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Integrated Practical Solutions

Acid Sulfate Soil Management Plan

The Store Redevelopment
854 Hunter Street, Newcastle West

Prepared for
Bloc (ACT) Pty Ltd

Project 81811.06
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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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1. Introduction

This report presents the results of an acid sulfate soil management plan undertaken for 'The Store' redevelopment at 854 Hunter Street, Newcastle West. The investigation was commissioned in an email dated 9 July 2018 by Matthew Walker of Bloc (ACT) Pty Ltd and was undertaken in with reference to Douglas Partners' proposal NCL180399 dated 3 July 2018.

This ASSMP has been prepared to provide a framework for achieving environmental objectives to minimise the risk of harm to human health and the environment during and following the above-mentioned works. This ASSMP provides the following:

- Acid sulfate soil (ASS) management strategies;
- Monitoring program for soil and water quality;
- Contingency procedures.

The management procedures outlined in this ASSMP are based on the results of Douglas Partners Pty Ltd (DP) 'Report on Stage 1 Targeted Site Investigation (Contamination)' undertaken at the site in May 2016 (Ref 1). The previous assessment included subsurface investigation, sampling and testing for the assessment of ASS conditions.

This ASSMP has been prepared with reference to the "Acid Sulfate Soils Manual" (Ref 2) published by the NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC) and the "Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines" (Ref 3) published by the Queensland Acid Sulfate Soil Investigation Team (QASSIT).

2. Proposed Development

It is understood that the development of the site will include:

- Demolition of the existing structures (i.e. 'The Store' plus adjoining carpark) and existing basement;
- Construction of 28-level (including one basement level) office and residential structures;
- Construction of a five-level car park;
- Construction of a bus interchange;
- Preliminary basement levels are RL 0.2 to RL -0.05.

Reference should be made to the preliminary architectural drawings by Bates Smary (Project No. S12133) provided in Appendix C showing the proposed development.

3. Site Description

The site known as “The Store” is defined as 854 Hunter Street, Newcastle West, New South Wales as shown on Drawing 1, Appendix C and in Figure 1 below, and comprises the following lots:

- Lots 4, 5 and 6 DP 456091;
- Lot 70 DP 882529;
- Lot 1 DP 232233;
- Lots 1 and 2 DP 573033;
- Lot 1 DP 82517;
- Lot 410 DP 705518.

Figure 1: Site locality

The site is bounded to the north by the Newcastle Rail Corridor, to the east by Stewart Avenue and Cooper Street, to the south by Hunter Street and to the west by commercial/retail premises. The site is an irregular shape and covers an area of approximately 1.2 ha.

The site is currently zoned B3 Commercial Core.

The investigation area (the site) and test location plans from previous DP assessment is shown on Drawing 1, Appendix C.

4. Regional Geology and Acid Sulfate Soil Risk Mapping

Reference to the 1:100,000 Newcastle Coalfields Geology geodatabase indicates that the site is underlain by Quaternary alluvium which typically comprises gravel, sand, silt and clay.

Reference to the NSW Contours Central and Hunter Coast LiDAR indicates the site levels vary between approximately 2.0 AHD to 3.5 AHD.

The regional groundwater flow regime is believed to be towards the Hunter River (Newcastle Harbour) (located approximately 300 m north-east of the site) and is considered to be the nearest sensitive receptor. The depth to the water table is likely to be 1 m to 2 m based on topography and previous investigations on nearby properties. It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

Subsequent inferred groundwater flow directions based on DP investigations at the site are shown on Drawing 1, Appendix C, and generally indicate groundwater flows in a northerly direction.

Reference to the Acid Sulfate Soil Risk Map, prepared by the Department of Land and Water Conservation (DLWC) indicates the north-east half of the site lies within an area mapped as having a high probability of acid sulfate soil (ASS) occurrence between 1 m and 3 m below the ground surface. The south-south-west half of the site is identified as low probability of ASS >3 m.

The approximate site extent relative to the ASS map is shown in Figure 2 below.

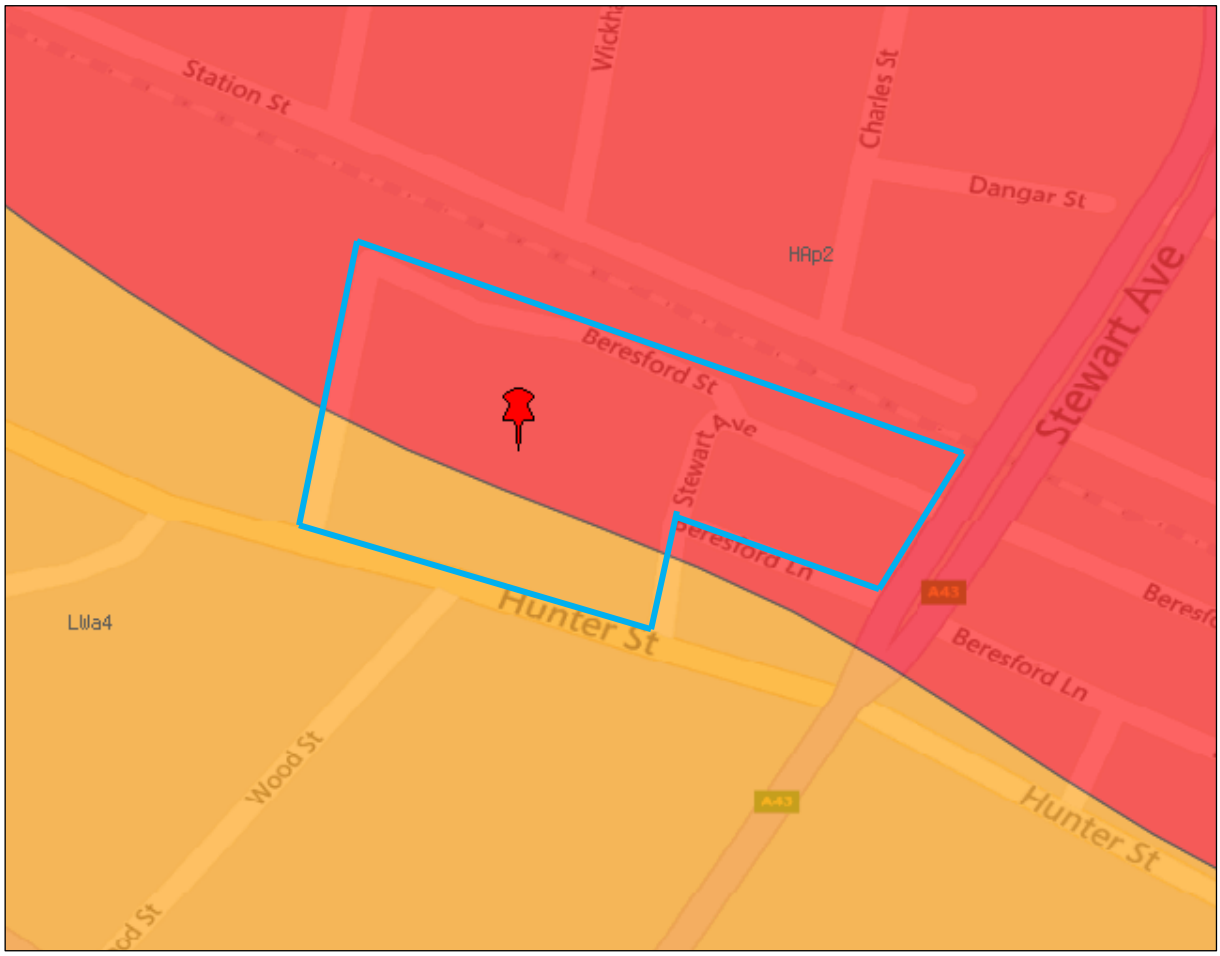


Figure 2: Approximate site extent (blue), high probability ASS (red) and low probability ASS (orange)

5. Previous Investigation

5.1 Introduction

DP has conducted a preliminary site investigation for contamination at the site, which included an acid sulfate soil assessment (Ref 1). The assessment included the following:

- Drilling of 12 boreholes (Bores 1 to 12) to depths of between 0.7 m and 5 m using a track-mounted Geoprobe drill rig using dual tube push tube drilling methods (or hand tools where access was restricted - Bores 9 and 12);
- Collection of soil samples for contamination and acid sulfate soil testing purposes from the boreholes;
- Screening of soil samples for volatile hydrocarbon impact with a photoionisation detector (PID);
- Sampling of surface fibro sheeting material potentially containing asbestos at one location;
- Installation of seven groundwater monitoring wells;

- Development, purging and sampling of groundwater from the monitoring wells;
- Gauging of groundwater monitoring wells prior to purging/sampling; and
- Survey and levelling of wells.

