Geotechnical Site Investigation Report

St Marys Detention Basins C and V6

5017200065

Prepared for
Lendlease

22 November 2019

Construction Sciences

Contact Information

Construction Sciences Pty Ltd
ABN 74 128 806 735

Level 9 - The Forum
203 Pacific Highway
St Leonards NSW 2065
Australia

www.Constructionsciences.net
Phone +61 2 9496 7700
Fax +61 2 9439 5170

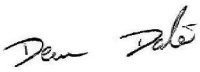
Document Information

Prepared for	Lendlease
Project Name	St Marys Detention Basins C and V6
File Reference	5017200065
Job Reference	5017200065
Date	22 November 2019
Version Number	1
Effective Date	22/11/2019
Date Approved	22/11/2019

Author(s):

Jack Brearley
Geologist

Approved By:



Deven Date
Senior Geotechnical Engineer

Document History

Version	Effective Date	Description of Revision	Prepared by	Reviewed by
-	14/11/2019	Draft for internal review	JPA / JB	AT
0	18/11/2019	Draft for client review	JPA / JB	DD
1	22/11/2019	Final Report	JPA / BW	DD

Table of Contents

Tables

Appendices

1 INTRODUCTION

1.1 Background

Construction Sciences (NSW/ACT) Pty Ltd was engaged by Lendlease ("the client") to prepare a geotechnical site investigation report as part of the Jordan Springs development project EIS requirement.

The proposal involves the construction of two detention basins (Basins C and V6) to detain, treat and attenuate stormwater runoff from Village 3 and Village 6; the Jordan Springs development. The basins are located within the north-western extent of the St Marys Development Site and within the Wianamatta Regional Park. Basins C and V6 will be constructed wetlands and act as water quality improvement basins with the provision for active stormwater detention during high flows.

Basin C will have a surface area of approximately 1.8 hectares and a notional depth of 1.7m. Whereas Basin V6 approximately 0.3 hectares and a notional depth of 1.6m.

Each basin is designed to contribute to the water quantity and quality management objectives under the Sydney Regional Environmental Plan No. 30 – St Marys (SREP 30) and Penrith City Council's (Council) Water Sensitive Urban Design Policy (December 2013). The basins will incorporate the features for both water quality treatment and detention including a drainage inlet point, low level culvert outlet, spillway with erosion protection and vegetated slopes to provide effective nutrient removal. An access track along the side of each basin with access ramps will be constructed for regular inspection and maintenance access.

This report provides the outcomes of the geotechnical investigation works along with the acid sulphate assessment. Site locality plans including the indicative location of basins and boreholes is provided in **Appendix A.**

1.2 Purpose, Objectives and Scope

The purpose of the investigation is to provide "the client" with geotechnical advice on the in-situ ground conditions to be encountered, as part of development / use as stormwater basins.

The scope of works as presented as part of the investigation are detailed below:

- Undertake a geotechnical investigation to determine the in-situ ground conditions to be encountered across the proposed basins area;
- Undertake an acid sulfate soils assessment in accordance with ASSMAC 1998 to inform the presence and extent of ASS at the site;
- Undertake sufficient testing to aid in-situ conditions for design of basins; for batter slopes, permeability, and use of liners (if deemed necessary);
- Undertake interpretative reporting to assess soil erosion potential, potential groundwater impacts and constructability to facilitate further design.
- Additional tests to determine CBR value to aid pavement design for haul road access.

This report presents the results of the geotechnical investigation undertaken to address the above geotechnical objectives, and must be read in conjunction with our attached 'General Notes'.

2 SITE DESCRIPTION

2.1 Site Definition

The subject site is part of Jordan Springs development, St Marys, NSW, located approximately 50 km west of the Sydney CBD, within Penrith City Council Local Government Area (LGA). The site will be subject to the proposed retention Basins V6 and C (**see Appendix A**) to facilitate future developments within the area.

2.2 Site Geology

Reference to the *Penrith 1:100 000 Geological Series* Sheet 9030, published by NSW Department of Minerals and Resources - 1991, indicates that the site and surrounds are generally underlain by Bringelly Shale (Rwb)

of the Triassic Period. This formation is comprised of shale, carbonaceous claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff. Episodes of erosion and uplift within the area rendered the landscape with natural depressions that transports surficial deposits comprised of quaternary fine grained sand, silt and clay.

The NSW Office of Environment and Heritage, eSPADE map, indicates that the soil landscape within the area is comprised primarily of the residual Blacktown soil landscape. This soil landscape occur on gently undulating rises over the Wianamatta Group Shales such as the Bringelly Shale (Rwb). The soils are typically acidic with low permeability. Minor intertounges of the Alluvial South Creek landscape are also present on site mainly on the floodplains of the area, derived from upstream weathering of Wianamatta Shales and Hawkesbury Sandstone.

2.3 Topography

The site is characterised by gently east sloping terrain ranging from 34 mAHD in the western section of the Site adjacent Basin C to 28 mAHD in the west at Basin V6. South Creek is the nearest waterbody located approximately 1.8 km east of the area. Drainage lines reportedly run through the investigation area towards South Creek.

2.4 Salinity

The former Department of Infrastructure Planning and Natural Resources (DIPNR) map “Salinity Potential in Western Sydney 2002” indicate that majority of the area was classified under “moderate salinity potential” with the creek/riverine areas being highlighted as “high salinity potential”

2.5 Acid Sulfate Soils

A review of the CSIRO Atlas of Australian Soils Probability Classification (2013) indicates that the area is mapped as Category C – Extremely Low Probability of Occurrence. An ASS risk map is provided in **Appendix A**.

3 INVESTIGATORY WORK

3.1 Borehole Locations

The ground co-ordinates of boreholes are listed in **Table 3-1** below. At the time of investigation, boreholes were located based on the proposed site Plan.

Table 3-1 Borehole Locations

Structure	Borehole ID	Easting (m)	Northing (m)	Reduced Level (mAHD)
Basin V6	BH01	290799.7869	6267029.044	27.5
	BH02	290854.3906	6267004.76	27.5
Basin C	BH03	290373.2022	6266891.708	31.5
	BH04	290339.8157	6266965.213	31.0
	BH05	290390.5186	6266955.844	30.5
	BH06	290269.034	6266894.88	33.0
Haul Road	BH07	290662.4204	6266961.665	28.5
	BH08	290511.3138	6266957.756	30.5

Notes:

1. All co-ordinates were taken in accordance with GDA94 / MGA zone 56, with reduced levels as per australian height datum (AHD)

3.2 Fieldworks

3.2.1 Underground Service Search

A Dial before you dig (DBYD) underground service search was conducted by Geotrace for the nominated borehole locations and surrounding area prior to the fieldworks. A qualified underground service locator cleared the borehole location from utilities, with the use of a pipe/cable locator & transmitter and ground penetrating radar (GPR) prior to excavation.

3.2.2 Geotechnical Drilling

Investigatory drilling was undertaken with the use of a Ute mounted drilling rig operated by Stratacore.

All boreholes were drilled vertically (90 degrees from the horizontal). Drilling through the soil was carried out using a solid flight auger with tungsten carbide "TC" – bit, up to 4.5m below ground level or refusal, whichever came first. Dynamic Cone Penetrometer (DCP) tests were undertaken through the soil profile from surface down to 3.0m or refusal, whichever came first, to determine soil consistency.

3.2.3 Fieldwork Activities

Fieldworks for the investigation were carried out on the 7th of November 2019 and comprised of the following sequence of activities.

- A Dial Before You Dig (DBYD) underground service search was undertaken prior with service clearing from Geotrace
- Drilling of Six (6) boreholes using a Ute-mounted drill rig equipped with; solid flight auger and TC- bit for the basins;
- Drilling of two (2) boreholes for the haul road;
- Collection of disturbed and undisturbed (U50) soil samples for laboratory testing;
- Installation of two (2) standpipes to undertake in-situ falling head test (slug test) to assess permeability of soils on BH01 and BH03.

All fieldworks, including logging of the subsurface profile, installation of wells and collection of disturbed/undisturbed U50 samples, were undertaken by experienced geotechnical engineers from Construction Sciences. The locations of the completed geotechnical boreholes are shown on the borehole location plan, presented in **Appendix A**.

Subsurface conditions encountered are summarised in Section 5 and detailed in engineering borehole logs, attached in **Appendix B**, together with explanatory notes.

Fieldwork was carried out in accordance with Australian Standard, AS1726-2017 'Australian Standard – Geotechnical Investigations'.

3.2.4 Laboratory Works

Samples of representative strata were recovered and returned to a NATA accredited laboratory. The following tests were carried out on selected samples:

- Atterberg Limits Tests and Particle Size Distribution tests (PSD) to aid in material classification.
- Emerson Dispersion tests to aid dispersion potential of soil material.
- Field Moisture Content to determine in situ moisture.
- In situ and Lab Permeability test to determine permeability of soils.
- Aggressivity (pH, Resistivity, Chloride, Sulfate), Sodicity (%ESP) and Salinity (EC) tests to aid in concept design of structures.
- California Bearing Ratio tests to determine the subgrade conditions of the haul road.

