Bromobenzene	µg/L	<1	<1	<1
n-propyl benzene	µg/L	<1	<1	<1
2-chlorotoluene	µg/L	<1	<1	<1
4-chlorotoluene	µg/L	<1	<1	<1
1,3,5-trimethyl benzene	µg/L	<1	<1	<1
Tert-butyl benzene	µg/L	<1	<1	<1
1,2,4-trimethyl benzene	µg/L	<1	<1	<1
1,3-dichlorobenzene	µg/L	<1	<1	<1
Sec-butyl benzene	µg/L	<1	<1	<1
1,4-dichlorobenzene	µg/L	<1	<1	<1
4-isopropyl toluene	µg/L	<1	<1	<1
1,2-dichlorobenzene	µg/L	<1	<1	<1
n-butyl benzene	µg/L	<1	<1	<1
1,2-dibromo-3-chloropropane	µg/L	<1	<1	<1
1,2,4-trichlorobenzene	µg/L	<1	<1	<1
Hexachlorobutadiene	µg/L	<1	<1	<1
1,2,3-trichlorobenzene	µg/L	<1	<1	<1
Surrogate Dibromofluoromethane	%	104	103	104
Surrogate toluene-d8	%	101	99	98
Surrogate 4-BFB	%	117	117	116

vTRH(C6-C10)/BTEXN in Water						
Our Reference		257346-1	257346-2	257346-3	257346-4	257346-5
Your Reference	UNITS	107-U	107B	1	202	105
Date Sampled		02/12/2020	02/12/2020	02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	04/12/2020	04/12/2020	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	07/12/2020	07/12/2020	07/12/2020	07/12/2020	07/12/2020
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	%	103	104	107	105	107
Surrogate toluene-d8	%	99	102	100	99	99
Surrogate 4-BFB	%	117	115	115	117	116

vTRH(C6-C10)/BTEXN in Water				
Our Reference		257346-6	257346-7	257346-8
Your Reference	UNITS	203B	203C	D1/JRK
Date Sampled		02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water
Date extracted	-	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	07/12/2020	07/12/2020	07/12/2020
TRH C_6 - C_9	µg/L	<10	<10	<10
TRH C_6 - C_{10}	µg/L	<10	<10	<10
TRH C_6 - C_{10} less BTEX (F1)	µg/L	<10	<10	<10
Benzene	µg/L	<1	<1	<1
Toluene	µg/L	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2
o-xylene	µg/L	<1	<1	<1
Naphthalene	µg/L	<1	<1	<1
Surrogate Dibromofluoromethane	%	104	103	104
Surrogate toluene-d8	%	101	99	98
Surrogate 4-BFB	%	117	117	116

svTRH (C10-C40) in Water						
Our Reference		257346-1	257346-2	257346-3	257346-4	257346-5
Your Reference	UNITS	107-U	107B	1	202	105
Date Sampled		02/12/2020	02/12/2020	02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	04/12/2020	04/12/2020	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	04/12/2020	04/12/2020	04/12/2020	04/12/2020	05/12/2020
TRH C_{10} - C_{14}	µg/L	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	µg/L	<100	130	130	<100	<100
TRH C_{29} - C_{36}	µg/L	<100	<100	<100	<100	<100
TRH >C_{10} - C_{16}	µg/L	<50	130	120	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	<50	130	120	<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	%	79	95	79	88	88

svTRH (C10-C40) in Water				
Our Reference		257346-6	257346-7	257346-8
Your Reference	UNITS	203B	203C	D1/JRK
Date Sampled		02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water
Date extracted	-	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	04/12/2020	05/12/2020	05/12/2020
TRH C_{10} - C_{14}	µg/L	<50	<50	<50
TRH C_{15} - C_{28}	µg/L	<100	<100	<100
TRH C_{29} - C_{36}	µg/L	<100	<100	<100
TRH >C_{10} - C_{16}	µg/L	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	<50	<50	<50
TRH >C_{16} - C_{34}	µg/L	<100	<100	<100
TRH >C_{34} - C_{40}	µg/L	<100	<100	<100
Surrogate o-Terphenyl	%	90	89	81

HM in water - dissolved						
Our Reference		257346-1	257346-2	257346-3	257346-4	257346-5
Your Reference	UNITS	107-U	107B	1	202	105
Date Sampled		02/12/2020	02/12/2020	02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	04/12/2020	04/12/2020	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	04/12/2020	04/12/2020	04/12/2020	04/12/2020	04/12/2020
Arsenic-Dissolved	µg/L	9	3	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	<1	1
Copper-Dissolved	µg/L	3	2	15	4	4
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	1	4	5	<1	24
Zinc-Dissolved	µg/L	9	14	18	10	140

HM in water - dissolved				
Our Reference		257346-6	257346-7	257346-8
Your Reference	UNITS	203B	203C	D1/JRK
Date Sampled		02/12/2020	02/12/2020	02/12/2020
Type of sample		Water	Water	Water
Date prepared	-	04/12/2020	04/12/2020	04/12/2020
Date analysed	-	04/12/2020	04/12/2020	04/12/2020
Arsenic-Dissolved	µg/L	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1
Copper-Dissolved	µg/L	3	3	14
Lead-Dissolved	µg/L	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	<1	1
Zinc-Dissolved	µg/L	7	6	9