5.2 Subsurface Profile

For the purposes of the ASSMP, a summary of subsurface conditions is presented below.

From (m)	To (m)	Description
Surface (0.0)	0.5 / 2.2	FILLING: concrete or asphalt pavement with some roadbase materials underlain by generally dark grey sand filling with some brick, ceramic, metal and slag gravel in some boreholes.
0.5 / 2.2	>0.8 / 3.7	FILLING: generally comprising grey brown, brown or grey sand filling.
0.1 / 0.5	0.15 / 1.1	SAND: generally grey to light grey brown, encountered beneath filling to termination depth (generally 4 m to 5 m depth).

Borehole logs from the previous DP investigation are provided in Appendix B.

5.3 Groundwater Conditions

5.3.1 Groundwater

Groundwater was encountered in all boreholes during drilling. Groundwater was generally observed within sand filling underlying upper fill materials. It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

The results of gauging of groundwater wells are presented in Table 1.

Table 1: Groundwater Levels Measured by Gauging in March 2016 (Ref 1)

Test Location	Date	Time	PID Well Headspace	Groundwater Depth below TOC (m)	Well stick-up (m from ground level)	RL TOC (AHD)	Groundwater RL (AHD)	Comments
1	30/3/16	10:45	<1	2.863	-0.070	3.803	0.94	Dark brown very turbid
4	30/3/16	11:15	<1	1.601	-0.045	2.163	0.562	Dark brown very turbid
8	30/3/16	12:00	<1	1.779	-0.020	2.573	0.794	Brown very turbid
9	31/3/16	10:00	<1	0.843	0.680	-	-	Dark brown very turbid
9A	31/3/16	10:15	-	0.850	0.550	-	-	Light brown, slightly turbid
10	30/3/16	12:30	<1	1.845	-0.050	2.618	0.773	Brown moderate to very turbid
11	30/3/16	13:00	<1	1.958	-0.125	2.883	0.925	Brown moderately turbid
12	31/3/16	10:30	<1	0.940	0.650	-	-	Dark brown very turbid
12A	31/3/16	10:45	-	0.300	0	-	-	Brown slightly turbid

Notes to Table 1:

9A – well opening adjacent to Bore 9

12A – well opening adjacent to Bore 12

Inferred groundwater flow directions are shown on Drawing 1, Appendix D, and generally indicate groundwater flows in a northerly direction.

Groundwater parameters measured during purging are provided in Table 2.

Table 2: Groundwater Field Parameters Measured During Purging and Sampling in March 2016 (Ref 1)

Test Location	Date	Time	PID Samples Headspace	Thickness of Floating Product	pH	Electrical Conductivity (mS/cm)	Redox Potential (mV)	Dissolved Oxygen (ppm)	Turbidity (NTU)	Comments
1	30/3/16	10:45	<1	Not observed	6.2	0.553	108	2.52	1500	Dark brown very turbid
4	30/3/16	11:15	<1	Not observed	5.9	0.330	95	0.40	2184	Dark brown very turbid
8	30/3/16	12:00	<1	Not observed	7.3	0.375	81	0.56	610	Brown very turbid
9	31/3/16	10:00	<1	Not observed	7.4	0.600	130	5.0	2000	Dark brown very turbid
9A	31/3/16	10:15	<1	Not observed	6.9	0.455	106	2.4	133	Light brown, slightly turbid
10	30/3/16	12:30	<1	Not observed	6.2	0.212	41	0.04	480	Brown moderate to very turbid
11	30/3/16	13:00	<1	Not observed	5.2	0.368	81	0.31	510	Brown moderately turbid
12	31/3/16	10:30	<1	Not observed	7.1	0.506	106	3.12	781	Dark brown very turbid
12A	31/3/16	10:45	<1	Not observed	7.4	0.517	110	5.03	54	Brown slightly turbid

The result of groundwater field testing indicated the following:

- Groundwater is generally neutral to slightly acidic (i.e. pH 5.2 to pH 7.4);
- Groundwater is fresh;
- Dissolved oxygen concentrations were variable (i.e. 0.04 mg/L to 5.03 mg/L);
- Aerobic conditions were encountered (i.e. Eh 41 mV to 110 mV);
- PID readings in groundwater samples were all <1 ppm;
- Groundwater was slightly to very turbid (i.e. 54 NTU to 2184 NTU);
- Hydrocarbon product was not detected in any of the wells;
- There was no observation of gross contamination (i.e. staining/odours) in groundwater at the well locations.

5.3.2 Water Quality Testing

The results of groundwater testing from the installed wells are shown in Table 3.

Table 3: Results of Groundwater and Surface Water Testing in March 2016 (Ref 1)

Sample Identification	W1	W4	W8	D1/JPS	W9	W9A	W10	W11	W12	W12A	R1	R2	R3	Laboratory PQL	Australian Drinking Water Guidelines - Health Based (mg/L)	ANZECC (2000) - Trigger Values			NEPM HSL [11]
																Slightly to Moderately Disturbed Systems		Irrigation Waters	
																Fresh	Marine		
Metal																			
As	<0.001	0.003	0.002	0.002	0.011	<0.001	0.003	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.01	0.013 [4]	0.0023 [L] [8]	0.1 [1]	NA
Cd	<0.0001	<0.0001	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.002	0.0002	0.0007	0.01 [1]	NA
Cr	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.05 [2]	0.001 [2]	0.0044 [2]	0.1 [1]	NA
Cu	0.006	0.002	0.002	<0.001	0.001	0.01	<0.001	0.006	0.002	0.005	<0.001	<0.001	<0.001	0.001	2	0.0014	0.0013	0.2 [1]	NA
Pb	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.01	0.0034	0.0044	2 [1]	NA
Hg	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00005	0.001	0.00006 [5]	0.0001 [5]	0.002 [1]	NA
Ni	0.003	0.004	<0.001	<0.001	<0.001	0.003	0.008	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.02	0.011	0.007	0.2 [1]	NA
Zn	0.025	0.16	0.064	0.069	0.002	0.03	0.021	0.12	0.009	0.008	<0.001	<0.001	<0.001	0.001	3 [3]	0.008	0.015	2 [1]	NA
Mn	0.066	0.31	0.03	0.031	0.14	0.023	0.12	0.031	0.017	<0.005	<0.005	<0.005	<0.005	0.005	0.5	1.9	0.08 [L]	0.2 [1]	NA
Fe^{2+}	0.015	2	0.013	0.014	0.12	0.093	5.3	1	0.024	0.013	<0.01	<0.01	<0.01	0.01	0.3 [3]	NC	NC	0.2 [1]	NA
TRH																			
C_6 - C_9	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	NC	NC	NC	NC	NA
C_{10} - C_{14}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	NC	NC	NC	NC	NA
C_{15} - C_{28}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	NC	NC	NC	NC	NA
C_{29} - C_{36}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	NC	NC	NC	NC	NA
F1 (C_6 - $<C_{10}$ - BTEX)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	NC	NC	NC	NC	1
F2 ($>C_{10}$ - C_{16} - naphthalene)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	NC	NC	NC	NC	1
F3 ($>C_{16}$ - C_{34})	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	NC	NC	NC	NC	NC
F4 ($>C_{34}$ - C_{40})	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	NC	NC	NC	NC	NC
BTEX																			
Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.95	0.5	NC	0.8
Toluene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.8	0.18 [L]	0.18 [L]	NC	NL
Ethyl Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.3	0.08 [L]	0.005 [L]	NC	NL
Xylene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.003	0.6	0.075 [6] [L]	NC	NC	NL
PAHs																			
Total PAHs	NIL (+)VE	0.0001	NIL (+)VE	NIL (+)VE	0.00042	NIL (+)VE	0.0024	0.00041	NIL (+)VE	NIL (+)VE	NIL (+)VE	NIL (+)VE	NIL (+)VE	0.0001 each	NC	NC	NC	NC	NC
Naphthalene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	NC	0.016	0.05	NC	NL
Acenaphthylene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Acenaphthene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Fluorene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Phenanthrene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0007	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	0.0006 [L]	0.0006 [L]	NC	NC
Anthracene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	0.00001 [L]	0.00001 [L]	NC	NC
Fluoranthene	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0006	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	0.001 [L]	0.001 [L]	NC	NC
Pyrene	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0005	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Benzo[*a*]anthracene	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Chrysene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Benzo[*b,k*]fluoranthene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	NC	NC	NC	NC	NC
Benzo[*a*]pyrene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.00001	0.0001 [L]	0.0001 [L]	NC	NC
Indeno[*123-cd*]pyrene	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Dibenzo[*ah*]anthracene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Benzo[*ghi*]perylene	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NC	NC	NC	NC	NC
Total Phenols	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NT	NT	NT	0.05	NC	0.32 [7]	0.4 [7]	NC	NC
VOCs																			
Dichlorodifluoromethane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	NT	NT	0.01	NC	NC	NC	NC	NC
Chloromethane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	NT	NT	0.01	NC	NC	NC	NC	NC
Vinyl Chloride	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	NT	NT	0.01	0.0003	NC	NC	NC	NC
Bromomethane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	NT	NT	0.01	NC	NC	NC	NC	NC
Chloroethane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	NT	NT	0.01	NC	NC	NC	NC	NC
Trichlorofluoromethane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NT	NT	NT	0.01	NC	NC	NC	NC	NC
1,1-Dichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.03	0.0003 [9]	NC	NC	NC
Trans-1,2-dichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,1-dichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Cis-1,2-dichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Bromochloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Chloroform	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	NT	NT	NT	0.001	0.25	0.37	NC	NC	NC
2,2-dichloropropane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2-dichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.003	0.01 [9]	NC	NC	NC
1,1,1-trichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,1-dichloropropene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Cyclohexane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Carbon tetrachloride	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.003	0.24	NC	NC	NC
Dibromomethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2-dichloropropane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	0.9	NC	NC	NC
Trichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	0.03 [9]	NC	NC	NC
Bromodichloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.25	NC	NC	NC	NC
trans-1,3-dichloropropene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
cis-1,3-dichloropropene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,1,2-trichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	6.5	1.9	NC	NC
1,3-dichloropropane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	1.1	NC	NC	NC
Dibromochloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.25	NC	NC	NC	NC
1,2-dibromoethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Tetrachloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.05	0.01 [9]	NC	NC	NC
1,1,1,2-tetrachloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Chlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.3/0.01 [3]	0.055	NC	NC	NC
Bromoform	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.25	NC	NC	NC	NC
Styrene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.03/0.004 [3]	0.25 [10]	NC	NC	NC
1,1,2,2-tetrachloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2,3-trichloropropane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Isopropylbenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	0.03	NC	NC	NC
Bromobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
n-propyl benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
2-chlorotoluene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
4-chlorotoluene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,3,5-trimethyl benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
Tert-butyl benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2,4-trimethyl benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,3-dichlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.02 [3]	0.26	NC	NC	NC
Sec-butyl benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,4-dichlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.04/0.0003 [3]	0.06	NC	NC	NC
4-isopropyl toluene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2-dichlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	1.5/0.001 [3]	0.16	NC	NC	NC
n-butyl benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2-dibromo-3-chloropropane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	NC	NC	NC	NC
1,2,4-trichlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	0.085	0.02	NC	NC
Hexachlorobutadiene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	0.0007	0.00004	0.00003	NC	NC
1,2,3-trichlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NT	NT	NT	0.001	NC	0.003	NC	NC	NC