The following labs were generally used:

- Construction Sciences – Oak Flats, NSW
- Eurofins Environmental – Lane Cove West, NSW

Laboratory test certificates are included in **Appendix C,** along with environmental test results included in **Appendix D**. Laboratory testing was carried out in accordance with Australian Standard AS1289 'Laboratory Testing for Engineering Purposes'

3.2.5 Standpipes

Standpipes were installed in order to undertake falling head tests in accordance with the following methodology:

1. Wells were constructed using a combination of 50mm Class 18 PVC flush-jointed, threaded well screen and blank casing;
2. Annuluses of the wells were backfilled with sand up to 1.0m BGL followed by a 0.5m to 0.7m thick bentonite plug, overlain by excavation spoil up to ground level;
3. The wells were completed with 1.0m of stickup and capped at the top;
4. In-situ falling head test was undertaken through the installed PVC casing.
5. Upon completion of in-situ tests, the casing was removed and abandoned with spoil / select fill.

Standpipe installation details are provided in borehole logs in **Appendix B.**

4 ENCOUNTERED SUBSURFACE CONDITIONS

4.1 Subsurface Strata

A brief summary of the encountered sub-surface conditions within each investigatory location is provided below. For full description of the sub-surface profiles encountered at each investigatory location, reference can be made to the borehole logs provided in **Appendix B.**

The subsurface profile encountered across the subject site were as follows:

- Topsoil: comprising of Silty SAND underlain by;
- Residual Soil: consisting of Silty CLAY and Silty SAND.
- The subsurface profiles are summarized below in **Table 4-1** and presented in the engineering logs attached in **Appendix B** together with explanatory notes.

Table 4-1 Subsurface Profile Summary

BH ID	Topsoil	Residual Soil		TD / RD[1]	Groundwater Encountered[2]
	Silty SAND/ Silty CLAY/ Sandy CLAY	Silty SAND	Silty CLAY		
BH01[4]	0.0-0.1	0.1-0.4	0.4-TD	4.5	3.2
BH02	0.0-0.1	0.1-0.5	0.5-TD	4.5	3.6
BH03[4]	0.0-0.2	-	0.2-TD	4.5	3.0
BH04	0.0-0.1	-	0.1-RD	4.0	3.0
BH05	0.0-0.2	-	0.2-TD	4.5	3.0
BH06	0.0-0.2	-	0.2-RD	2.5	NE[3]
BH07	0.0-0.5	-	0.5-TD	1.5	NE[3]
BH08	0.0-0.5	-	0.5-TD	1.5	NE[3]

Notes;

1. TD = Termination Depth / RD = Refusal Depth;
2. Groundwater Depth measured from existing surface level;
3. NE: Not Encountered;
4. Standpipe was installed.

4.2 Groundwater and Permeability

4.2.1 Groundwater

Groundwater was generally encountered in boreholes located across the site. Groundwater level encountered at depths of approximately 3.0 to 3.6m from the surface.

It is expected that groundwater level may fluctuate depending on the time of the year and following periods of wet weather. Seepage may also occur through granular material and along the soil/rock interfaces during and after periods of wet weather.

4.2.2 In-situ Permeability Test

Two (2) in-situ falling head tests / slug tests were undertaken within the proposed area of the retention basin to measure in-situ permeability of the subsurface profiles. Test results were interpreted using the basic time lag method. The In-situ test results are presented below in **Table 4-2.**

Table 4-2 Permeability Test Results

BH	Test Depth (m bgl)	Hydraulic Conductivity (m)(m/sec)
BH01	1.0-4.5	4.32E-08
BH03	1.0-4.5	1.23E-08

The results were interpreted using the basic time lag method (Hvorsvlev, 1951). The basic time lag is defined as the time required for a full natural logarithmic cycle head drop. It is obtained graphically by plotting H/Ho on a log scale versus time. The intercept to the linear trend line at H/Ho = 0.37 provides the basic time lag. The shape factors were taken from Chapuis,1989. For this test, the time lag was extrapolated.

4.3 Laboratory Testing Results

Upon the completion of fieldworks, collected samples were returned to our laboratory for selection of laboratory testing. Laboratory tests were undertaken on select samples dependent on site specific features, founding stratums, etc. and to further validate the field log material classification descriptions.

4.3.1 Soil Properties and Classification

The results of material classification testing on selected samples are summarized below in **Tables 4-3 and 4-4**

Table 4-3 Geotechnical Laboratory Test Results

BH ID	Depth (m BSL)	Sand & Gravel (%)	Clay & Silt (%)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index(%)	Linear Shrinkage (%)	Emerson Crumb
BH01	2.0-2.5	23	77	13.6	46	17	29	15.0	2
BH04	2.5-3.0	38	62	17.0	38	16	22	12.0	2
BH03	2.0-2.5	44	72	65.0	44	16	28	14.5	2

Table 4-4 California Bearing Ratio (CBR) Test Results

TP ID	Depth (m BSL[1])	SMDD (t/m^3)[2]	OMC[3]	CBR(%)	Swell(%)
BH07	0.5-1.0	1.72	13.0	1.0	3.5
BH08	0.5-1.0	1.85	11.5	2.0	2.0

Notes;

1. Meters below surface level
2. Standard Maximum Dry Density
3. Optimum Moisture Content

CBR testing was undertaken on remoulded specimens compacted to a target 95% standard maximum dry density with a surcharge of 4.5kg and soaked for four days. Subgrade strength is moisture and density dependent and where the existing subgrade is compacted to less than 95% standard compaction and moistures above OMC exists, the in situ CBR values may be less than the above tested values.

4.3.2 Environmental Soil Aggressivity Results

Results of soil aggressivity tests on selected samples obtained from select borehole and considered representative of the soil and weathered rock profiles encountered across the site are summarised below in **Table 4-5.**

Table 4-5 Soil Aggressivity Table

Environmental Soil Aggressivity									
BH ID	Depth (m BSL)	Chloride (mg/kg)	pH	Conductivity (µS/cm)	Sulphate (mg/kg)	Moisture (%)	Resistivity (ohm.m)	Exposure Classification[1](AS 3600-2009)	Exposure Classification[2] (AS2159-2009)
BH01	0.5	670	6.5	360	130	24	28	A1	Non-Aggressive
BH01	3.5	3100	7.6	870	160	12	11	A1	Non-Aggressive
BH02	2.5	1400	7.9	660	200	9.1	15	A1	Non-Aggressive
BH03	2.0	1000	8.7	840	170	13	12	A1	Non-Aggressive
BH04	4.0	2100	7.5	1300	280	13	7.7	A1	Non-Aggressive
BH05	0.1	1100	7.2	480	260	29	21	A1	Non-Aggressive
BH05	1.5	710	8.3	430	180	24	23	A1	Non-Aggressive
BH05	2.5	1200	7.5	640	190	35	16	A1	Non-Aggressive
BH06	0.5	10	7.7	16	640	19	640	A1	Non-Aggressive

Notes:

1. Taken from Table 4.8.1 Exposure Classification for concrete in sulfate soils
2. Taken from Table 6.4.2 Exposure classification for concrete piles – piles in soil

4.3.3 Soil Salinity and Sodicity Results

Results of analytical testing of the soils at the site were compared to the following guideline values as shown in **Table 4-6 and Table 4-7,** derived from the Department of Land Water Conservation NSW, 2002; Site investigations for urban salinity. It is noted that the values provided in Site Investigations for urban salinity, were derived for agricultural purposes although are considered appropriate when used in conjunction with soil aggressivity values further outlined in this report.

Table 4-6 Salinity Class

Class	EC_e (dS/m)
Non – Saline	<2
Slightly Saline	2-4
Moderately saline	4-8
Very Saline	8-16
Highly Saline	>16

Table 4-7 Laboratory Salinity and Sodicity Classification

BH ID	Depth	Electrical Conductivity (uS/cm)	Soil Type	Multiplier	EC_e(dS/m)	Salinity Class	ESP(%)	Sodicity Rating
BH01	0.5	360	Silty Clay	8	2.88	Slightly Saline	33	Highly Sodic
BH01	3.5	870	Silty Clay	8	6.96	Moderately Saline	38	Highly Sodic
BH02	2.5	660	Silty Clay	8	5.28	Moderately Saline	35	Highly Sodic
BH03	2.0	840	Silty Clay	8	6.72	Moderately Saline	20	Highly Sodic
BH04	4.0	1300	Silty Clay	8	10.4	Very Saline	33	Highly Sodic
BH05	0.1	480	Silty Clay	8	3.84	Slightly Saline	26	Highly Sodic
BH05	1.5	430	Silty Clay	8	3.44	Slightly Saline	33	Highly Sodic
BH05	2.5	640	Silty Clay	8	5.12	Moderately Saline	27	Highly Sodic
BH06	0.5	16	Silty Clay	8	0.128	Non-Saline	3.9	Non-Sodic

5 GEOTECHNICAL ASSESSMENT

5.1 Subsurface Conditions

Subsurface conditions within the investigated areas were generally uniform, consisting of thin veneers of topsoil, varying between 200-400mm thick, overlying residual Clay stratum to a maximum target depth of 4.5m below surface level.

5.2 General Clay Soils Engineering Properties

Laboratory test results indicate that moisture content of encountered soils typically range between 13.6% and 65.0%.