Method ID	Methodology Summary
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.
Org-020	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-023	Water samples are analysed directly by purge and trap GC-MS.
Org-023	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: VOCs in water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			04/12/2020	5	04/12/2020	04/12/2020		04/12/2020	[NT]
Date analysed	-			07/12/2020	5	07/12/2020	07/12/2020		07/12/2020	[NT]
Dichlorodifluoromethane	µg/L	10	Org-023	<10	5	<10	<10	0	[NT]	[NT]
Chloromethane	µg/L	10	Org-023	<10	5	<10	<10	0	[NT]	[NT]
Vinyl Chloride	µg/L	10	Org-023	<10	5	<10	<10	0	[NT]	[NT]
Bromomethane	µg/L	10	Org-023	<10	5	<10	<10	0	[NT]	[NT]
Chloroethane	µg/L	10	Org-023	<10	5	<10	<10	0	[NT]	[NT]
Trichlorofluoromethane	µg/L	10	Org-023	<10	5	<10	<10	0	[NT]	[NT]
1,1-Dichloroethene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Trans-1,2-dichloroethene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,1-dichloroethane	µg/L	1	Org-023	<1	5	<1	<1	0	103	[NT]
Cis-1,2-dichloroethene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Bromochloromethane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Chloroform	µg/L	1	Org-023	<1	5	<1	<1	0	96	[NT]
2,2-dichloropropane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2-dichloroethane	µg/L	1	Org-023	<1	5	<1	<1	0	101	[NT]
1,1,1-trichloroethane	µg/L	1	Org-023	<1	5	<1	<1	0	103	[NT]
1,1-dichloropropene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Cyclohexane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Carbon tetrachloride	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Benzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Dibromomethane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2-dichloropropane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Trichloroethene	µg/L	1	Org-023	<1	5	<1	<1	0	111	[NT]
Bromodichloromethane	µg/L	1	Org-023	<1	5	<1	<1	0	105	[NT]
trans-1,3-dichloropropene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
cis-1,3-dichloropropene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,1,2-trichloroethane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Toluene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,3-dichloropropane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Dibromochloromethane	µg/L	1	Org-023	<1	5	<1	<1	0	112	[NT]
1,2-dibromoethane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Tetrachloroethene	µg/L	1	Org-023	<1	5	<1	<1	0	113	[NT]
1,1,1,2-tetrachloroethane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Chlorobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Ethylbenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Bromoform	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
m+p-xylene	µg/L	2	Org-023	<2	5	<2	<2	0	[NT]	[NT]
Styrene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,1,2,2-tetrachloroethane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]

QUALITY CONTROL: VOCs in water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
o-xylene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2,3-trichloropropane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Isopropylbenzene	µg/L	1	Org-023	<1	5	2	<1	67	[NT]	[NT]
Bromobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
n-propyl benzene	µg/L	1	Org-023	<1	5	2	<1	67	[NT]	[NT]
2-chlorotoluene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
4-chlorotoluene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,3,5-trimethyl benzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Tert-butyl benzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2,4-trimethyl benzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,3-dichlorobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Sec-butyl benzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,4-dichlorobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
4-isopropyl toluene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2-dichlorobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
n-butyl benzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2-dibromo-3-chloropropane	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2,4-trichlorobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Hexachlorobutadiene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
1,2,3-trichlorobenzene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-023	102	5	107	105	2	102	[NT]
Surrogate toluene-d8	%		Org-023	100	5	99	100	1	100	[NT]
Surrogate 4-BFB	%		Org-023	112	5	116	102	13	113	[NT]

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			04/12/2020	5	04/12/2020	04/12/2020		04/12/2020	[NT]
Date analysed	-			07/12/2020	5	07/12/2020	07/12/2020		07/12/2020	[NT]
TRH C_6 - C_9	µg/L	10	Org-023	<10	5	<10	<10	0	110	[NT]
TRH C_6 - C_{10}	µg/L	10	Org-023	<10	5	<10	<10	0	110	[NT]
Benzene	µg/L	1	Org-023	<1	5	<1	<1	0	111	[NT]
Toluene	µg/L	1	Org-023	<1	5	<1	<1	0	111	[NT]
Ethylbenzene	µg/L	1	Org-023	<1	5	<1	<1	0	106	[NT]
m+p-xylene	µg/L	2	Org-023	<2	5	<2	<2	0	111	[NT]
o-xylene	µg/L	1	Org-023	<1	5	<1	<1	0	111	[NT]
Naphthalene	µg/L	1	Org-023	<1	5	<1	<1	0	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-023	102	5	107	105	2	102	[NT]
Surrogate toluene-d8	%		Org-023	100	5	99	100	1	100	[NT]
Surrogate 4-BFB	%		Org-023	112	5	116	102	13	113	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			04/12/2020	[NT]	[NT]	[NT]	[NT]	04/12/2020	[NT]
Date analysed	-			04/12/2020	[NT]	[NT]	[NT]	[NT]	04/12/2020	[NT]
TRH C_{10} - C_{14}	µg/L	50	Org-020	<50	[NT]	[NT]	[NT]	[NT]	95	[NT]
TRH C_{15} - C_{28}	µg/L	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	98	[NT]
TRH C_{29} - C_{36}	µg/L	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	87	[NT]
TRH >C_{10} - C_{16}	µg/L	50	Org-020	<50	[NT]	[NT]	[NT]	[NT]	95	[NT]
TRH >C_{16} - C_{34}	µg/L	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	98	[NT]
TRH >C_{34} - C_{40}	µg/L	100	Org-020	<100	[NT]	[NT]	[NT]	[NT]	87	[NT]
Surrogate o-Terphenyl	%		Org-020	90	[NT]	[NT]	[NT]	[NT]	83	[NT]

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			04/12/2020	[NT]	[NT]	[NT]	[NT]	04/12/2020	[NT]
Date analysed	-			04/12/2020	[NT]	[NT]	[NT]	[NT]	04/12/2020	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	[NT]	[NT]	[NT]	[NT]	102	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	94	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Appendix C

Quality Assurance / Quality Control
Chain of Custody (Field and Despatch)
Sample Receipts

Data Quality Assessment Report
Report on Groundwater Sampling
Newcastle Art Gallery Proposed Alterations and Additions
9 1 Laman Street, Newcastle

C1 Data Quality Objectives

The report on Groundwater Sampling was prepared with reference to 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 1.