Notes to Table 3:
Results expressed in mg/L unless otherwise stated
PQL - Practical Quantitation Limits
NT - Not Tested
D1/JPS is a replicate sample of W8
R1, R2 and R3 are rinsate samples
(1) - Long Term Trigger Values (up to 100 yrs)
(2) - Chromium (VI)
(3) - Aesthetic Guideline Value
(4) - Arsenic (V) (conservative)
(5) - Mercury (Inorganic)
(6) - m-xylene low reliability trigger value
(7) - Trigger Value for Phenol not Total Phenols (Conservative)
(8) - Environmental Concern Level (ECL) - indicative interim working level only
(9) - Guidelines for Recreational Water Quality and Aesthetics
(10) - Guidelines for chemical compounds in water found to cause tainting of fish flesh and other aquatic organisms
(11) - Health Screening Level for residential use (A/B) for sand, groundwater depth 2 m to <4 m below the surface
(L) - 95% Low Reliability Trigger Values (99% protection level applied where recommended (ie benzo(a)pyrene))
NC - No Criteria
NA - Not Applicable

Exceeds ANZECC 2000 Trigger Values for Slightly to Moderately Disturbed Systems - Marine Waters
Exceeds ANZECC 2000 Trigger Values for Slightly to Moderately Disturbed Systems - Fresh Waters

5.4 Results of Acid Sulfate Testing

Thirty-four soil samples of the filling and underlying natural soils were subject to ASS screening tests in DP's laboratory. Selected soil samples were tested for pH in distilled water and pH following oxidation in peroxide. Table 4 presents the screening test results.

Based on the screening test results, five sample was sent to Envirolab Services Pty Ltd for detailed testing, comprising the Chromium suite. The results are summarised in Table 4.

Table 4: Results of Acid Sulfate Soil Tests – March 2016 (Ref 1)

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results				Laboratory Results							
			pH			Strength of Reaction [b]	pH_{KCL}	Scr %S	s-TAA %S	S_{NAS} %S	s-ANC_{BT} %S	s-C_{IN} %S	Net Acidity[c] %S	Exisiting and Potential Acidity %S
			pH_F	pH_{FOX}	pH_F - pH_{FOX}									
Bore 1	2.9-3.0	Light brown sand filling	6.7	6.5	0.2	1	NT	NT	NT	NT	NT	NT	NT	NT
	3.4-3.6	Light brown sand filling	6.4	4.4	**2**	3	NT	NT	NT	NT	NT	NT	NT	NT
	3.9-4.0	Brown sand	6.5	5.3	**1.2**	2	NT	NT	NT	NT	NT	NT	NT	NT
	4.9-5.0	Brown sand	6.5	5.4	**1.1**	2	NT	NT	NT	NT	NT	NT	NT	NT
Bore 2	2.5	Grey brown sand filling	6.5	5.5	1	3	NT	NT	NT	NT	NT	NT	NT	NT
	3.0-3.3	Grey brown sand	6.7	2.5	**4.2**	4	4.6	0.34	0.02	0	<0.05	NT	0.35	0.36
	4.4-5.0	Grey brown sand	6.6	3.7	**2.9**	4	NT	NT	NT	NT	NT	NT	NT	NT
Bore 3	2	Dark grey brown sandy clay	6.7	2.8	**3.9**	4	NT	NT	NT	NT	NT	NT	NT	NT
	2.8	Grey brown sand	6.5	3	**3.5**	4	NT	NT	NT	NT	NT	NT	NT	NT
	3.5	Grey brown sand	6.6	3.4	**3.2**	4	NT	NT	NT	NT	NT	NT	NT	NT
	4.5	Grey brown sand	6.8	4.9	**1.9**	2	NT	NT	NT	NT	NT	NT	NT	NT
Bore 4	0.9	Dark brown sand filling	6.2	4.9	**1.3**	3	NT	NT	NT	NT	NT	NT	NT	NT
	1.7-2.0	Light brown sand filling	6.7	3.7	**3**	3	NT	NT	NT	NT	NT	NT	NT	NT
	2.2-2.5	Grey brown sand	6.2	2.1	**4.1**	4	NT	NT	NT	NT	NT	NT	NT	NT
	3.5	Grey brown sand	6.4	2.8	**3.6**	4	NT	NT	NT	NT	NT	NT	NT	NT
Bore 5	1.6-1.8	Dark brown sand filling	6.6	5	**1.6**	3	NT	NT	NT	NT	NT	NT	NT	NT
	2.6-2.8	Grey sand	6.6	2.2	**4.4**	4	4.5	0.14	0.02	0	<0.05	NT	0.16	0.16
	3.4-3.6	Grey sand	6	2.8	**3.2**	4	NT	NT	NT	NT	NT	NT	NT	NT
	4.8-5.0	Grey sand	5.9	2.8	**3.1**	4	NT	NT	NT	NT	NT	NT	NT	NT
Bore 6	1.8-2.0	Brown sand filling	6.3	5.2	**1.1**	3	NT	NT	NT	NT	NT	NT	NT	NT
	2.5-2.7	Grey brown sand	6.6	2.3	**4.3**	4	NT	NT	NT	NT	NT	NT	NT	NT
	3.8-4.0	Grey brown sand	6.5	2.8	**3.7**	4	NT	NT	NT	NT	NT	NT	NT	NT
Bore 7	2.2-2.4	Grey brown clayey sand/sandy clay	6.9	2.4	**4.5**	4	5.5	0.14	0.00	0	<0.05	NT	0.14	0.14
	2.8-3.0	Grey brown sand	6.8	4	**2.8**	2	NT	NT	NT	NT	NT	NT	NT	NT
	3.5	Grey brown sand	6.7	3	**3.7**	3	NT	NT	NT	NT	NT	NT	NT	NT
	4.5-4.6	Grey brown sand	6.1	2.5	**3.6**	4	NT	NT	NT	NT	NT	NT	NT	NT
Bore 8	1.8-2.0	Grey brown sand filling	7	4.9	**2.1**	3	NT	NT	NT	NT	NT	NT	NT	NT
	2.9-3.0	Grey brown sand	7	2.8	**4.2**	3	5.8	0.08	0.00	0	<0.05	NT	0.08	0.08
	3.9-4.0	Grey brown sand	7	3.1	**3.9**	3	NT	NT	NT	NT	NT	NT	NT	NT
Bore 9	0.5	Brown sand filling	7.2	3.9	**3.3**	3	NT	NT	NT	NT	NT	NT	NT	NT
Bore 10	2.5-2.7	Dark grey sand	6.4	2.2	**4.2**	4	NT	NT	NT	NT	NT	NT	NT	NT
Bore 11	1.7-2.0	Dark grey sand filling	6.6	2.2	**4.4**	4	6.0	<0.005	<0.01	0	<0.05	NT	<0.01	<0.005
	2.5-2.7	Dark grey clay/sandy clay	6.6	4.5	**2.1**	4	NT	NT	NT	NT	NT	NT	NT	NT
	3.0-3.3	Grey sand	6.5	3.7	**2.8**	4	NT	NT	NT	NT	NT	NT	NT	NT
Guideline		Coarse sands, poorly buffered	<4[d]	<3.5[e]	**≥1[e]**	-	-	-	-	-	-	-	-	0.01
		Coarse sands to loamy sands and peats												0.03
		Medium sandy loams to light clays												0.06[f]/0.03[g]
		Fine medium to heavy clays & silty clays												0.1[f]/0.03[g]