Clay soil samples collected from all boreholes exhibit medium plasticity properties, However, it may be inferred from the laboratory test results that soils at shallower depths (e.g. <1m BGL) have lower plasticity characteristics.

Based on the Linear Shrinkage laboratory test results, it can be concluded that clay soils within the investigated areas have 'Marginal' to 'Critical' expansive rating with 'Medium' to 'High' potential volume change, in accordance with the classification provided by Public Works Department (1977), Mills et. Al. (1980), Hicks (2007).

Emerson Class numbers indicate that clay soils are generally moderately to highly reactive and / or disperse in water. Tunnelling Erosion is a major hazard considering the emersion class numbers to be 2. Considering the material type and emerson class numbers, the sediment export risk level of encountered materials can be categorised as 'Moderate' to 'High'.

5.3 Exposure Classification

In accordance with AS3600 (2009), exposure classification for concrete returned a value of A1 from the subsurface materials across the investigated areas. Future concrete structures should be designed in accordance with the concrete cover specifications in AS 3600 (2009) for an exposure classification of 'A1'.

5.4 Soil Salinity

Salinity and Sodicity of the subsurface materials can be categorised in **Table 5-1** for each of the investigated areas:

Table 5-1 Generalised Soil Salinity Condition

Area	Generalised Salinity Condition	Generalised Sodicity Condition
Basin V6	Moderately Saline	Highly Sodic
Basin C	Very Saline	Highly Sodic

5.5 Site Preparation

All site preparation work should be carried out in accordance with AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'

All soil containing grass and root material should be stripped from the construction and access areas prior to construction. This material is not considered suitable for use as structural fill but may be stockpiled for possible future landscaping purposes, if required.

Where any existing fill is encountered, it is considered that this fill was not placed in accordance with recognised standards and as such, much be deemed 'uncontrolled'. Removal of this fill and re-compaction of the fill to the standards discussed below is recommended.

5.6 Excavatability

Excavations will likely encounter stiff to hard clays within the area.

In light of this, soils should be readily excavated using conventional earthmoving equipment such as a hydraulic excavator with bucket attachment. Some light ripping may be required where seams of extremely to distinctly weathered rock are encountered. Rock breaker or ripping tyne attachment may be required for excavation of medium or higher strength shale.

While there is no direct reliable relationship between drilling resistance and excavatability, as a rule of thumb auger 'TC' bit refusal depth may be taken as an indication of limit of excavation for a medium sized dozer or large excavator.

Generally, below the 'TC' bit refusal depth, larger excavation equipment, hydraulic rock breakers, or compressor driven pneumatic tools would be required for excavation.

Care should also be taken to ensure that there is no surcharge from stockpiled materials and building or vehicular loads near the excavation depth beyond the crest of excavations.

5.7 Suitability of In Situ Clay Soils as Liner

The results of in-situ and laboratory permeability testing indicate that the clay material are of low permeability, and should be considered suitable to be used as a clay liner within the proposed basin areas. However, further testing and inspections will be required at the time of construction to ensure clay liner meets the design requirements.

5.8 Structural Fill Placement

Given the medium plastic nature of most of the soils encountered on site, handling and subsequent compaction difficulties will possibly be experienced during earthworks and construction of basins. The use of such materials as structural fill is not recommended. However, considering the low permeability properties, such material may be used in any of the proposed basins or other open areas of the site, provided the excavation and placement be carried out during the dry season, in order to minimize the construction issues.

Prior to any placement of any structural fill, the site should be proof rolled using a minimum 19 tonne vibrating pad foot roller. Should isolated soft/loose areas be encountered during this process, this material should be removed and replaced with select fill.

Depressions formed by the removal of vegetation should have all disturbed soil cleaned out and be backfilled with compacted select fill material.

To minimise the potential for post compaction volume, change due to moisture content variations, any structural clay bearing fill/fill containing cohesive strata should be placed in loose layers not greater than 200mm thick at a moisture content in the range -1% to +3% of the standard optimum moisture content, and be compacted to a minimum dry density ratio of 98% standard compaction as per AS1289 5.1.1.

Measures should be adopted to ensure that this clay fill material is not allowed to dry out prior to the placement of succeeding layers and final covering.

It is recommended that the placement of all structural fill be inspected, tested and certified by suitably qualified geotechnical engineers to Level 1 requirements, during the earthworks operations to ensure that all fill is placed in a 'controlled manner', in accordance with AS3798-2007

5.9 Drainage and Erosion

Salinity and Sodicity classifications as defined by the Site investigations for Urban Salinity from the Department of Land and Water Conservation are provided in Section 5.3. Sodic environments may prevent drainage during periods of wet weather and may result in tunnelling erosion if exposed. Furthermore, a significant amount of crops may be affected by highly saline soils.

Effective erosion and sedimentation control measures should be installed and maintained for the duration of the construction. Furthermore, adequate drainage of all working areas shall be maintained throughout the period of construction to ensure run-off of water without ponding except where ponding forms part of a planned erosion and sedimentation control system. Allowance should be made to designate nondispersive materials as a liner for the embankments and basin.

Consideration should also be given to the permeability of any proposed fill and foundation materials, and the depth and flow direction of groundwater at the site to verify the requirements for the design of any core or cut-off within the embankment and safely channel seepage water to the downstream section of the embankment.

5.10 Batter Slopes, Retaining Walls and Culvert Structures

Recommended maximum slopes for permanent and temporary batters are presented in **Table 5-2**

Table 5-2 Recommended Maximum Dry Batter

Unit	Max Permanent Batter Slope (H:V)	Max Temporary Batter Slope (H:V)
Residual Clay	2:1	1:1
Class V/IV Shale	1.5:1	0.75:1
Class III (or better) Shale	Vertical[1]	Vertical[1]

Note:

1. Subject to inspection and confirmation by a Geotechnical Engineer

5.11 Pavements

As presented in **Table 4-4,** laboratory soaked CBR tests indicate that the subgrade material has a swell of 2.0% - 3.5%. The material therefore has a "moderate" expansiveness for pavement design purposes. The test result for the specimens indicate CBR values in the range of 1.0% to 2.0%. Taking this into consideration a pavement design CBR of 1% is recommended for the site locality. Should field conditions at the time of construction indicate that field CBR is less than 1%, Cardno should be consulted to provide additional advice

6 ACID SULFATE SOILS ASSESSMENT

Acid Sulfate Soils Assessment has been undertaken in accordance with the requirements for the site. Details of the assessment are provided in the following sections.

6.1 General Parameters of Proposed Works

From the information provided, the proposed works involve excavation of two basins. As such, the following parameters of proposed works are assumed:

- Volume of soil to be disturbed >1000 tonnes.
- Maximum depth of disturbance is likely 3.3 mBGL associated with excavation and keying of the basins.
- Soil disturbance to be predominantly permanent, with excavation and construction of basins.
- Excavated soils are likely to be stockpiled onsite prior to disposal.
- Construction Sciences is not aware of any existing ASS issues at the Site.

6.2 Geomorphic / Site Criteria

The following geomorphic criteria has been used to determine the potential for PASS / ASS to be present on-site.

Acid Sulfate Soils

- Dominance of mangroves, reeds, marshes and other marine/estuarine or swamp-tolerant vegetation
- Low lying areas, back swamps or scalded/bare areas in coastal estuaries and floodplains
- Sulfurous smell after rain following a dry spell or when the soils are disturbed

Actual Acid Sulfate Soil

- Field pH ~4 in soils
- Presence of shell
- Any jarosite horizons or substantial iron oxide mottling in auger holes, in surface encrustations or in any material dredged or excavated and left exposed. Jarosite is a characteristic pale yellow mineral deposits which can be precipitate as pore fillings and coatings on fissures. In the situation of a fluctuating watertable, jarosite may be found along cracks and root channels in the soil. However, jarosite is not always found in actual acid sulfate soils.
- Water of pH < 5.5 in adjacent streams, drains, groundwater or ponding on the surface
- Unusually clear or milky blue-green drain water flowing from or within the area (aluminium released by the acid sulfate soils acts as a flocculating agent.)
- Extensive iron stains on any drain or pond surfaces, or iron-stained water and ochre deposits
- Scalded or bare low lying areas
- Corrosion of concrete and/or steel structures.

Potential Acid Sulfate Soils

- Waterlogged soils - unripe muds (soft, buttery, blue grey or dark greenish grey) or estuarine silty sands or sands (mid to dark grey) or bottom sediments of estuaries or tidal lakes (dark grey to black)
- Presence of shell
- Soil pH usually neutral but may be acid - positive Peroxide Test
- Water pH usually neutral but may be acidic.

6.3 Acid Sulfate Soils Criteria

The action criteria to determine the need for an Acid Sulfate Soil Management Plan (ASSMP) are detailed in the Acid Sulfate Soil Manual (ASSM), which includes values for acidity and the percentage of oxidisable sulfur for soil types broadly categorised as fine texture, medium texture, and coarse texture.

For the purpose of acid sulfate assessment, the soils have been classified in accordance with ASSM and are described as 'Fine Textured' being generally CLAY.

The action criteria are also based on the extent of the proposed ASS soil disturbance, with various trigger values for where greater than 1,000 tonnes are disturbed. Based on the expected scope of works (basin excavation), soil volumes greater than 1,000 tonnes would be expected to be disturbed.