Table 1: Data Quality Objectives

Data Quality Objective	Report Section where Addressed
State the Problem	S1 Introduction
Identify the Decision	S1 Introduction (objective) S8 Discussion/Comments
Identify Inputs to the Decision	S1 Introduction S2 Site Identification S7.1 Assessment Criteria S10 Assessment of Contamination
Define the Boundary of the Assessment	S2 Site Identification Site Drawings - Appendix D
Develop a Decision Rule	S7.1 Assessment Criteria
Specify Acceptable Limits on Decision Errors	S5 and 6 Field work and Analysis S7.1 Site Assessment Criteria QA/QC Procedures and Results – Sections 5 and 6
Optimise the Design for Obtaining Data	S1 Introduction S5.1 Sample Rationale QA/QC Procedures and Results – Sections 5 and 6

C2 Field and Laboratory Quality Control

The field and laboratory quality control (QC) procedures and results are summarised in Tables 2 and 3. Reference should be made to the field work and analysis procedures in Sections 5 and 6 and the laboratory results certificates in Appendix B for further details.

Table 2: Field QC

Item	Frequency	Acceptance Criteria	Achievement
Intra-laboratory replicates	5% primary samples	RPD <30% inorganics), <50% (organics)	Yes[1]

Notes to Table 2:

1 Qualitative assessment of RPD results overall; refer Section 2.1

Table 3: Laboratory QC

Item	Frequency	Acceptance Criteria	Achievement
Analytical laboratories used	-	NATA accreditation	Yes
Holding times	-	In accordance with NEPC (2013) which references various Australian and international standards	Yes
Laboratory / Reagant Blanks	1 per lab batch	<PQL	Yes
Laboratory duplicates	10% primary samples	Laboratory specific [1]	Yes[2]
Matrix Spikes	1 per lab batch	70-130% recovery (inorganics); 60-140% (organics); 10-140% (SVOC, speciated phenols)	Yes
Surrogate Spikes	organics by GC	70-130% recovery (inorganics); 60-140% (organics); 10-140% (SVOC, speciated phenols)	Yes
Control Samples	1 per lab batch	70-130% recovery (inorganics); 60-140% (organics); 10-140% (SVOC, speciated phenols)	Yes

Notes to Table 3:

1 Envirolab: <10xPQL – any RPD; >10xPQL – 20-50%RPD
ALS: <10xPQL – any RPD; 10-20xPQL – 0-50%RDP; >20xPQL – 0-20%RPD

2 Minor RPD exceedance limits were identified by the laboratory for metals in one sample.

In summary, the QC data is considered to be of sufficient quality to be acceptable for the assessment.

C2.1 Intra-Laboratory Replicates

Intra-laboratory replicates were analysed as an internal check of the reproducibility within the primary laboratory Envirolab Services and as a measure of consistency of sampling techniques. The comparative results of analysis between original and intra-laboratory replicate samples are summarised in Tables 4.

Note that, where both samples are below the PQL the difference and RPD has been given as zero. Where one sample is reported below the PQL, but a concentration is reported for the other, the PQL value has been used for calculation of the RPD for the less than PQL sample.