Notes to Table 4:

a Depth below ground surface

b Strength of Reaction

1 denotes no or slight reaction

2 denotes moderate reaction

3 denotes high reaction

4 denotes very vigorous reaction

F denotes bubbling/frothy reaction indicative of organics

H denotes heat generated

c Calculated from ABA equation in ASS Laboratory Methods Guidelines (Ref 7)

d For actual acid sulphate soils (ASS)

e Indicative value only for Potential Acid Sulphate Soils (PASS)

f QASSIT Action Criteria for disturbance of 1-1000 tonnes of material

g QASSIT Action Criteria for disturbance of more than 1000 tonnes of material

Bold results indicate an exceedence of ASSMAC criteria (Ref 2)

Shaded results indicate an exceedence of QASSIT criteria (Ref 3)

pH_F - Soil pH Test (1:5 soil:distilled water)

pH_{FOX} - Soil Peroxide pH Test (1:4 soil:distilled water following oxidation of soil with 30% hydrogen peroxide (H_20_2))

*Laboratory methods used to quantify ANC are likely to overestimate environmental effectiveness

The Acid Sulfate Soil Management Advisory Committee (ASSMAC) guidelines (Ref 2) suggest that a soil pH<4 in water is an indicator of actual ASS. The results of screening tests therefore suggest the absence of actual ASS at the locations and depths tested.

The ASSMAC guidelines also suggest that indicators of potential acid sulfate soils (PASS) include the following:

- Soil pH <3.5 following oxidation with H_2O_2 (i.e. pH_{FOX});
- Drop of 1 pH unit or more between pH_F and pH_{FOX}.

The results of screening tests indicated that 32 of the 34 samples exhibited a pH drop equal to or greater than one unit. Eighteen of the samples also exhibited a soil pH below 3.5 following oxidation.

It is noted that ASS screening tests are a qualitative method only and give an indication of the intensity of total acidification (pH). The guidelines indicate that peroxide may also oxidise organic matter (in addition to pyrite) to produce acids which are unlikely to form under natural conditions, thus giving falsely high indication of acid sulfate potential.

Based on the results of the screening tests, five soil samples (three natural sand, one natural clayey sand/sandy clay sample and one sand filling sample) were selected for detailed laboratory testing, comprising the Full Chromium Suite with reference to Queensland Acid Sulfate Soil Investigation Team (QASSIT) guidelines (Ref 2).

The results of detailed laboratory testing indicate the natural sand materials located in central and northern portions of the site have potential acid generation capacity to the investigated depths. Tested natural sand materials and sand filling in the south-western portion of the site at Bore 1 had minimal potential acid generation capacity to the investigated depths.

Net acidity values were above the QASSIT action criteria for disturbance of natural sand materials across the majority of the site. The testing also indicated the absence of effective acid neutralising capacity.

The results of the assessment indicated that the natural sands identified above within the central and northern portions of the site will require management in accordance with this site-specific ASSMP, if disturbed during future development. The ASS materials are present from a depth of approximately 2 m below the surface (i.e. approximately RL 1 AHD) and were generally encountered to the depth of assessment (4 m / 5 m below the ground surface).

6. Potential to Oxidise Soils

The following activities may expose acid sulfate soils to oxidising conditions during construction:

- Excavations for construction including basement excavations, service trenches, lift pits / wells, which extend into natural clayey soils;
- Installation of piles and subsequent generation of spoil at the surface;
- Dewatering of excavations, as required during the construction works; and
- Excavation of the existing basement.

The recommended management option for excavated ASS is neutralisation by full lime treatment and oxidation.

7. Management Strategy

7.1 Soil Treatment

Neutralisation of acid sulfate soils (ASS) should be undertaken in accordance with this ASSMP which has been prepared with reference to the ASSMAC (Ref 2) and QASSIT (Ref 3) guidelines. It will be necessary to prepare suitable treatment area(s) on site, as described below.

The treatment methodology applies to natural sand soils at the site in which ASS has been identified. Where upper sand filling is intermixed with underlying natural sand soils (e.g. spoil generation from pile installation), the materials should be considered as ASS.

The excavated ASS material or generated pile spoil should be segregated from non-ASS and contained within suitably bunded area(s) prepared as follows:

- Construct perimeter bunding around the treatment area(s) to prevent run-off or run-on (minimum height of 300 mm depending on the size of the treatment area and volume of material to be treated). If on-site soils are utilised for the bunding, they should also be lime treated at the rates as discussed below;
- Strip surface vegetation within area(s) to be used for treatment/stockpiling of ASS;
- Where sandy or highly permeable surface soils are present, place appropriate low permeability soils or low permeability membrane over the surface of the treatment area(s);
- Broadcast a guard layer of agricultural lime over the ground surface to be used for treatment/stockpiling (1 kg/m^2). Re-application of lime may be required if this guard layer is disturbed or removed during treatment of soils;
- Construct a catch drain/sump at the lowest point on the inside of the bund to collect run-off / leachate from the treatment area. The base of the sump should be inspected and must comprise low permeability (i.e. clayey) soils. If low permeability soils are not present the sump should be lined with a low permeability layer or membrane. The surface of the sump/catch drain should also be limed with 1 kg/m^2 of agricultural lime;
- Install appropriate erosion and sediment control measures for the perimeter of the treatment area(s).

It is noted that the above recommendations for the preparation of the treatment area rely on ASS treatment being conducted as soon as practical (i.e. within 24 hours of excavation for clayey soils).

The location of the bunded area(s) should be selected in order to minimise the potential for impact on nearby sensitive receptors. Any leachate produced in the bunded area should be contained for monitoring and treatment (if required) as discussed below.

Suitable neutralising agents for actual acid sulfate or potential acid sulfate soils include agricultural lime ($CaCO_3$), calcined magnesia (MgO or $Mg(OH)_2$), and dolomite ($MgCO_3.CaCO_3$).

An assessment of the dosing rate for lime treatment can be calculated from the results of detailed laboratory testing, using the following equation, which includes a factor of safety.

Alkali Material Required (kg)

$$\textit{per unit volume of soil } (m^3) = \left(\frac{\%S \times 623.7}{19.98}\right) \times \frac{100}{ENV(\%)} \times D \times FOS$$

where: *%S = net acidity (% S units);*
623.7 = % S to mol H^+/t;
19.98 = mol H^+/t to kg $CaCO_3$/t;
D = Bulk density of soil (t/m^3);
FOS = safety factor (usually 1.5);
ENV = Effective Neutralising Value (e.g. 80% for Grade 1 Agricultural lime).

Note:
The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with ASSMAC (Ref 2).

It is recommended that Grade 1 agricultural lime is used for the neutralisation of potential acid sulfate soils excavated during the construction.