The relevant action criteria where greater than 1,000 tonnes of soil are disturbed from Table 4.4 of ASSM is summarised as:

- A sulfur trail (percentage of oxidisable sulfur) of 0.03%, and an acid trail (Titratable Potential Acidity or Titratable Sulfidic Acidity) of 18 mole H+/tonne for coarse texture "sands to loamy sands".

6.4 Laboratory Results

6.4.1 Acid Sulfate Soils Field Screening

In accordance with the ASSM, pH values of less than or equal to 4 indicate that actual acid sulfate soils (AASS) are present. Potential acid sulphate soils (PASS) are indicated where oxidised pH values are less than 3.5 (preferably 3), and where the pH drop is more than 1 unit. Sample results for oxidised pH between 3.5 and 5 are considered inconclusive and analysis by SPOCAS or Chromium Reducible Sulfur is required.

The results of the ASS field screening tests (pH_F / pH_{FOX}) of 28 analysed samples returned the following results:

- Field pH values (pH_F) ranged between 6.2 (slight acidic) and 9.3 (highly alkaline).
- Peroxide pH values (pH_{FOX}) ranged between 4.5 (acidic) and 9.4 (highly alkaline).
- pH_F - pH_{FOX} differential (>1) was observed in 8 tested samples.

From the initial results, Actual Acid Sulfate Soils are unlikely to be present based on the field pH, and Potential Acid Sulfate Soils are also unlikely to be present based on the oxidised pH values.

For completeness, limited detailed analysis of two samples showing an oxidised pH of less than 5 was selected.

Tabulated analytical results are provided in **Appendix E** and laboratory analytical certificates are provided in **Appendix D.**

6.4.2 Detailed Analysis

Standard methods have been developed for routine analysis of soil samples for ASS and are described in the Laboratory Methods Guidelines in the ASS Manual. The principle analytical methods are:

- Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) analysis; and
- Chromium reducible Sulfur analysis (SCr).

SCr testing was selected as the preferred method for the site, and two samples were selected for detailed analysis based on the initial screening results (lowest oxidised pH).

The results of the detailed analysis of two samples revealed the following:

- pH KCl results ranged from 5.1 to 5.8 indicating Actual ASS are not present
- Chromium Reducible Sulfur was reported below the Limit of Reporting (LOR) and the assessment criteria
- Titratable Actual Acidity was detected below the assessment criteria with values ranging from 5.4 Moles H+/t to 13 Moles H+/t indicating some acidity in the material.

Based on the results obtained during the course of the investigation, ASS are unlikely to be present within the soils investigated.

7 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill, excavations, excavation retention (shoring, retaining wall) installation, unsupported cut and battered excavations, plant induced vibrations, groundwater seepage from excavation faces, ground settlement, exposed materials at foundation levels and sedimentation downslope of excavated areas be inspected, tested and certified where necessary, by a Geotechnical Engineer to ensure recommendations made in this report have been adhered to.

Should subsurface conditions other than those described in the report be encountered, Construction Sciences should be consulted immediately and appropriate modifications developed and implement if necessary.

8 Closure

We appreciate the opportunity to work collaboratively with you on this project. Our team looks forward to bringing our high level of expertise to deliver successful outcomes in your future projects.

Your attention is drawn to the appended document titled "*Important Information about this Geotechnical Report".* This document is intended to clarify to the reader what the realistic expectations of this report should be, and what is the correct use of the document. Misinterpretation of geotechnical information presents significant risk to projects: The document includes a discussion on general limitations of geotechnical services, which by nature, are based extensively on opinion and judgement.

The statements included in this document are not intended to be exculpatory clauses or to reduce the general responsibility accepted by Construction Sciences, but rather to identify where Construction Sciences and our Client's responsibilities lie. The statements ensure that all parties that may rely on the report are aware of their respective responsibilities.

For further enquiries, please do not hesitate to contact Construction Sciences on the information supplied.

Construction Sciences

Important Information about this Geotechnical Report

Scope of Work

The purpose of this report and any associated documentation is expressly stated in the document. This document does not form a complete assessment of the site, and no implicit determinations about Construction Sciences scope can be taken if not specifically referenced. Whilst this report is intended to reduce geotechnical risk, no level of detail or scope of work can entirely eliminate risk.

The nature of geotechnical data typically precludes auxiliary environmental assessment without undertaking specific methods in the investigation. Therefore, unless it is explicitly stated in the scope of work, this report does not provide any contamination or environmental assessment of the site or adjacent sites, nor can it be inferred or implied from any component of the document.

The scope of work, geotechnical information, and assessments made by Construction Sciences may be summarised in the report; however, all aspects of the document, including associated data and limitations should be reviewed in its entirety.

Standard of care

Construction Sciences have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, data that was available or was collected, and previous experience.

Construction Sciences findings and assessment represent its reasonable judgment, diligence, skill, with sound professional standards, within the time and budget constraints of its commission. No warranty, expressed or implied, is made as to the professional advice included in this report.

Data sources

In preparing this document, or providing any consulting services during the commission, Construction Sciences may have relied on information from third parties including, but not limited to; sub-consultants, published data, and the Client including its employees or representatives. This data may not be verified and Construction Sciences assumes no responsibility for the adequacy, incompleteness, inaccuracies, or reliability of this information.

Construction Sciences does not assume any responsibility for assessments made partly, or entirely based on information provided by third parties.

Variability in conditions and limitations of data

Subsurface conditions are complex and can be highly variable; they cannot be accurately defined by discrete investigations. Geotechnical data is based on investigation locations which are explicitly representative of the specific sample or test points. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and there are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted.

The precision and reliability of interpretive assessment between discrete points is dependent on the uniformity of the subsurface strata, as well as the frequency, detail, and method of sampling or testing.

Subsurface conditions are formed by various natural and anthropogenic processes and therefore are subject to change over time. This is particularly relevant with changes to the site ownership or usage, site boundary or layout, and design or planning modifications. Aspects of the site may also not be able to be determined due to physical or project related constraints and any information provided by Construction Sciences cannot apply following modification to the site, regulations, standards, or the development itself.

It is important to appreciate that no level of detail in investigation, or diligence in assessment, can eliminate uncertainty related to subsurface conditions and thus, geotechnical risk. Construction Sciences cannot and does not provide unqualified warranties nor does it assume any liability for site conditions not observed or accessible during the investigations.

Verification of opinions and recommendations

Geotechnical information, by nature, represents an opinion and is based extensively on judgment of both data and interpretive assessments or observation. This report and its associated documentation are provided explicitly based on Construction Sciences opinion of the site at the time of inspection, and cannot be extended beyond this.

Any recommendations or design are provided as preliminary until verified on site during project implementation or construction. Inspection and verification on site shall be conducted by a suitably qualified geotechnical consultant or engineer, and where subsurface conditions or interpretations differ from those provided in this document or otherwise anticipated, Construction Sciences must be notified and be provided with an opportunity to review the recommendations.

Client and copyright

This document is produced by Construction Sciences solely for the benefit and use by the Client in accordance with the terms of the engagement. Construction Sciences does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by any third party on the content of this document.

St Marys Detention Basins C and V6

APPENDIX A

SITE PLANS

Construction Sciences

lendlease

N

1:1,800 Scale at A3

m

0 20 40 60

St Mary's Basins Geotechnical Investigation

SITE PLAN

Construction Sciences

Map Produced by Construction Sciences
Professional Services NSW
Date: 2019-11-18
Coordinate System: GDA 1994 MGA Zone 56
Map: Site Plan Rev 3.mxd

St Marys Detention Basins C and V6

APPENDIX

B

BOREHOLE LOGS WITH EXPLANATORY NOTES

Construction Sciences

Construction Sciences

Explanatory Notes

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. Material descriptions are deduced from field observation or engineering examination, and may be appended or confirmed by in situ or laboratory testing. The information is dependent on the scope of investigation, the extent of sampling and testing, and the inherent variability of the conditions encountered.

Subsurface investigation may be conducted by one or a combination of the following methods.

Method	
Test Pitting: excavation/trench	
BH	Backhoe bucket
EX	Excavator bucket
R	Ripper
H	Hydraulic Hammer
X	Existing excavation
N	Natural exposure
Manual drilling: hand operated tools	
HA	Hand Auger
Continuous sample drilling	
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
Hammer drilling	
AH	Air hammer
AT	Air track
Spiral flight auger drilling	
AS	Auger screwing
AD/V	Continuous flight auger: V-bit
AD/T	Continuous spiral flight auger: TC-Bit
HFA	Continuous hollow flight auger
Rotary non-core drilling	
WB	Washbore drilling
RR	Rock roller
Rotary core drilling	
PQ	85mm core (wire line core barrel)
HQ	63.5mm core (wire line core barrel)
NMLC	51.94mm core (conventional core barrel)
NQ	47.6mm core (wire line core barrel)
DT	Diatube (concrete coring)

Sampling is conducted to facilitate further assessment of selected materials encountered.