Table 4: Relative Percentage Difference Results – Intra-laboratory Replicates

		Lab Report No:	257346	257346	
		Field ID	203B	D1/JRK	RPD
		Sampled Date/Time	2/12/2020	2/12/2020	
ChemName	**Units**	**PQL**			
Metals					
Arsenic (Filtered)	µg/L	1	<1.0	<1.0	0
Cadmium (Filtered)	µg/L	0.1	<0.1	<0.1	0
Chromium (III+VI) (Filtered)	µg/L	1	<1.0	<1.0	0
Copper (Filtered)	µg/L	1	**3.0**	**14.0**	**129**
Lead (Filtered)	µg/L	1	<1.0	<1.0	0
Mercury (Filtered)	µg/L	0.05	<0.05	<0.05	0
Nickel (Filtered)	µg/L	1	<1.0	1.0	0
Zinc (Filtered)	µg/L	1	7.0	9.0	25
svTRH (C10-C40) in Water					
C10-C16	µg/L	50	<50.0	<50.0	0
C10-C16 (F2 minus Naphthalene)	µg/L	50	<50.0	<50.0	0
C16-C34	µg/L	100	<100.0	<100.0	0
C34-C40	µg/L	100	<100.0	<100.0	0
vTRH(C6-C10)/BTEXN in Water					
C6-C10	µg/L	10	<10.0	<10.0	0
C6-C10 (F1 minus BTEX)	µg/L	10	<10.0	<10.0	0
VOCs in water					
Benzene	µg/L	1	<1.0	<1.0	0
Toluene	µg/L	1	<1.0	<1.0	0
Ethylbenzene	µg/L	1	<1.0	<1.0	0
Xylene (m & p)	µg/L	2	<2.0	<2.0	0
Xylene (o)	µg/L	1	<1.0	<1.0	0
vTRH(C6-C10)/BTEXN in Water					
Benzene	µg/L	1	<1.0	<1.0	0
Toluene	µg/L	1	<1.0	<1.0	0
Ethylbenzene	µg/L	1	<1.0	<1.0	0
Xylene (m & p)	µg/L	2	<2.0	<2.0	0
Xylene (o)	µg/L	1	<1.0	<1.0	0
VOCs in water					
1,1,1,2-tetrachloroethane	µg/L	1	<1.0	<1.0	0
1,1,1-trichloroethane	µg/L	1	<1.0	<1.0	0
1,1,2,2-tetrachloroethane	µg/L	1	<1.0	<1.0	0
1,1,2-trichloroethane	µg/L	1	<1.0	<1.0	0
1,1-dichloroethane	µg/L	1	<1.0	<1.0	0
1,1-dichloroethene	µg/L	1	<1.0	<1.0	0
1,1-dichloropropene	µg/L	1	<1.0	<1.0	0
1,2,3-trichloropropane	µg/L	1	<1.0	<1.0	0
1,2-dibromo-3-chloropropane	µg/L	1	<1.0	<1.0	0
1,2-dichloroethane	µg/L	1	<1.0	<1.0	0
1,2-dichloropropane	µg/L	1	<1.0	<1.0	0
1,3-dichloropropane	µg/L	1	<1.0	<1.0	0
2,2-dichloropropane	µg/L	1	<1.0	<1.0	0
Bromochloromethane	µg/L	1	<1.0	<1.0	0
Bromodichloromethane	µg/L	1	<1.0	<1.0	0
Bromoform	µg/L	1	<1.0	<1.0	0
Carbon tetrachloride	µg/L	1	<1.0	<1.0	0
Chlorodibromomethane	µg/L	1	<1.0	<1.0	0
Chloroethane	µg/L	10	<10.0	<10.0	0
Chloroform	µg/L	1	<1.0	<1.0	0
Chloromethane	µg/L	10	<10.0	<10.0	0
cis-1,2-dichloroethene	µg/L	1	<1.0	<1.0	0
cis-1,3-dichloropropene	µg/L	1	<1.0	<1.0	0
Dibromomethane	µg/L	1	<1.0	<1.0	0
Hexachlorobutadiene	µg/L	1	<1.0	<1.0	0
Trichloroethene	µg/L	1	<1.0	<1.0	0
Tetrachloroethene	µg/L	1	<1.0	<1.0	0
trans-1,2-dichloroethene	µg/L	1	<1.0	<1.0	0
trans-1,3-dichloropropene	µg/L	1	<1.0	<1.0	0
Vinyl chloride	µg/L	10	<10.0	<10.0	0
1,2,3-trichlorobenzene	µg/L	1	<1.0	<1.0	0
1,2,4-trichlorobenzene	µg/L	1	<1.0	<1.0	0
1,2-dichlorobenzene	µg/L	1	<1.0	<1.0	0
1,3-dichlorobenzene	µg/L	1	<1.0	<1.0	0
1,4-dichlorobenzene	µg/L	1	<1.0	<1.0	0
2-chlorotoluene	µg/L	1	<1.0	<1.0	0
4-chlorotoluene	µg/L	1	<1.0	<1.0	0
Bromobenzene	µg/L	1	<1.0	<1.0	0
Chlorobenzene	µg/L	1	<1.0	<1.0	0
1,2-dibromoethane	µg/L	1	<1.0	<1.0	0
Bromomethane	µg/L	10	<10.0	<10.0	0
Dichlorodifluoromethane	µg/L	10	<10.0	<10.0	0
Trichlorofluoromethane	µg/L	10	<10.0	<10.0	0
1,2,4-trimethylbenzene	µg/L	1	<1.0	<1.0	0
1,3,5-trimethylbenzene	µg/L	1	<1.0	<1.0	0
Isopropylbenzene	µg/L	1	<1.0	<1.0	0
n-butylbenzene	µg/L	1	<1.0	<1.0	0
n-propylbenzene	µg/L	1	<1.0	<1.0	0
p-isopropyltoluene	µg/L	1	<1.0	<1.0	0
sec-butylbenzene	µg/L	1	<1.0	<1.0	0
Styrene	µg/L	1	<1.0	<1.0	0
tert-butylbenzene	µg/L	1	<1.0	<1.0	0
vTRH(C6-C10)/BTEXN in Water					
Naphthalene	µg/L	1	<1.0	<1.0	0
VOCs in water					
Cyclohexane	µg/L	1	<1.0	<1.0	0
svTRH (C10-C40) in Water					
C10-C14	µg/L	50	<50.0	<50.0	0
C15-C28	µg/L	100	<100.0	<100.0	0
C29-C36	µg/L	100	<100.0	<100.0	0
vTRH(C6-C10)/BTEXN in Water					
C6-C9	µg/L	10	<10.0	<10.0	0

The calculated RPD values were generally within the acceptable range of ± 30 for inorganic analytes and ± 50% for organics with the with the exception of those in bold. However, this is not considered to be significant because: The typically low actual differences in the concentrations of the replicate pairs where some RPD exceedances occurred. High RPD values reflect the small differences between two small numbers;

- All other QA/QC parameters met the DQIs.