The following liming/monitoring procedures for the treatment of ASS are recommended:

- All excavated ASS should be contained within the suitably bunded area(s) and kept moist to minimise oxidation, prior to treatment with lime. Progressive neutralisation will minimise the area required for bunding;
- Stockpiled natural clayey ASS soil should be limed initially at a rate of about 8 to 16 kg/m^3 of soil as soon as practicable following excavation. The above lime rate is recommended initially, and should be refined based on monitoring results as construction proceeds;
- The neutralising agent and acid sulfate soils should be thoroughly mixed and aerated using, for example, an agricultural lime spreader and excavator or rotary hoe. The soil should be treated in layers up to 300 mm thick to encourage aeration;
- The actual lime rate required will depend on the results of monitoring during neutralisation. Additional lime will be required if monitoring results indicate that appropriate neutralisation has not been achieved. Conversely the liming rate may decrease if monitoring suggests over-liming has occurred;
- Sampling and testing should be undertaken in accordance with Section 8.1 to verify the neutralisation treatment. The acceptance criteria are discussed in Section 8.2. Depending on the results of testing, reapplication of lime may be necessary to gain adequate neutralisation. Care should be taken to avoid over-liming of soils;

- Upon verification of treatment, the neutralised acid sulfate soils could be reused on site. The geotechnical suitability of the treated soils should be confirmed prior to reuse. Alternatively, treated ASS could be disposed at a licensed landfill following confirmation of the waste classification by an appropriate qualified consultant. It is noted that ASS must be appropriately neutralised prior to off-site landfill disposal in accordance with NSW EPA "Waste Classification Guidelines - Part 4: Acid Sulfate Soils" (Ref 8). Alternatively, the NSW EPA may assess an application for reuse of the treated soils on another site, via classification with a specific exemption. The requirements for the exemption should be confirmed prior to construction.

7.2 Neutralising Leachate

Leachate water collected from the bunded area(s) should be neutralised as necessary before disposal. Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) is the recommended neutralising agent as it produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over-neutralisation to occur.

The amount of neutraliser required to be added to the leachate can be calculated from the following equation:

$$\textit{Alkali Material Required (kg)} = \frac{M_{Alkali} \times 10^{-pH\ initial}}{2 \times 10^{3}} \times V$$

where: pH initial = initial pH of leachate

V = volume of leachate (litres)

M_{Alkali} = molecular weight of alkali material (g/mole)

Note: molecular weight of calcined magnesia (M_{MgO}) = 40 g/mole.

The alkali should be added to the leachate as slurry. Mixing of the slurry is best achieved using an agitator.

Notwithstanding regulatory authority requirements, the leachate should consider the water quality criteria presented in Section 8.2 prior to discharge.

Regular monitoring of leachate should be conducted as discussed in Section 8.1.2.

7.3 Dewatering

Options for the management/disposal of extracted groundwater during dewatering include the following:

- Re-injection of groundwater at a location away from the dewatered excavation;
- Overland discharge and infiltration, or infiltration from a detention basin;
- Disposal to sewer.

Dewatering activities should be conducted under the appropriate licence and regulatory requirements (i.e. NSW Office of Water, Council requirements).

If stormwater disposal is considered as an option for extracted groundwater disposal, it is recommended that contact be made with the appropriate regulatory authorities (i.e. Council, NSW Office of Water) to discuss quality and monitoring requirements.

The following procedure is recommended in order to minimise potential adverse impacts resulting from excavation and dewatering of acid sulfate soils during construction:

- Minimise the dewatering depth required for installation (i.e. as close as practicable to the invert level of the excavation);
- Minimise the time and volume of exposed acid sulfate soils (i.e. stage excavation and dewatering);
- If re-injection is proposed, periodic monitoring of reinjected water should be conducted to assess potential impacts from the dewatering process;
- For discharge/infiltration methods, extracted groundwater should be collected in a suitably sized multi stage sedimentation tank or on-site detention structures and neutralised as necessary prior to disposal;
- The extracted groundwater could then be discharged to a bunded area or constructed pond away from the dewatering site (i.e. re-injected or evaporation/infiltration) or discharged overland or to sewer, subject to regulatory requirements;
- The pH of the extracted water should be monitored prior to discharge. Neutralisation should be undertaken, as discussed below, if discharge water pH falls below natural background levels (re-injection/evaporation/infiltration) or outside regulatory requirements (sewer disposal);
- Dose the base of temporary excavations (i.e. pier holes, service trenches, basement floor levels, lift wells etc.) at a rate of approximately 1 kg/m^2 of agricultural lime prior to construction and cessation of dewatering in order to counteract the generation of acidic leachate following groundwater recovery;
- Treat ASS excavated during construction as discussed in Section 7.1;
- Undertake monitoring as recommended in Section 8.

The following procedure is recommended for neutralising groundwater if required:

- The neutralising agent (e.g. agricultural lime or calcined magnesia) should be added as a slurry at the first stage of a multi-stage sedimentation tank or detention structure to allow the lime to mix with the extracted groundwater prior to discharge;
- The neutralising agent should be added at a constant rate during dewatering. The rate of dosing should be minimal initially and be monitored and adjusted based on the results of regular monitoring of the treated extracted groundwater.

8. Monitoring Strategies

8.1 Procedures

8.1.1 Soil Neutralisation / Management

It is recommended that the following inspections and monitoring be undertaken when excavating ASS materials (i.e. natural sand soils), based on guidelines presented in the ASSMAC (Ref 2) and QASSIT (Ref 3) manuals:

- Daily inspection of liming operations during initial excavation, to be reviewed following establishment of liming procedures;
- Sampling and testing after lime treatment (i.e. measurements of soil pH in distilled water and pH following oxidation with peroxide) should initially be undertaken at a frequency of at least one sample per 20 m^3 excavated soil to verify the neutralisation treatment. The frequency of testing could be reviewed as treatment progresses. A lower frequency of testing could be considered, subject to consistent results, soil conditions and treatment procedures;
- Analysis of one sample per 50 m^3 for Chromium Suite analysis by a NATA accredited laboratory to confirm appropriate neutralisation;
- Check testing should also be conducted on sandy filling during excavation works to confirm the absence of ASS as found in previous investigations.

8.1.2 Leachate Management

Leachate collected within the treatment bunded area(s) should be temporarily stored and neutralised as necessary. The pH of the leachate should be monitored daily and prior to discharge. The leachate could be discharged overland (i.e. re-injection evaporation/infiltration) or discharged to sewer, subject to regulatory requirements and licences.

Neutralisation should be undertaken if leachate water pH falls below natural background groundwater levels (evaporation/infiltration) or outside regulatory requirements (sewer discharge).

A contingency procedure should be in place to allow lime dosing and monitoring to confirm neutralisation prior to discharge.

8.1.3 Dewatering

Extracted groundwater should be temporarily stored, and neutralised as necessary. The pH of extracted water associated with areas of acid sulfate soils should be monitored twice daily (am, pm) prior to discharge. The groundwater could be reinjected, discharged overland (i.e. evaporation / infiltration) as discussed in Section 7.3, or discharged to sewer or stormwater subject to regulatory requirements and licences.

Neutralisation should be undertaken if discharge water pH falls below natural background groundwater levels (re-injection/evaporation/infiltration) or outside regulatory requirements (sewer discharge). Current natural groundwater pH should be confirmed at the commencement of dewatering.

A contingency procedure should be in place to allow for lime dosing and monitoring confirming that neutralisation has been achieved prior to discharge.

8.1.4 Surface Water Monitoring

In the event that extracted water is disposed into the stormwater system, a surface water monitoring program should be established due to the proximity of the receiving water (i.e. Hunter River). The monitoring program should include pH and EC testing of surface waters upstream, downstream and adjacent to the discharge point within the Hunter River.

Monitoring should be conducted at an initial daily frequency during construction. A reduced frequency could be considered subject to consistent daily results and consistent construction activities.

The monitoring program should be developed prior to the commencement of construction with consideration to the staging of excavation and dewatering works.

8.1.5 Reporting

A record of treatment of acid sulfate soil and leachate should be maintained by the contractor and should include the following details:

- Date;
- Location;
- Time of excavation and reuse or disposal (i.e. time stockpile has been exposed);
- Neutralisation process undertaken;
- Lime rate utilised;
- Results of monitoring of soil, leachate, groundwater and surface water (if required).

A record of water monitoring and any treatment and discharge activities should also include the following:

- Background surface water pH and EC monitoring within the Hunter River, upstream and downstream of the site/discharge area in the event that stormwater discharge is approved and conducted;
- Daily monitoring at the point of discharge of any waters (i.e. on-site discharge point).

A record should also be maintained confirming contingency measures and additional treatment if undertaken. Monitoring should be commensurate with licencing and regulatory requirements.