Sampling method	
Soil sampling	
B	Bulk disturbed sample
D	Disturbed sample
C	Core sample
ES	Environmental soil sample
SPT	Standard Penetration Test sample
U	Thin wall tube ‘undisturbed’ sample
Water sampling	
WS	Environmental water sample

Field testing may be conducted as a means of assessment of the in situ conditions of materials.

Field testing	
SPT	Standard Penetration Test
HP/PP	Hand/Pocket Penetrometer
Dynamic Penetrometers (blows per noted increment)	
DCP	Dynamic Cone Penetrometer
PSP	Perth Sand Penetrometer
MC	Moisture Content
VS	Vane Shear
PBT	Plate Bearing Test
IMP	Borehole Impression Test
PID	Photo Ionization Detector

If encountered, refusal (R), virtual refusal (VR) or hammer bouncing (HB) of penetrometers may be noted.

The quality of the rock can be assessed by the degree of natural defects/fractures and the following.

Rock quality description	
TCR	Total Core Recovery (%) (length of core recovered divided by the length of core run)
RQD	Rock Quality Designation (%) (sum of axial lengths of core greater than 100mm long divided by the length of core run)

Notes on groundwater conditions encountered may include.

Groundwater	
Not Encountered	Excavation is dry in the short term
Not Observed	Water level observation not possible
Seepage	Water seeping into hole
Inflow	Water flowing/flooding into hole

Perched groundwater may result in a misleading indication of the depth to the true water table. Groundwater levels are also likely to fluctuate with variations in climatic and site conditions.

Notes on the stability of excavations may include.

Excavation conditions	
Stable	No obvious/gross short term instability noted
Spalling	Material falling into excavation (minor/major)
Unstable	Collapse of the majority, or one or more face of the excavation

Explanatory Notes: General Soil Description

The methods of description and classification of soils used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, a material is described as a soil if it can be remoulded by hand in its field condition or in water. The dominant component is shown in upper case, with secondary components in lower case. In general descriptions cover: soil type, plasticity or particle size/shape, colour, strength or density, moisture and inclusions.

In general, soil types are classified according to the dominant particle on the basis of the following particle sizes.

Soil Classification		Particle Size (mm)
CLAY		< 0.002
SILT		0.002 0.075
SAND	fine	0.075 to 0.21
	medium	0.21 to 0.6
	coarse	0.6 to 2.36
GRAVEL	fine	2.36 to 6.7
	medium	6.7 to 19
	coarse	19 to 63
COBBLES		63 to 200
BOULDERS		> 200

Soil types may be qualified by the presence of minor components on the basis of field examination methods and/or the soil grading.

Terminology	In coarse grained soils		In fine soils
	% fines	% coarse	% coarse
Trace	≤5	≤15	≤15
With	>5, ≤12	>15, ≤30	>15, ≤30

The strength of cohesive soils is classified by engineering assessment or field/lab testing as follows.

Strength	Symbol	Undrained shear strength
Very Soft	VS	≤12kPa
Soft	S	12kPa to ≤25kPa
Firm	F	25kPa to ≤50kPa
Stiff	St	50kPa to ≤100kPa
Very Stiff	VSt	100kPa to ≤200kPa
Hard	H	>200kPa

Cohesionless soils are classified on the basis of relative density as follows.

Relative Density	Symbol	Density Index
Very Loose	VL	<15%
Loose	L	15% to ≤35%
Medium Dense	MD	35% to ≤65%
Dense	D	65% to ≤85%
Very Dense	VD	>85%

The plasticity of cohesive soils is defined by the Liquid Limit (LL) as follows.

Plasticity	Silt LL	Clay LL
Low plasticity	≤ 35%	≤ 35%
Medium plasticity	N/A	> 35% ≤ 50%
High plasticity	> 50%	> 50%

The moisture condition of soil (*w*) is described by appearance and feel and may be described in relation to the Plastic Limit (PL), Liquid Limit (LL) or Optimum Moisture Content (OMC).

Moisture condition and description	
Dry	Cohesive soils: hard, friable, dry of plastic limit. Granular soils: cohesionless and free-running
Moist	Cool feel and darkened colour: Cohesive soils can be moulded. Granular soils tend to cohere
Wet	Cool feel and darkened colour: Cohesive soils usually weakened and free water forms when handling. Granular soils tend to cohere

The structure of the soil may be described as follows.

Zoning	Description
Layer	Continuous across exposure or sample
Lens	Discontinuous layer (lenticular shape)
Pocket	Irregular inclusion of different material

The structure of soil layers may include: defects such as softened zones, fissures, cracks, joints and root-holes; and coarse grained soils may be described as strongly or weakly cemented.

The soil origin may also be noted if possible to deduce.

Soil origin and description	
Fill	Anthropogenic deposits or disturbed material
Topsoil	Zone of soil affected by roots and root fibres
Peat	Significantly organic soils
Colluvial	Transported down slopes by gravity/water
Aeolian	Transported and deposited by wind
Alluvial	Deposited by rivers
Estuarine	Deposited in coastal estuaries
Lacustrine	Deposited in freshwater lakes
Marine	Deposits in marine environments
Residual soil	Soil formed by in situ weathering of rock, with no structure/fabric of parent rock evident
Extremely weathered material	Formed by in situ weathering of geological formations, with the structure/fabric of parent rock intact but with soil strength properties

The origin of the soil generally cannot be deduced solely on the appearance of the material and the inference may be supplemented by further geological evidence or other field observation. Where there is doubt, the terms ‘possibly’ or ‘probably’ may be used

Explanatory Notes: General Rock Description

The methods of description and classification of rocks used in this report are based on Australian Standard AS1726-2017 Geotechnical Site Investigations. In practice, if a material cannot be remoulded by hand in its field condition or in water, it is described as a rock. In general, descriptions cover: rock type, grain size, structure, colour, degree of weathering, strength, minor components or inclusions, and where applicable, the defect types, shape, roughness and coating/infill.

Rock types are generally described according to the predominant grain or crystal size, and in groups for each rock type as follows.

Rock type	Groups
Sedimentary	Deposited, carbonate (porous or non), volcanic ejection
Igneous	Felsic (much quartz, pale), Intermediate, or mafic (little quartz, dark)
Metamorphic	Foliated or non-foliated
Duricrust	Cementing minerology (iron oxides or hydroxides, silica, calcium carbonate, gypsum)

Reference should be made to AS1726 for details of the rock types and methods of classification.

The classification of rock weathering is described based on definitions in AS1726 and summarised as follows.

Term and symbol		Definition
Residual Soil	RS	Soil developed on rock with the mass structure and substance of the parent rock no longer evident
Extremely weathered	XW	Weathered to such an extent that the rock has 'soil-like' properties. Mass structure and substance still evident
Distinctly weathered	DW	The strength is usually changed and may be highly discoloured. Porosity may be increased by leaching, or decreased due to deposition in pores. May be distinguished into MW (Moderately Weathered) and HW (Highly Weathered).
Slightly weathered	SW	Slightly discoloured; little or no change of strength from fresh rock
Fresh Rock	FR	The rock shows no sign of decomposition or staining

The rock material strength can be defined based on the point load index as follows.

Term and symbol		Point Load Index I_s50 (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1.0
High	H	1.0 to 3
Very High	VH	3 to 10
Extremely High	EH	> 10

It is important to note that the rock material strength as above is distinct from the rock mass strength which can be significantly weaker due to the effect of defects.

A preliminary assessment of rock strength may be made using the field guide detailed in AS1726, and this is conducted in the absence of point load testing.

The defect spacing measured normal to defects of the same set or bedding, is described as follows.

Definition	Defect Spacing (mm)
Thinly laminated	< 6
Laminated	6 to 20
Very thinly bedded	20 to 60
Thinly bedded	60 to 200
Medium bedded	200 to 600
Thickly bedded	600 to 2000
Very thickly bedded	> 2000

Terms for describing rock and defects are as follows.

Defect Terms			
Joint	JT	Sheared zone	SZ
Bedding Parting	BP	Seam	SM
Foliation	FL	Vein	VN
Cleavage	CL	Drill Lift	DL
Crushed Seam	CS	Handling Break	HB
Fracture Zone	FZ	Drilling Break	DB

The shape and roughness of defects in the rock mass are described using the following terms.

Planarity		Roughness	
Planar	PR	Very Rough	VR
Curved	CU	Rough	RF
Undulose	UN	Smooth	S
Irregular	IR	Slickensided	SL
Stepped	ST	Polished	POL
Discontinuous	DIS		

The coating or infill associated with defects in the rock mass are described as follows.