Overall, the intra-laboratory replicate comparisons indicate that the sampling techniques were generally consistent and repeatable.

C3 Data Quality Indicators

The reliability of field procedures and analytical results was assessed against the following data quality indicators (DQIs):

- Completeness – a measure of the amount of usable data from a data collection activity;
- Comparability – the confidence (qualitative) that data may be considered to be equivalent for each sampling and analytical event;
- Representativeness – the confidence (qualitative) of data representativeness of media present on site;
- Precision – a measure of variability or reproducibility of data; and
- Accuracy – a measure of closeness of the data to the 'true' value.

The DQIs were assessed as outlined in the following Table 5.

Table 5: Data Quality Indicators

DQI	Frequency	Data Acceptance Criteria
Completeness		
Field documentation correct	All samples	All samples
Soil bore logs complete and correct	All samples	All samples
Suitably qualified and experience sampler	All samples	All samples
Appropriate lab methods and limits of reporting (LORs)	All samples	All samples
Chain of custodies (COCs) completed appropriately	All samples	All samples
Sample holding times complied with	All samples	All samples
Proposed/critical locations sampled	-	Proposed/critical locations sampled
Comparability		
Consistent standard operating procedures for collection of each sample. Samples should be collected, preserved and handled in a consistent manner	All samples	All samples
Experienced sampler	All samples	All samples
Consistent analytical methods, laboratories and units	All samples	All samples

Table 5: Data Quality Indicators (cont)

DQI	Frequency	Data Acceptance Criteria
Representativeness		
Sampling appropriate for media and analytes (appropriate collection, handling and storage)	All samples	All Samples
Samples extracted and analysed within recommended holding times	All samples	-
Precision		
Blind duplicates (intra-laboratory duplicates)	1 per 20 samples	30% RPD, then review RPDs >30% would be reviewed in relation to heterogeneity of sample and LOR
Split duplicates (inter-laboratory duplicates)	1 per 20 samples	30% RPD, then review RPDs >30% would be reviewed in relation to heterogeneity of sample and LOR
Laboratory duplicates	1 per 20 samples	<20% RPD Result > 20 × LOR <50% RPD Result 10-20 × LOR No Limit when RPD Result <10 × LOR
Accuracy		
Surrogate spikes	All organic samples	50-150%
Matrix spikes	1 per 20 samples	70-130% (inorganics) 60-140% (organics)
Laboratory control samples	1 per 20 samples	70-130% (inorganics) 60-140% (organics)
Method blanks	1 per 20 samples	<LOR

Based on the above, it is considered that the DQIs have been complied with. As such, it is concluded that the field and laboratory test data obtained are reliable and useable for this assessment.

Douglas Partners Pty Ltd

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Geotechnics | Environment | Groundwater

CHAIN OF CUSTODY FIELD SHEET

Project No:	49737.04	**Client Project Name:**	Newcastle Art Gallery Proposed Alterations and Additions
Client:	Newcastle City Council	**Location:**	1 Laman Street, Newcastle
Project Manager:	Chris Bozinovski	**DP Lab Received**	By: Date:

Do samples contain 'potential' HBM? Yes ☐ No ☑ (If YES, then handle, transport and store in accordance with FPM HAZID)

Field									DP Lab	For Despatch to			Notes
Sample ID	Depth (m)	Duplicate Sample	Sample Type S - soil W - water	Container Type G - glass P - plastic	ASS Samples	Sampling By	Sampling Date	Sampling Time	Storage Locn *	Lab 1 A Envirolab Date	Lab 2 B Date	Lab 3 C Date	
107-U	-		W	G, P		JRK	2/12/20	8:00		2/12/20 ✓			
1	-		↓	↓		↓	↓	↓		✓			
107B	-									✓			
202	-									✓			
203B	-	D1/JRK								✓			
203C	-							↓		✓			
105	-		↓	↓		↓	↓	14:30		✓			

98024306834 2-5 TNT

* **Default storage: glass containers in fridge, plastic containers shelved, ASS in freezer, water samples in fridge**

A Envirolab Services

B Provide name of Lab 2

C Provide name of Lab 3

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	49737.04	**Suburb:**	Newcastle	**To:**	Envirolab Services
Project Name:	Newcastle	**Order Number**	153551		12 Ashley Street, CHATSWOOD
Project Manager:	Chris Bozinovski	**Sampler:**	JRK	**Attn:**	Sample Receipt
Emails:	chris.bozinovski / joshua.kramer@douglaspartners.com.au			**Phone:**	02 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ **Standard X**			**Email:**	
Prior Storage:	**X Esky** ☐ Fridge ☐ Shelved	Do samples contain 'potential' HBM?	Yes ☐	No ☑	(If YES, then handle, transport and store in accordance with FPM HAZID)

Sample ID	Lab ID	Date Sampled	Sample Type: S - soil W - water	Container Type: G - glass P - plastic	Analytes: Metals	TRH and BTEXN	VOC	---	---	---	---	---	---	Notes/preservation
107-U	1	2/12/20	W	G, P	✓	✓	✓							
107B	2				✓	✓	✓							
1	3				✓	✓	✓							
202	4				✓	✓	✓							
105	5				✓	✓	✓							
203B	6				✓	✓	✓							
203C	7				✓	✓	✓							
D1/JRK	8	↓	↓	↓	✓	✓	✓							
PQL (S) mg/kg														**ANZECC PQLs req'd for all water analytes** ☐