A final report should be issued upon completion of the works presenting the monitoring regime and results to confirm that no adverse environmental impact has occurred during the works.

8.2 Acceptance Criteria

8.2.1 Water

Notwithstanding regulatory requirements, it is recommended that the pH of discharge waters from dewatering or leachate are within measured background groundwater pH levels, and that the ANZECC (2000) Guidelines for Fresh and Marine Water Quality (Ref 5) be considered before discharging any waters to the environment. The ANZECC (2000) guidelines trigger value range of pH 7.0 to pH 8.5 for estuarine environments is considered to be appropriate for surface water / stormwater discharge, rather than the marine or fresh water criteria, given the close proximity of the site to the Hunter River.

The background pH levels in groundwater should be confirmed prior to commencement of works.

8.2.2 Soil

Further treatment of soils may be required if monitoring of the material reveals any of the following properties:

- pH of soil in water is less than background values (to be confirmed at the commencement of works;
- pH of soil in water minus pH of soil in hydrogen peroxide is greater than 1 and pH in water is less than background values;
- pH of soil in hydrogen peroxide is greater than background (i.e. potential over-liming).

Depending on the results of testing, reapplication of lime may be necessary to gain adequate neutralisation. Care should be taken to ensure over-liming does not occur.

The background pH levels in soils should be confirmed at the commencement of works.

9. Contingency Plan

Remedial action will be required if the standards or acceptance criteria outlined above are not being achieved. Remedial action shall comprise mixing of additional lime through the excavated material and neutralisation of leachate (if under-liming has occurred). If monitoring indicates that over-liming has occurred, additional ASS or leachate should be mixed with soils and leachate respectively to reduce pH to acceptable levels. The required mixing rate to treat the soil or leachate should be confirmed by on-site monitoring tests.

Where overland discharge or sewer discharge of extracted groundwater is proposed, a contingency plan should be in place to allow neutralisation and confirmation monitoring prior to discharge if pH levels are low or fall below natural background levels.

During periods of heavy or prolonged rainfall, stockpiled of acid sulfate soils should be appropriately contained/bunded to collect leachate for testing and neutralisation (if required) prior to disposal (see Section 7.2). Alternatively, temporary backfilling of acid sulfate soils could be undertaken to prevent the migration of leachate.

Sufficient lime should be stored on site during construction for the neutralisation of acid sulfate soils and contingency measures.

The development should be conducted with due regard to erosion and sediment controls to minimise potential impacts to nearby sensitive receptors.

Site development should be conducted in accordance with a site specific Construction Environmental Management Plan (CEMP). The CEMP should incorporate mitigation measures for soil and water management including those recommended for the management of ASS. Details should be provided in the CEMP by the contractor, in conjunction with other management plans as required by the consent authority.

10. Reporting

A report will be prepared by the environmental consultant with reference to ASSMAC and QASSIT guidelines (Refs 2 and 3) and other appropriate guidance documentation detailing the results of ASS management during construction.

The report shall include (where required) details of the total volume of ASS excavated, detailed analytical results confirming that acceptable ASS treatment has occurred, water monitoring results of extracted groundwater and surface water (where required), site records from contractors and records of the final disposal destination of the materials removed from site (if required).

11. References

1. Douglas Partners Pty Ltd, “Report on Stage 1 Targeted Investigation (Contamination), Newcastle Urban Transformation and Transport Program – The Store, 854 Hunter Street Newcastle West, prepared for UrbanGrowth NSW, Project 81811.01, May 2016.
2. ASSMAC, “ASSMAC Acid Sulfate Soil Manual”, New South Wales Acid Sulfate Soil Management Advisory Committee, August 1998.
3. Dear SE, Ahern CR 2014, O’Brien LE, Dobos SK, McElnea AE, Moore NG and Watling KM “Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines”, Department of Science, Information Technology, Innovation and the Arts, Queensland Government, June 2014.
4. NHMRC (2011), ‘National water quality management strategy, Australian Drinking Water Guidelines’, National Health and Medical Research Council and National Resource Management Ministerial Council, Australia.
5. ANZECC (2000), ‘Australian Water Quality Guidelines for Fresh and Marine Waters’, November 2000.
6. National Environment Protection Council (2013), ‘National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013.

7. Ahern CR, Sullivan LA and McElnea AE, “Acid Sulfate Soils Laboratory Methods Guidelines” in “Queensland Acid Sulfate Soil Technical Manual”, Department of Natural Resources and Mines, June 2004.

8. NSW EPA “Waste Classification Guidelines, Part 4: Acid Sulfate Soils”, Department of Environment and Climate Change, November 2014.

12. Limitations

Douglas Partners (DP) has prepared this report for this project at 854 Hunter Street Newcastle West with reference to DP’s proposal dated 3 July 2018 and acceptance received from Bloc (ACT) Pty Ltd dated 9 July 2018. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Bloc (ACT) Pty Ltd 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 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 the previous 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 testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life.

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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

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

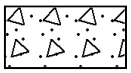
Symbols & Abbreviations

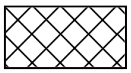
Graphic Symbols for Soil and Rock

General

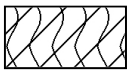

Asphalt

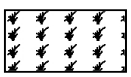

Road base

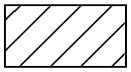

Concrete

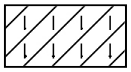

Filling

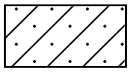
Soils


Topsoil

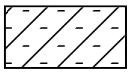

Peat

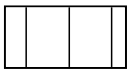

Clay

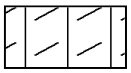

Silty clay

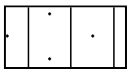

Sandy clay

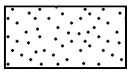

Gravelly clay

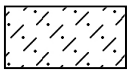

Shaly clay

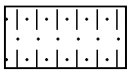

Silt


Clayey silt


Sandy silt

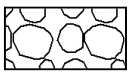

Sand

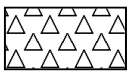

Clayey sand


Silty sand


Gravel

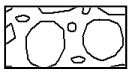

Sandy gravel


Cobbles, boulders

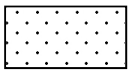

Talus

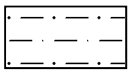
Sedimentary Rocks

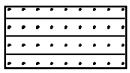

Boulder conglomerate

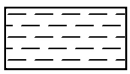

Conglomerate


Conglomeratic sandstone

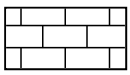

Sandstone


Siltstone

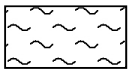

Laminite

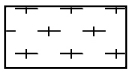

Mudstone, claystone, shale

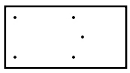

Coal


Limestone

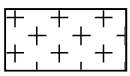
Metamorphic Rocks

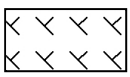

Slate, phyllite, schist

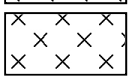

Gneiss

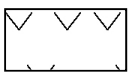

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Borehole Logs – Bores 1 to 12 (from Ref 1)

BOREHOLE LOG

CLIENT: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 1
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.05	ASPHALT							Gatic cover; From 0m to 0.1m, concrete
		FILLING - Grey/dark grey sandy gravel filling, cement/stabilsed		A	0.1 – 0.2				From 0.1m to 0.5m, bentonite
	0.35	FILLING - Dark grey brown, fine to medium grained sand filling, with some gravel, slag gravel, moist		A	0.4 – 0.5				
				A	0.9 – 1.0				From 0m to 1.5m, 50mm diameter Class 18 PVC casing
1				A	1.4 – 1.5				
				A	1.9 – 2.0				
2	2.1	FILLING - Generally comprising dark brown, fine to coarse grained sand filling, moist							From 0.5m to 4.5m, 2/5mm washed gravel
	2.7	FILLING - Generally comprising pale brown, fine to coarse grained sand filling, wet		A	2.9 – 3.0			18-03-16	From 1.5m to 4.5m, Class 18, 50mm diameter machine slotted PVC screen
3		From 2.9m, saturated		A	3.4 – 3.6				
	3.7	From 3.6m, 100mm band of fine to medium sized subangular/subrounded gravel							
		SAND - (Medium dense) brown, fine to medium grained sand, saturated		A	3.9 – 4.0				
4									
				A	4.9 – 5.0				End cap
	5.0	Bore discontinued at 5.0m, limit of investigation							