Infill and Coating		
Clean	CN	
Stained	SN	
Carbonaceous	X	
Minerals	MU	Unidentified mineral
	MS	Secondary mineral
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
Veneer	VNR	Thin or patchy coating
Coating	CT	Infill up to 1mm

Construction Sciences

Graphic Symbols Index


CLAY


Silty CLAY


Sandy CLAY


Gravelly CLAY


Silty Gravelly CLAY


Silty Sandy CLAY


Sandy Gravelly


CLAY SILT


Clayey SILT


Sandy SILT Gravelly


SILT


Clayey Sandy SILT


Clayey Gravelly SILT


Sandy Gravelly SILT


SAND


Clayey SAND


Silty SAND


Gravelly SAND


Clayey Silty SAND


Clayey Gravelly SAND


Silty Gravelly SAND


GRAVEL


Clayey GRAVEL


Silty GRAVEL


Sandy GRAVEL


Clayey Silty GRAVEL


Clayey Sandy GRAVEL


Silty Sandy GRAVEL


COBBLES & BOULDERS


PEAT, highly organic soil


TOPSOIL


FILL


FILL: Asphalt or Bituminous Seal


FILL: Ballast


FILL: Concrete


FILL: Roadbase


Sedimentary rock: fine, mostly clay (CLAYSTONE)


Sedimentary rock: fine, mostly silt (SILTSTONE)


Sedimentary rock: fine, silt and clay (MUDSTONE, SHALE, LAMINITE)


Sedimentary rock: medium (SANDSTONE, GREYWACKE)

Sedimentary rock: fine to coarse, angular (BRECCIA)

Sedimentary rock: coarse, rounded (CONGLOMERATE)

Sedimentary rock: Organic (COAL)

Sedimentary rock: Carbonate (LIMESTONE, DOLOMITE)

Sedimentary rock: Volcanic (TUFF, VOLCANIC BRECCIA, AGGLOMERATE)

Igneous rock: Felsic, fine (RHYOLITE)

Igneous rock: Felsic, coarse (GRANITE)

Igneous rock: Mafic, fine to medium (BASALT, DOLERITE)

Igneous rock: Mafic, coarse (GABBRO)

Metamorphic rock: Foliated, fine to medium (SLATE, PHYLLITE, SHIST)

Metamorphic rock: Foliated, coarse (GNEISS)

Metamorphic rock: Non-foliated (QUARTZITE, HORNFELS, MARBLE)

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH01

Job No: 5017200065 **Sheet:** 1 of 1

Position: Basin V6 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP (blows per 100 mm)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
AD/T	E			ES 0.50 m	5 9 12 9 7 11 13 21 17 10 15 25 Refusal	0.10m		SM	Silty SAND: fine to medium grained, dark brown, with organics		D to VD	TOPSOIL	
						0.40m			Silty SAND: fine to coarse grained, pale brown			RESIDUAL SOIL	
									Silty CLAY: medium plasticity, orange mottled brown, with fine to coarse grained sand, trace fine to medium grained gravel				
				ES 1.00 m		1							
	H			ES 1.50 m						D			
				D 2.00 - 2.50 m ES 2.00 m		2					H		
				ES 2.50 m				CI					
				ES 3.00 m		3							
			08/11/19						3.20m: becoming brown				
				ES 3.50 m									
	F									M	St to VSt		
				ES 4.00 m		4			4.00m: becoming grey				
				ES 4.50 m		4.50m			TERMINATED AT 4.50 m Target depth				
						5							
						6							
						7							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH02

Job No: 5017200065 **Sheet:** 1 of 1

Position: Basin V6 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test	DCP (blows per 100 mm) 1 2 4 8		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E			ES 0.50 m	8 10 13 8 13 11 12 15 11 10			SM	0.10m Silty SAND: fine to medium grained, dark brown, with organics Silty SAND: fine to coarse grained, pale brown 0.50m		D to VD	TOPSOIL RESIDUAL SOIL
				ES 1.00 m	15 12 10 12 13 12 11 8	1			Silty CLAY: medium plasticity, orange mottled brown, with fine to coarse grained sand, trace fine to medium grained gravel			
				ES 1.50 m						D		
	H			D 2.00 - 2.50 m ES 2.00 m	7 8	2					VSt to H	
				ES 2.50 m	7 8 9 8 9			CI				
				U50 3.00 - 3.50 m		3						
			07/11/19	ES 3.50 m					3.60m: turning grey			
	F			ES 4.00 m		4				M	St to VSt	
				ES 4.50 m					4.50m TERMINATED AT 4.50 m Target depth			
						5						
						6						
						7						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH03

Job No: 5017200065 **Sheet:** 1 of 1

Position: Basin C **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	DCP (blows per 100 mm) 1 2 4 8	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
AD/T	E			ES 0.50 m	10 8 10	0			0.20m Silty SAND: fine to medium grained, dark brown, with rootlets			TOPSOIL	
									Silty CLAY: medium plasticity, brown mottled orange, with fine to coarse grained sand, trace fine to medium grained gravel			RESIDUAL SOIL	
				ES 1.00 m	10 9 10 7	1							
	H			ES 1.50 m	9 6 5					D	VSt to H		
				D 2.00 - 2.50 m ES 2.00 m	6 5 6 7	2		Cl					
				ES 2.50 m	9 10 12 15								
			08/11/19	ES 3.00 m		3			3.00m: turning orange brown mottled grey				
	F			ES 3.50 m						M	St to VSt		
				ES 4.00 m		4			4.50m				
				ES 4.50 m					TERMINATED AT 4.50 m Target depth				
						5							
						6							
						7							

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

CS 2.01.7.GLB Log CARDNO NON-CORED 5017200065 - ST MARYS BASINS - LOGS.GPJ <<DrawingFile>> 18/11/2019 09:20 10.0.000 Datgel AGS RTA, Photo, Monitoring Tools

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH04

Job No: 5017200065 **Sheet:** 1 of 1

Position: Basin C **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test	DCP (blows per 100 mm) 1 2 4 8		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E			ES 0.50 m	6 7 11 10 9 10 7 10	0			0.10m Silty SAND: fine to medium grained, dark brown, with organics	D		TOPSOIL
									Silty CLAY: medium plasticity, orange mottled brown, with fine to coarse grained sand, trace fine to medium grained gravel		VSt to H	RESIDUAL SOIL
				ES 1.00 m	6 4	1						
	H			ES 1.50 m	6 4 5					M	St to VSt	
				ES 2.00 m	3 6 12 10 8 10	2		CI				
				D 2.50 - 3.00 m ES 2.50 m	9 10						VSt to H	
			07/11/19	ES 3.00 m	14 15	3			3.00m: turning grey			
	F			ES 3.50 m						W	St to VSt	
									4.00m			
				ES 4.00 m		4			TERMINATED AT 4.00 m Refusal			
						5						
						6						
						7						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH05

Job No: 5017200065 **Sheet:** 1 of 1

Position: Basin C **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test	DCP (blows per 100 mm) 1 2 4 8		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E			ES 0.50 m	3 5 6 / 5 6 / 4 3 4 6	0			0.20m Silty SAND: fine to medium grained, dark brown, with rootlets			TOPSOIL
									Silty CLAY: medium plasticity, brown mottled orange, with fine to coarse grained sand, trace fine to medium grained gravel			RESIDUAL SOIL
											St to VSt	
				ES 1.00 m	9 10 / 8 9 10	1						
	H			D 1.50 - 2.00 m ES 1.50 m	11 / 8 9					D		
				ES 2.00 m U50 2.00 - 2.50 m	14 16 / 13 18 / 25 Refusal	2		CI			VSt to H	
				ES 2.50 m								
			07/11/19	ES 3.00 m		3			3.00m: turning brown mottled grey			
	F			ES 3.50 m						M	St to VSt	
				ES 4.00 m		4			4.50m			
				ES 4.50 m					TERMINATED AT 4.50 m Target depth			
						5						
						6						
						7						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH06

Job No: 5017200065 **Sheet:** 1 of 1

Position: Basin C **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test	DCP (blows per 100 mm) 1 2 4 8		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E		Not Encountered	ES 0.50 m	3 5 6 8 10 13 18 25	0			0.20m Silty SAND: fine to medium grained, dark brown, with organics			TOPSOIL
	H			ES 1.00 m		1		CI	Silty CLAY: medium plasticity, orange mottled brown, with fine to coarse grained sand, trace fine to medium grained gravel	D	VSt to H	RESIDUAL SOIL
				ES 1.50 m								
	VH			ES 2.00 m		2			2.50m			
				ES 2.50 m		3			TERMINATED AT 2.50 m Refusal			
						4						
						5						
						6						
						7						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH07

Job No: 5017200065 **Sheet:** 1 of 1

Position: Haul Road **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Sampling & Testing: DCP (blows per 100 mm)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E		Not Encountered		8 12 11 9 11				Silty SAND: fine to medium grained, dark brown, with organics			TOPSOIL
									0.50m			
	F			B 0.50 - 1.00 m	9 10 12 7 10	1		CI	Silty CLAY: medium plasticity, orange mottled brown, with fine to coarse grained sand, trace fine to medium grained gravel	D	VSt to H	RESIDUAL SOIL
					8 10 9				1.50m			
									TERMINATED AT 1.50 m Target depth			

DCP (blows per 100 mm): 1 2 4 8

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

CS 2.01.7.GLB Log CARDNO NON-CORED 5017200065 - ST MARYS BASINS - LOGS.GPJ <<DrawingFile>> 18/11/2019 09:20 10.0.000 Datgel AGS RTA, Photo, Monitoring Tools

Construction Sciences

BOREHOLE LOG SHEET

Client: Lendlease
Project: St Mary Basins Geotechnical Investigation
Location: Jordan Springs

Hole No: BH08

Job No: 5017200065 **Sheet:** 1 of 1

Position: Haul Road **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Ute Mounted Drill Rig **Mounting:** ute-mounted **Driller:** DM
Casing Diameter: **Contractor:** Stratacore
Date Started: 7/11/19 **Date Completed:** 7/11/19 **Logged By:** JA **Checked By:** AT