ENVIROLAB

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

Job No: 257346
~~Date Received:~~ 03/12/2020
Time Received: 10:45
Received By: RL
Temp: ~~Cool/Ambient~~
Cooling: ~~Ice/Icepack~~
Security: ~~Intact/Broken/None~~

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here: As, Cd, Cr, Cu, Pb, Hg, Ni, Zn

Lab Report/Reference No:

Total number of samples in container: 8 **Relinquished by:** JRK 2/12/20 **Transported to laboratory by:** TNT Courier - Overnight Express

Send Results to: Douglas Partners Pty Ltd **Address:** **Phone:** **Fax:**

Signed: **Received by:** R-Chazeen ~~12/11/2020~~ 03/12/2020 10:45 **Date & Time:**

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

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Newcastle
Attention	Chris Bozinovski, Joshua Kramer

Sample Login Details

Your reference	49737.04, Newcastle
Envirolab Reference	257346
Date Sample Received	03/12/2020
Date Instructions Received	03/12/2020
Date Results Expected to be Reported	10/12/2020

Sample Condition

Samples received in appropriate condition for analysis	
No. of Samples Provided	8 Water
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	18
Cooling Method	
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

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

Sample ID	VOCs in water	vTRH(C6-C10)/BTEXN in Water	svTRH (C10-C40) in Water	HM in water - dissolved
107-U	✓	✓	✓	✓
107B	✓	✓	✓	✓
1	✓	✓	✓	✓
202	✓	✓	✓	✓
105	✓	✓	✓	✓
203B	✓	✓	✓	✓
203C	✓	✓	✓	✓
D1/JRK	✓	✓	✓	✓

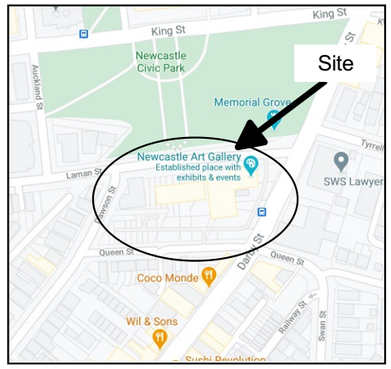
The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.
Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.
TAT for Micro is dependent on incubation. This varies from 3 to 6 days.

Appendix D

Drawing 1 – Test Location Plan
Drawing DA-A-SK100 – Level 0
Drawing DA-A-SK101 – Level 1
Drawing DA-A-SK202 - Sections



Site Location

Legend

- Existing Groundwater Wells
- Missing Groundwater Wells
- Additional Wells (Not DP)
- Approximate Site Boundary

0 5 10 15 20 m

Drawing adapted from aerial imagery from Metromap dated 3 September 2020.
Test locations are approximate only and were located using Differential GPS.

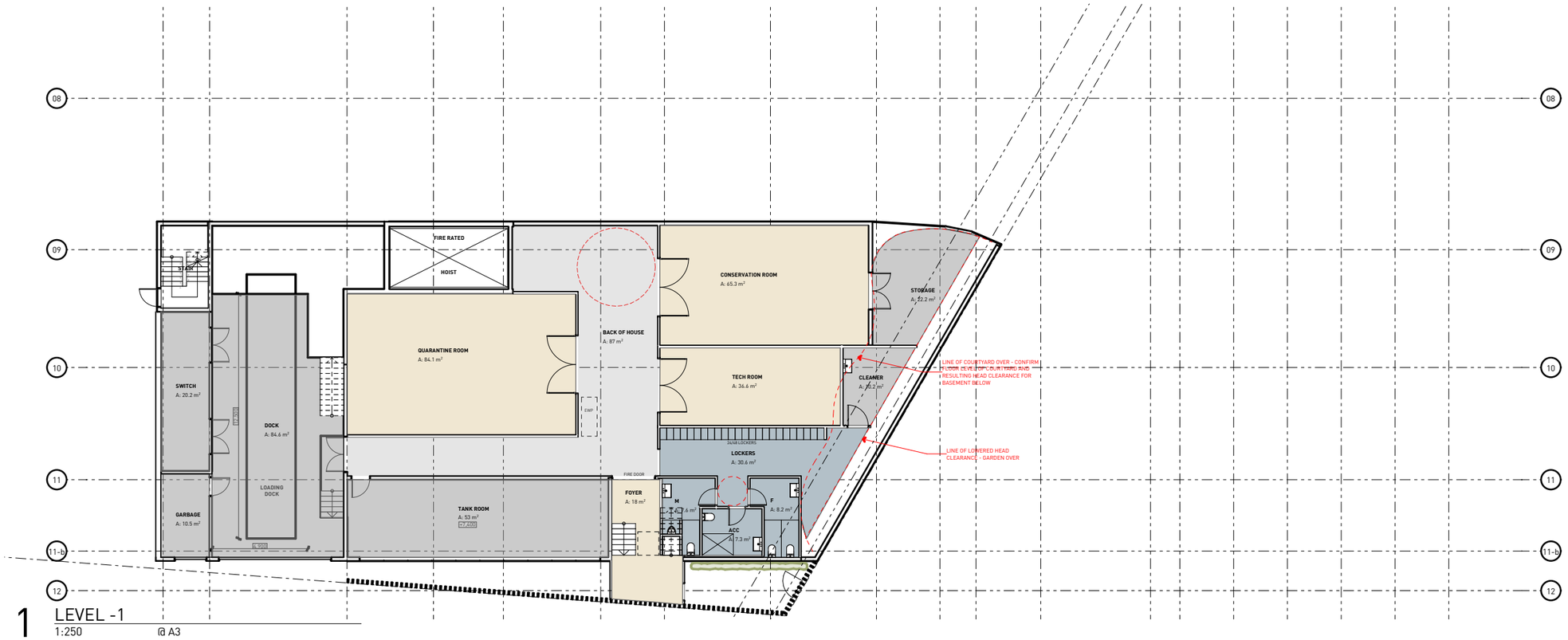
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Newcastle City Council	
OFFICE:	Newcastle	DRAWN BY: JRK
SCALE:	1:550 @ A3	DATE: 04 February 2021