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**

TYPE OF BORING: Hand auger to 1.2m, dual tube to 5.0m

WATER OBSERVATIONS: Free groundwater observed at ~2.9m whilst 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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 2
PROJECT No: 81811.01
DATE: 18/3/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	CONCRETE							
		FILLING - Dark grey/black, fine to coarse grained gravelly sand, some metal and ceramic fragments, damp to moist		A	0.2				
				A	0.5				
	1								1
				A	1.5				
					1.8				
	2								2
	2.2	FILLING - Grey brown, fine to medium grained sand filling, moist to wet							
		From 2.5m, saturated		U	2.5			▼ 18-03-16	
	2.8	SAND - Grey/grey brown, fine to medium grained sand, trace to some clay, saturated							
	3	From 3.0m, light grey brown		U	3.0				3
					3.3				
	4			U	4.0				4
					4.2				
					4.4				
		From 4.5m, brown		U					
	5.0				5.0				

Bore discontinued at 5.0m, limit of investigation

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**

TYPE OF BORING: Hand auger to 0.9m, dual tube to 5.0m

WATER OBSERVATIONS: Free groundwater observed at 2.5m

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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 3
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.05	ASPHALT							
		FILLING - Dark grey brown, fine to coarse grained sand gravel filling, moist		A	0.2				
					0.3				
				A	0.5				
					0.7				
	1								1
				A	1.1				
					1.3				
	1.4	FILLING - Dark grey/black, fine to medium grained sand filling, moist		U	1.6				
	1.8	SANDY CLAY - Dark grey brown sandy clay, M>Wp		U	2.0			▼ 18-03-16	2
	2.4	SAND - Grey brown, fine to medium grained sand, saturated		U	2.8				3
	3			U	3.5				
	4								4
				U	4.5				
	5.0								

Bore discontinued at 5.0m, limit of investigation

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**

TYPE OF BORING: Hand auger to 1.0m, dual tube to 5.0m

WATER OBSERVATIONS: Free groundwater observed at 2.0m depth

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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 4
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.05	ASPHALT							Gatic cover From 0m to 0.1m, concrete
		FILLING - Dark grey sandy gravel filling		A	0.2				From 0.1m to 0.5m, bentonite
	0.4	FILLING - Dark grey/black clayey sand filling, moist		A	0.5				From 0m to 1.0m, 50mm diameter Class 18 PVC casing
	0.7	FILLING - Dark brown sand filling, trace clay, moist		A	0.9				
1		From 1.3m, light brown, wet							1
				U	1.7				
2	2.0	SAND - Grey brown, fine to medium grained sand, saturated			2.0			18-03-16	2
				U	2.2				From 0.5m to 4.0m, 2/5mm washed gravel
					2.5				From 1.0m to 4.0m, Class 18, 50mm, diameter machine slotted PVC screen
3				U	3.5				3
4	4.0	Bore discontinued at 4.0m							End cap 4

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**
TYPE OF BORING: Hollow flight auger to 0.7m, dual tube to 4.0m
WATER OBSERVATIONS: Free groundwater observed at 2.0m
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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 5
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.16	CONCRETE							
		FILLING - Light brown sandy gravel filling, with some cobbles, damp		A	0.3				
	0.7	FILLING - Dark grey sand filling, damp to moist		A	0.9				
	1	From 1.2m, dark brown, moist to wet							
				U	1.6				
					1.8				
	2	From 2.0m, saturated						▼ 18-03-16	
	2.5	SAND - Grey, fine to medium grained sand, trace clay, saturated		U	2.6				
					2.8				
	3	From 3.5m, siltstone gravel layer		U	3.4				
					3.6				
	4			U	4.0				
					4.1				
				U	4.8				
	5.0				5.0				

Bore discontinued at 5.0m

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**
TYPE OF BORING: Hand auger to 1.1m, dual tube to 4.0m
WATER OBSERVATIONS: Free groundwater observed at 2.0m
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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 6
PROJECT No: 81811.01
DATE: 18/3/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	CONCRETE							
		FILLING - Dark grey/black, fine to coarse grained sand and gravel filling, with slag/ash gravel, damp		A	0.3 0.4				
	0.45	FILLING - Grey brown sandy clay filling, some gravel, M>Wp		A	0.5				
	0.7	FILLING - Dark grey, fine to medium grained sand filling, damp to moist		A	0.7 0.9				
1	1.1	FILLING - Light brown/brown, fine to medium grained sand filling, moist to wet							1
				U	1.8				
2		From 2.0m, saturated			2.0			▼ 18-03-16	2
	2.1	SAND - Grey brown, fine to medium grained sand, saturated		U	2.5				
					2.7				
3				U	3.0				3
					3.2				
				U	3.8				
4	4.0	Bore discontinued at 4.0m			4.0				4

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Benson **CASING:**
TYPE OF BORING: Hand auger to 1.0m, dual tube to 4.0m
WATER OBSERVATIONS: Free groundwater observed at 2.0m
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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 7
PROJECT No: 81811.01
DATE: 18/3/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.15	CONCRETE							
		FILLING - Dark grey brown, fine to coarse grained gravelly sand, some cobbles and brick fragments, damp		A	0.2				
					0.3				
				A	0.5				
					0.6				
					0.8				
				A					
	1				1.0				1
	1.5	FILLING - Grey brown, fine to medium grained sand filling, wet							
					1.8				
				U					
	2	From 2.0m, saturated			2.0			▼ 18-03-16	2
	2.1	CLAYEY SAND/SANDY CLAY - Grey brown, fine to medium grained clayey sand/sandy clay, saturated/M>Wp			2.2				
				U					
					2.4				
	2.5	SAND - Grey brown, fine to medium grained sand, saturated							
					2.8				
				U					
	3				3.0				3
				U	3.5				
	4								4
				U	4.5				
	5.0	Bore discontinued at 5.0m							

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**
TYPE OF BORING: Hand auger to 1.0m, dual tube from 1.0m to 5.0m
WATER OBSERVATIONS: Free groundwater observed at 2.0m
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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 8
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.05	ASPHALT							Gatic cover From 0m to 0.1m, concrete
		FILLING - Dark grey, fine to coarse grained sand and gravel (possibly stabilised), damp		A	0.2 0.3				From 0.1m to 0.5m, bentonite
	0.5	FILLING - Light grey/green, coarse sand filling (granulated slag), moist		A A	0.5 0.6 0.7				From 0m to 1.0m, 50mm diameter Class 18 PVC casing
	0.9	FILLING - Dark grey, fine to medium grained sand filling, some gravel, moist		U	0.9 1.1				
	1.4	FILLING - Dark grey, fine to medium grained sandy clay filling, M>Wp		U	1.5 1.6				
	1.7	FILLING - Grey brown, fine to medium grained sand filling, wet From 2.0m, saturated		U	1.8 2.0			18-03-16	
	2.4	SAND - Grey brown, fine to medium grained sand, slightly clayey to 2.6m		U	2.9 3.0				From 0.5m to 4.0m, 2/5mm washed gravel From 1.0m to 4.0m, Class 18, 50mm diameter machine slotted PVC screen
				U	3.9				
	4.0	Bore discontinued at 4.0m			4.0				End cap

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**
TYPE OF BORING: Hand auger/solid flight auger to 1.0m, dual tube 4.0m
WATER OBSERVATIONS: Free groundwater observed at 2.0m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 9
PROJECT No: 81811.01
DATE: 24/3/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.2	CONCRETE - Comprising slag gravel From 0.07m to 0.08m, dark grey/black ?? From 0.08m, dark grey concrete with slag							Gatic cover From 0m to 0.1m, bentonite From 0m to 0.2m, 50mm diameter Class 18 PVC casing From 0.1m to 0.7m, 2/5mm washed gravel From 0.2m to 0.7m, Class 18, 50mm diameter machine slotted PVC screen End cap
		FILLING - Generally comprising brown/dark grey sand filling, with some silt and trace fine rounded gravel and timber and brick fragments, saturated		A	0.3	E		24-03-16	
				A	0.5	E			
	0.7	Bore discontinued at 0.7m, collapse							
	1								
	2								
	3								
	4								

RIG: Hand tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:**
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: Free groundwater observed at 0.2m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 10
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.05	ASPHALT							Gatic cover From 0m to 0.1m, concrete
		FILLING - Grey/dark grey sandy gravel filling, with slag cobbles, damp		A	0.2				
	0.3	FILLING - Dark grey, fine to medium grained sand filling, moist		A	0.6				From 0.1m to 0.5m, bentonite From 0m to 1.0m, 50mm diameter Class 18 PVC casing
1									1
		From 1.4m, grey brown		U	1.6 1.8				
2	2.0	SAND - Brown/dark brown, fine to medium grained sand, trace clay						18-03-16	2 From 0.5m to 4.0m, 2/5mm washed gravel
				U	2.5 2.7				From 1.0m to 4.0m, Class 18, 50mm diameter machine slotted PVC screen
3		From 3.0m to 4.0m, no sample recovery (obstruction, cobble fell in borehole)							3
4	4.0	Bore discontinued at 4.0m							4 End cap