Drilling			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test	DCP (blows per 100 mm) 1 2 4 8		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
AD/T	E		Not Encountered						Silty SAND: fine to medium grained, dark brown			TOPSOIL
									0.50m			
	F			B 0.50 - 1.00 m	7 10 7 9 10 11 10	1		CI	Silty CLAY: medium plasticity, brown mottled orange, with fine to coarse grained sand, trace fine to medium grained gravel	D	VSt to H	RESIDUAL SOIL
									1.50m			
									TERMINATED AT 1.50 m Target depth			
						2						
						3						
						4						
						5						
						6						
						7						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
DT Diatube

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES

St Marys Detention Basins C and V6

APPENDIX

C

GEOTECHNICAL LABORATORY TEST CERTIFICATES

Construction Sciences

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

EMERSON CLASS NUMBER REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16020-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	14/11/2019 Page 1 of 1

Test Procedures:	AS1289.3.8.1

Sample Number	10848/S/44158	10848/S/44159	10848/S/44161	
ID / Client ID	-	-	-	
Lot Number	-	-	-	
Date / Time Sampled	7/11/2019	7/11/2019	7/11/2019	
Date Tested	14/11/2019	14/11/2019	14/11/2019	
Material Source	Insitu	Insitu	Insitu	
Material Type	Silty CLAY	Silty CLAY	Silty CLAY	
Sampling Method	Tested As Received	Tested As Received	Tested As Received	
Water Type	Distled water	Distled water	Distiled water	
Water Temperature (C°)	24	24	24	
Client Sample ID	BH01	BH04	BH03	
	2-2.5m	2.5-3m	2-2.5m	
Soil Description	Sandy Silty CLAY	Sandy Silty CLAY	Silty CLAY	
Emerson Class Number	**2**	**2**	**2**	

Remarks	Results apply to the sample/s as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Tim Mathie
Form ID: W34Rep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

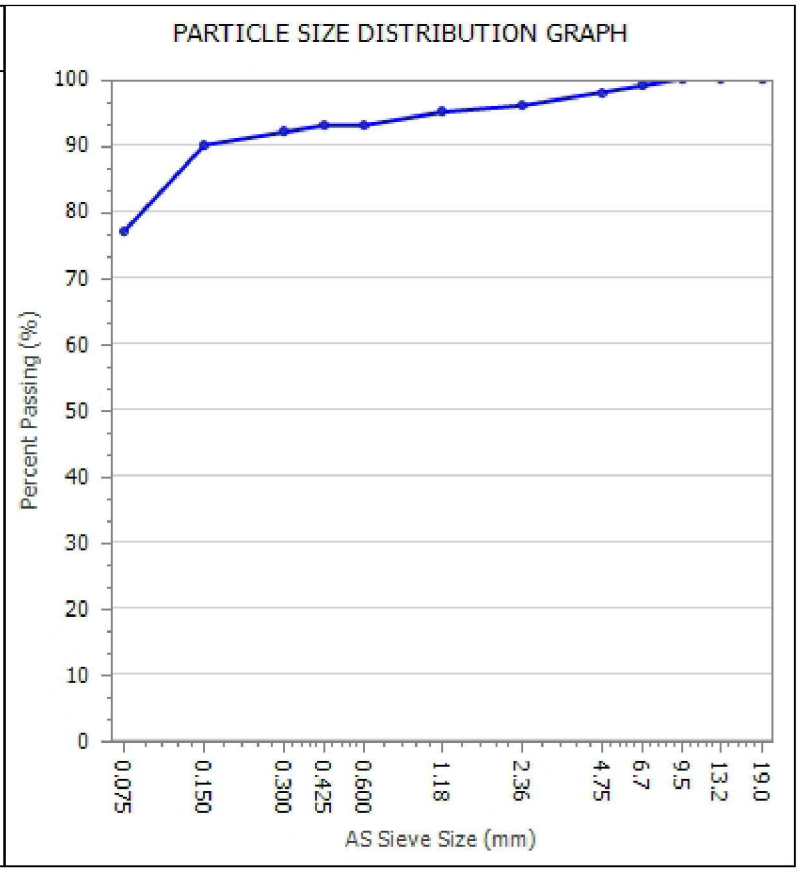
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16058-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	15/11/2019 Page 1 of 3

Test Procedures:	AS1289.3.6.1

Sample Number	10848/S/44158	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH01
Date Sampled	7/11/2019		2-2.5m
Sampled By	Client Sampled		
Date Tested	14/11/2019		
Material Source	Insitu	Material Type	Silty CLAY

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
13.2		**100**	
9.5		**100**	
6.7		**99**	
4.75		**98**	
2.36		**96**	
1.18		**95**	
0.600		**93**	
0.425		**93**	
0.300		**92**	
0.150		**90**	
0.075		**77**	



Remarks	Results apply to the sample/s as received.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W9Rep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

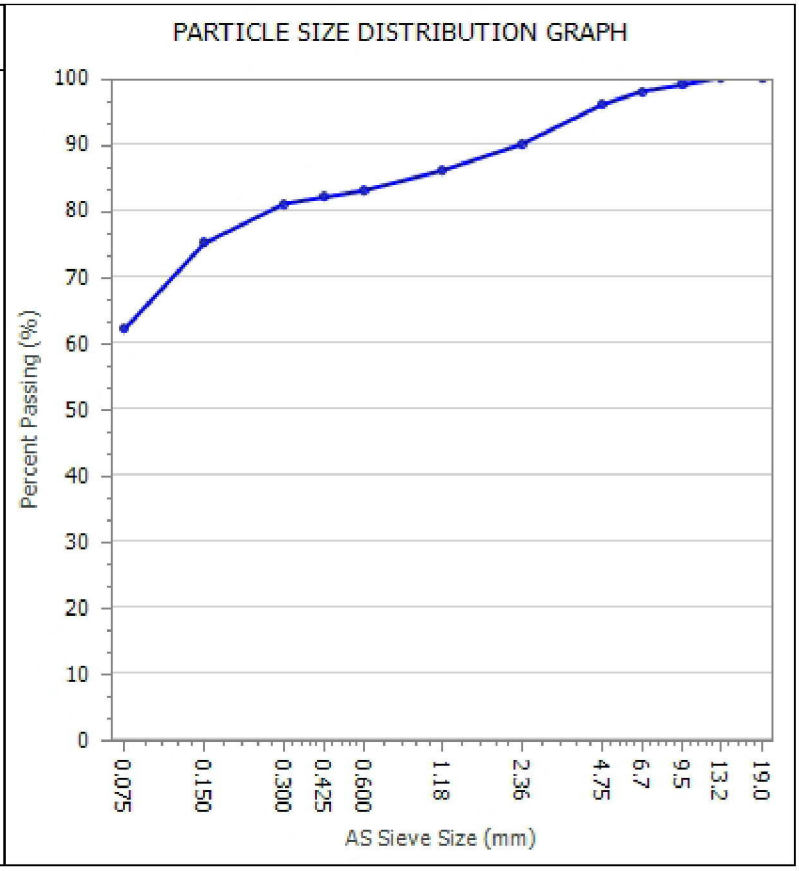
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16058-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	15/11/2019 Page 2 of 3

Test Procedures: AS1289.3.6.1

Sample Number	10848/S/44159	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH04
Date Sampled	7/11/2019		2.5-3m
Sampled By	Client Sampled		
Date Tested	13/11/2019		
Material Source	Insitu	Material Type	Silty CLAY

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
13.2		**100**	
9.5		**99**	
6.7		**98**	
4.75		**96**	
2.36		**90**	
1.18		**86**	
0.600		**83**	
0.425		**82**	
0.300		**81**	
0.150		**75**	
0.075		**62**	



Remarks: Results apply to the sample/s as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W9Rep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

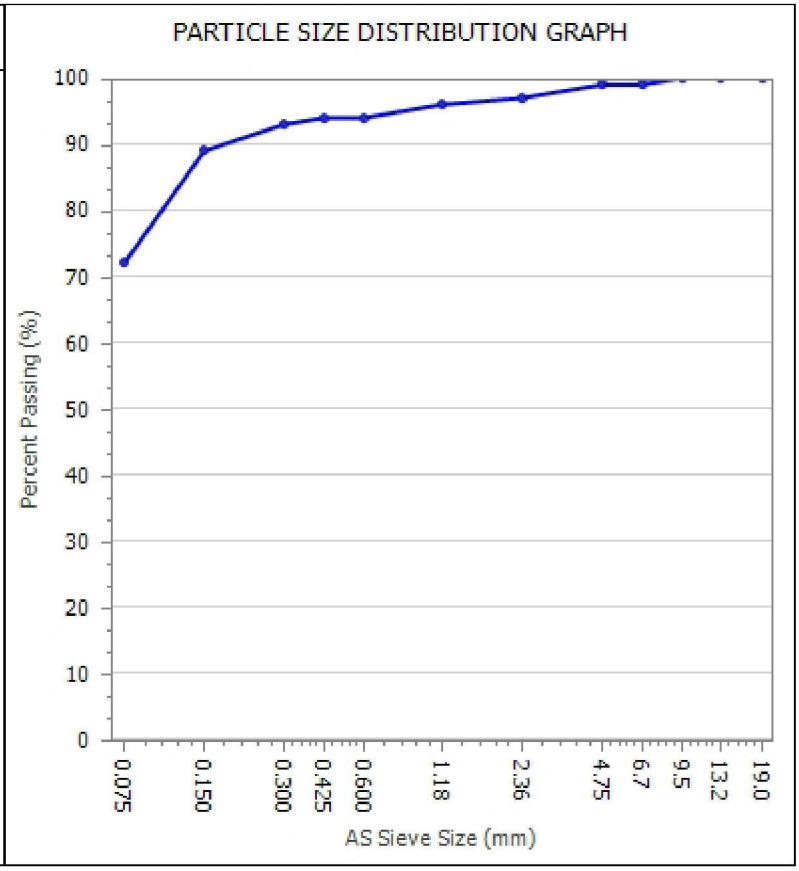
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16058-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	15/11/2019 Page 3 of 3