TITLE: **Test Location Plan**
Newcastle Art Gallery - Groundwater Sampling
1 Laman Street, Newcastle

Project:	49737.04
DRAWING No:	1
REVISION:	0

DP.QGIS.A3LandScapeDrawingLayout.DftA



1 LEVEL -1
1:250 @ A3

PRELIMINARY

REV 23/09/2020 MODEL *12_002 Model-S4.55*

LEVEL -1

S4.55

NEWCASTLE ART GALLERY EXPANSION

City of Newcastle

IN ASSOCIATION WITH

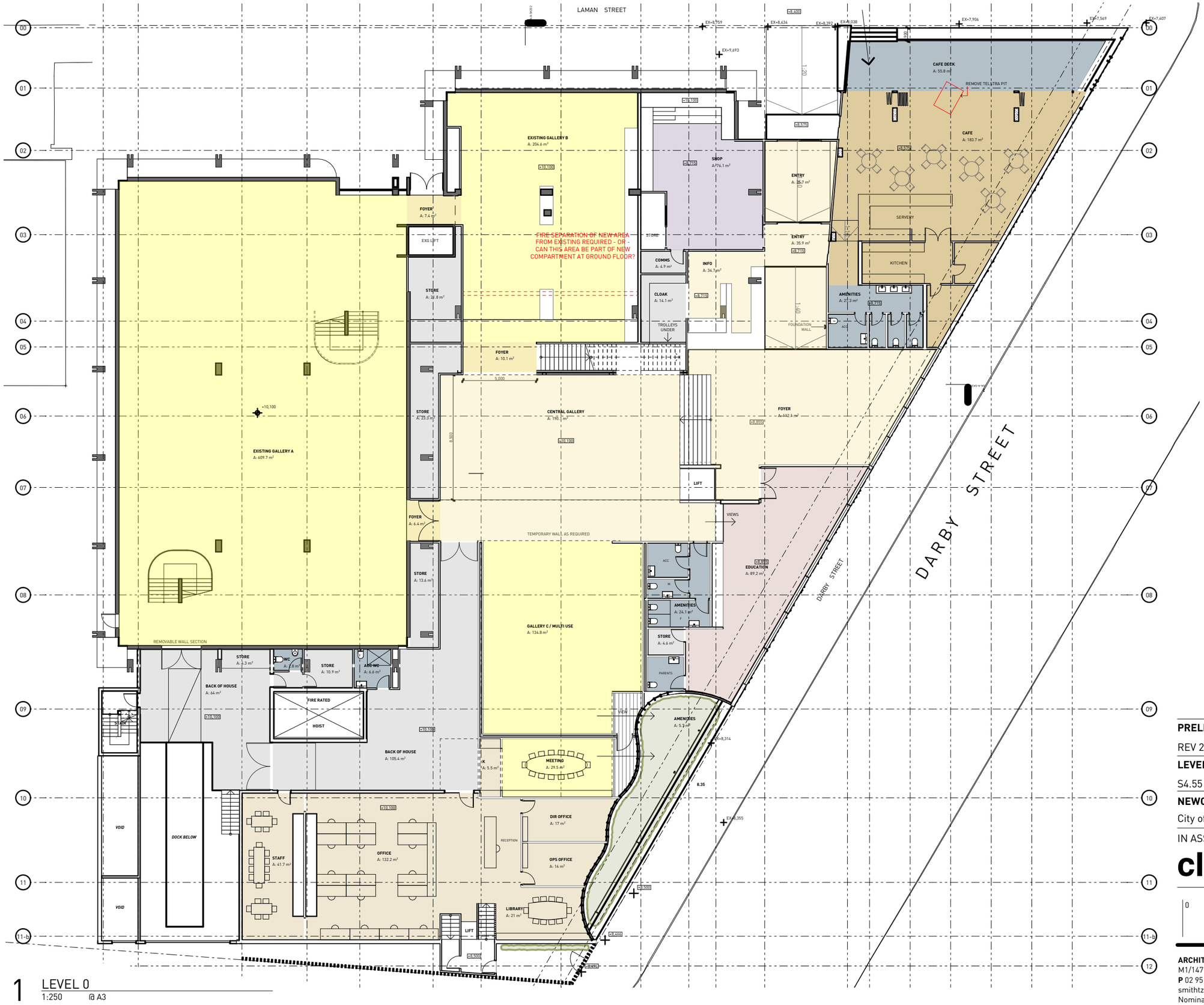
claredesign

0 | | | | | 10m - 1:200
5.0m - 1:100
2.5m - 1:50
1.25m - 1:25

ARCHITECTURE URBAN PLANNING
M1/147 McEvoy Street Alexandria NSW 2015
P 02 9516 2022 **E** email@smithtzannes.com.au
smithtzannes.com.au
Nominated Architect: Peter Smith (Reg 7024)