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**

TYPE OF BORING: Hand auger to 1.2m, dual tube 4.0m

WATER OBSERVATIONS: Free groundwater observed at ~~1.9m 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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 11
PROJECT No: 81811.01
DATE: 18/3/2016
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
	0.05	ASPHALT							Gatic cover; From 0m to 0.1m, concrete
		FILLING - Dark grey/brown silty sand and gravel filling, with trace coal fragments and slag gravel, some brick fragments, damp		A	0.2				From 0.1m to 0.5m, bentonite
				A	0.5				From 0m to 1.0m, 50mm diameter Class 18 PVC casing
	0.6	FILLING - Dark grey, fine to medium grained sand, moist		A	0.9				
1									1
				U	1.7				
2		From 2.0m, wet			2.0			18-03-16	2
	2.4	CLAY/SANDY CLAY - Dark grey clay/sandy clay, M>Wp		U	2.5				From 0.5m to 4.0m, 2/5mm washed gravel
		From 2.8m, grading to clayey sand			2.7				From 1.0m to 4.0m, Class 18, 50mm diameter machine slotted PVC screen
3	3.0	SAND - Grey brown/brown, fine to medium grained sand, saturated		U	3.0				3
					3.3				
4	4.0	Bore discontinued at 4.0m							End cap; 4

RIG: Geo Probe **DRILLER:** Terratest **LOGGED:** Heads **CASING:**
TYPE OF BORING: Hand auger to 1.0m, dual tube to 4.0m
WATER OBSERVATIONS: Free groundwater observed at ~~2.0m 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: UrbanGrowth NSW
PROJECT: NUTTP - The Store
LOCATION: 854 Hunter Street, Newcastle West

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

BORE No: 12
PROJECT No: 81811.01
DATE: 24/3/2016
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
	0.12	CONCRETE						24-03-16 ▼	Gatic cover
	0.2	FILLING - Generally comprising light brown sand filling, with trace rounded gravel, wet							From 0m to 0.1m, bentonite
		FILLING - Generally comprising brown/dark brown sand filling, with trace silt and rounded gravel, saturated		A	0.3	E	PID<1		From 0m to 0.2m, 50mm diameter Class 18 PVC casing
	0.5	FILLING - Generally comprising grey/brown sand filling, with some silt and trace fine rounded gravel, saturated		A	0.6	E	PID<1		From 0.1m to 0.8m, 2/5mm washed gravel
	0.8	Bore discontinued at 0.8m, collapse							From 0.2m to 0.8m, Class 18, 50mm diameter machine slotted PVC screen
	1								End cap
	2								
	3								
	4								

RIG: Hand tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:**
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: Free groundwater observed at 0.12m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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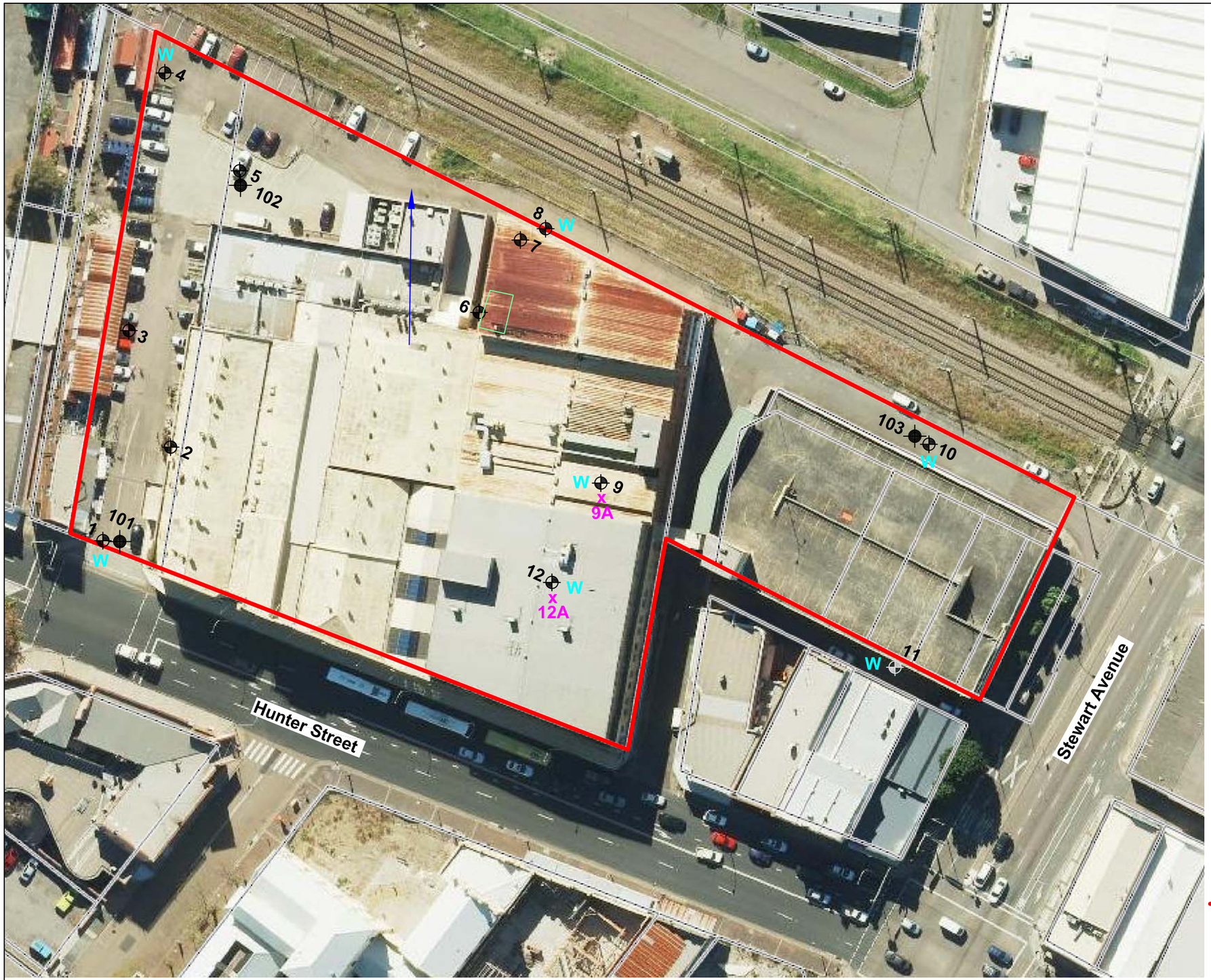
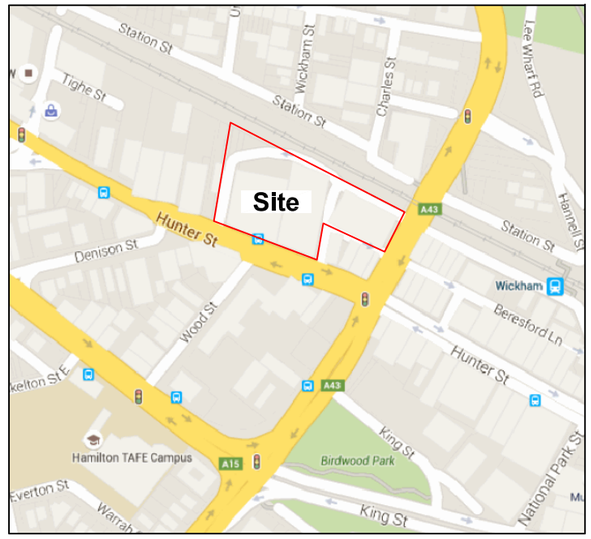
Appendix C

Drawing 1 – Test Location Plan
Architectural Drawings – Bates Smart (Project No. S12133)





Locality Plan

0 5 10 15 20 30 40 50 75m

1:750 @ A3

NOTE: Base drawing from Nearmap Image dated 8 May 2015

LEGEND

- Approximate Site Boundary
- Approximate Borehole Location
- W — Groundwater Monitoring Well Installed at Borehole Location
- Approximate CPT Location
- x — Approximate Basement Well Location
- Observed Possible Asbestos Containing Materials at the Surface
- Approximate Inferred Groundwater Flow Direction

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CLIENT: UrbanGrowth NSW		
OFFICE: Newcastle	DRAWN BY: PLH	
SCALE: 1:750@A3 Sheet	DATE: 29.04.2016	

TITLE: **Test Location Plan, Stage 1 Targeted Site Investigation**
NUTTP - The Store
854 - 868 Hunter Street, Newcastle West

PROJECT No:	81811.01
DRAWING No:	1
REVISION:	0