SMITH & TZANNES

12_002 DA-A-SK100



1 LEVEL 0
1:250 @ A3

PRELIMINARY

REV 23/09/2020 MODEL *12_002 Model-S4.55*

LEVEL 0

S4.55

NEWCASTLE ART GALLERY EXPANSION

City of Newcastle

IN ASSOCIATION WITH

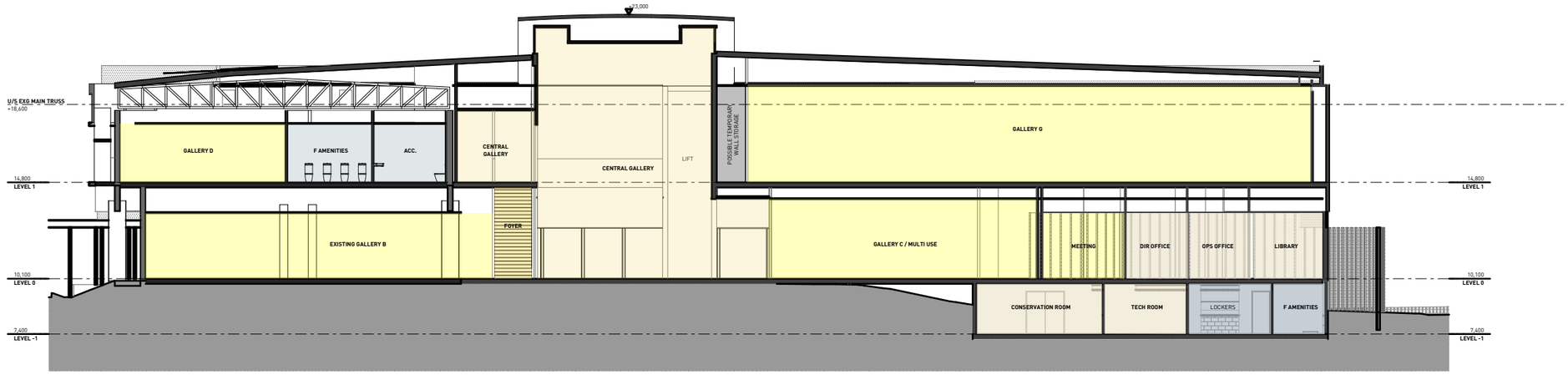
claredesign

0 | | | | | 10m - 1:200
5.0m - 1:100
2.5m - 1:50
1.25m - 1:25

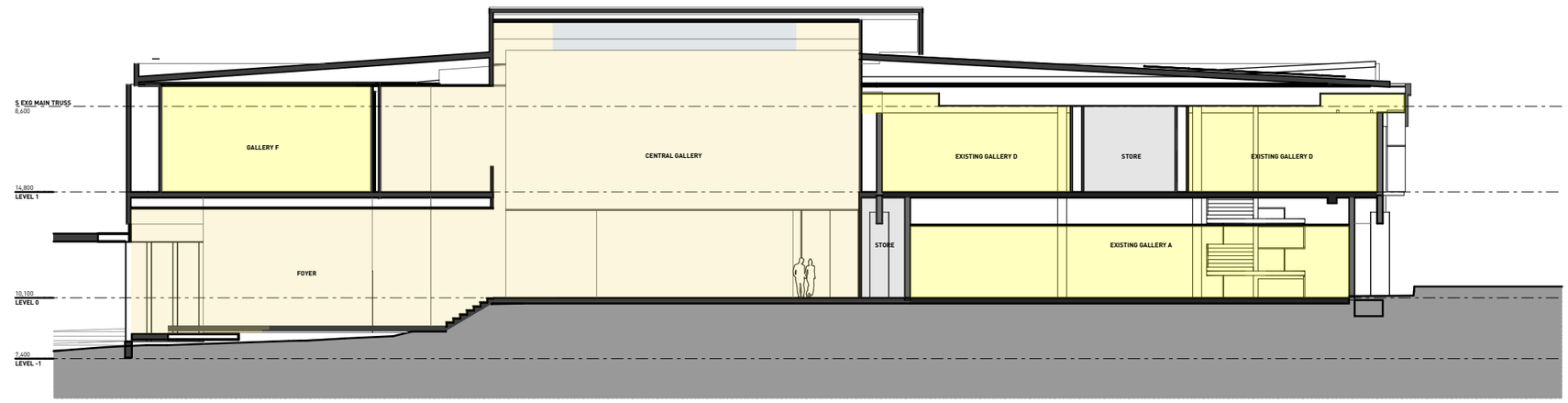
ARCHITECTURE URBAN PLANNING
M1/147 McEvoy Street Alexandria NSW 2015
P 02 9516 2022 **E** email@smithtzannes.com.au
smithtzannes.com.au
Nominated Architect: Peter Smith (Reg 7024)

SMITH & TZANNES

12_002 DA-A-SK101



1 SECTION 02 (ATRIUM)
1:250



2 SECTION 04
1:250

REV 23.09.20

MODEL *12_002 Model-S4.55*

SECTIONS

S4.55

NEWCASTLE ART GALLERY EXPANSION

City of Newcastle

IN ASSOCIATION WITH

claredesign

ARCHITECTURE URBAN PLANNING
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Nominated Architect: Peter Smith (Reg 7024)

SMITH & TZANNES

12_002 DA-A-SK202