Test Procedures:	AS1289.3.6.1

Sample Number	10848/S/44161	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH03
Date Sampled	7/11/2019		2-2.5m
Sampled By	Client Sampled		
Date Tested	14/11/2019		
Material Source	Insitu	Material Type	Silty CLAY

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
13.2		**100**	
9.5		**100**	
6.7		**99**	
4.75		**99**	
2.36		**97**	
1.18		**96**	
0.600		**94**	
0.425		**94**	
0.300		**93**	
0.150		**89**	
0.075		**72**	



Remarks	Results apply to the sample/s as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W9Rep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

MOISTURE CONTENT REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16059-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	15/11/2019 Page 1 of 1

Test Procedures:	AS1289.2.1.1

Sample Number	10848/S/44158	10848/S/44159	10848/S/44161	
ID / Client ID	-	-	-	
Lot Number	-	-	-	
Date / Time Sampled	7/11/2019	7/11/2019	7/11/2019	
Sampling Method	Tested As Received	Tested As Received	Tested As Received	
Sampled By	Client Sampled	Client Sampled	Client Sampled	
Tested By	Joshua Quinn	Joshua Quinn	Joshua Quinn	
Date Tested	14/11/2019	14/11/2019	14/11/2019	
Material Source	Insitu	Insitu	Insitu	
Material Type	Silty CLAY	Silty CLAY	Silty CLAY	
Client Sample ID	BH01 2-2.5m	BH04 2.5-3m	BH03 2-2.5m	
Moisture Content (%)	**13.6**	**17.0**	**65.0**	

Sample Number				
ID / Client ID				
Lot Number				
Date / Time Sampled				
Sampled By				
Tested By				
Sampling Method				
Date Tested				
Material Source				
Material Type				
Client Sample ID				
Moisture Content (%)				

Remarks	Results apply to the sample/s as received.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W20Rep Rev 3

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16060-2
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	18/11/2019 Page 1 of 3

Test Procedures:	AS1289.3.1.1, AS 1289.3.3.1, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1		
Sample Number	10848/S/44158	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH01
Date Sampled	7/11/2019		2-2.5m
Sampled By	Client Sampled		
Date Tested	14/11/2019		
Att. Drying Method	Oven Dried	Material Source	Insitu
Atterberg Preparation	Dry Sieved	Material Type	Silty CLAY
Material Description	Sandy Silty CLAY		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**46**	
Plastic Limit (%)		**17**	
Plasticity Index (%)		**29**	
Linear Shrinkage (%)		**15.0**	
Linear Shrinkage Mould Length / Defects:	Mould Length: 250.2mm / Curling		

Remarks	Re-Issued Report Replaces Report No 10848/R/16060-1 (reason: Linear Shrinkage result added to report)., Results apply to the sample/s as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W11bRep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16060-2
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	18/11/2019 Page 2 of 3

Test Procedures:	AS1289.3.1.1, AS 1289.3.3.1, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1		
Sample Number	10848/S/44159	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH04
Date Sampled	7/11/2019		2.5-3m
Sampled By	Client Sampled		
Date Tested	14/11/2019		
Att. Drying Method	Oven Dried	Material Source	Insitu
Atterberg Preparation	Dry Sieved	Material Type	Silty CLAY
Material Description	Sandy Silty CLAY		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**38**	
Plastic Limit (%)		**16**	
Plasticity Index (%)		**22**	
Linear Shrinkage (%)		**12.0**	
Linear Shrinkage Defects:	Curling		

Remarks	Re-Issued Report Replaces Report No 10848/R/16060-1 (reason: Linear Shrinkage result added to report)., Results apply to the sample/s as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W11bRep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

ATTERBERG LIMITS REPORT

Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16060-2
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	18/11/2019 Page 3 of 3

Test Procedures:	AS1289.3.1.1, AS 1289.3.3.1, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1

Sample Number	10848/S/44161	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH03
Date Sampled	7/11/2019		2-2.5m
Sampled By	Client Sampled		
Date Tested	14/11/2019		
Att. Drying Method	Oven Dried	Material Source	Insitu
Atterberg Preparation	Dry Sieved	Material Type	Silty CLAY
Material Description	Sandy Silty CLAY		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**44**	
Plastic Limit (%)		**16**	
Plasticity Index (%)		**28**	
Linear Shrinkage (%)		**14.5**	
Linear Shrinkage Defects:	Curling		

Remarks	Re-Issued Report Replaces Report No 10848/R/16060-1 (reason: Linear Shrinkage result added to report)., Results apply to the sample/s as received.

NATA

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Troy Gasseling
Form ID: W11bRep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

CALIFORNIA BEARING RATIO REPORT

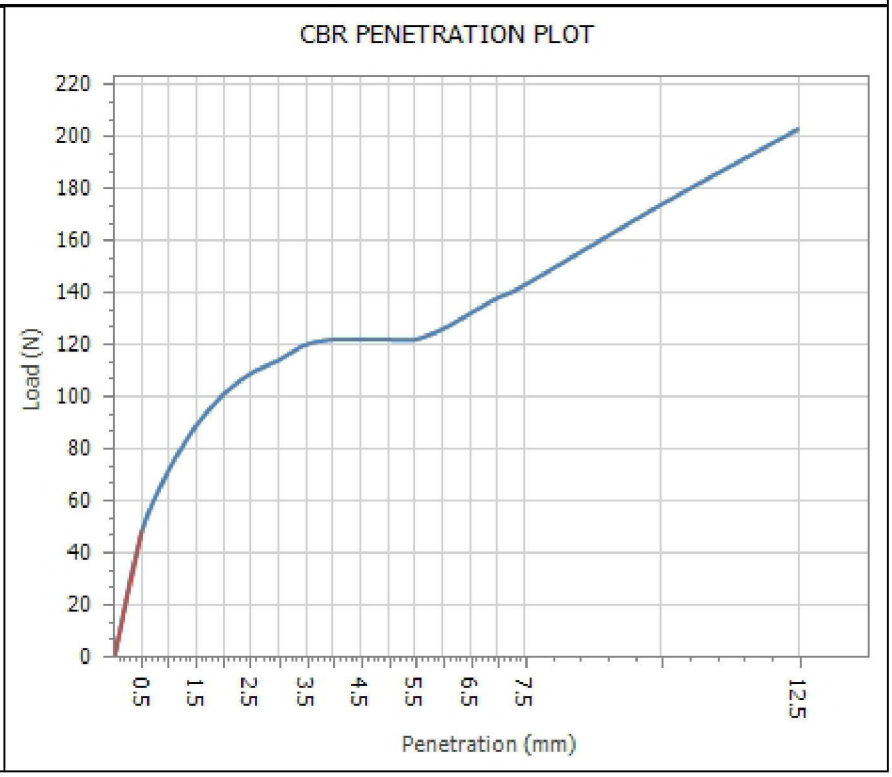
Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16240-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	20/11/2019 Page 1 of 2

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1

Sample Number	10848/S/44163	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH07 0.5-1m
Date Sampled	7/11/2019		
Sampled By	Client Sampled		
Date Tested	19/11/2019		
Material Source	Insitu	Material Limit Start	-
Material Type	Silty CLAY	Material Limit End	-
Client Reference	-	Compactive Effort	Standard

Material Description	(CL) Silty CLAY

Maximum Dry Density (t/m³):	1.72
Optimum Moisture Content (%):	13.0
Field Moisture Content (%):	11.6
Sample Percent Oversize (%)	0.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	95
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.62
Placement Dry Density Ratio (%):	94.5
Placement Moisture Content (%):	13.0
Placement Moisture Ratio (%):	101.0
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.57
Total Curing Time (hrs)	51
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	26.5
Moisture (remainder) After Soak (%)	22.1
CBR Swell (%):	3.5
Minimum CBR Specification (%):	-
CBR Value @ 2.5mm (%):	**1.0**



Remarks	Results apply to the sample/s as received.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Chris Newman
Form ID: W2ASRep Rev2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 140 Industrial Road
Oak Flats NSW 2529

Laboratory: **Wollongong Laboratory**
Phone: 02 4257 4458
Fax: 02 4257 4463
Email: wollongong@constructionsciences.net

CALIFORNIA BEARING RATIO REPORT

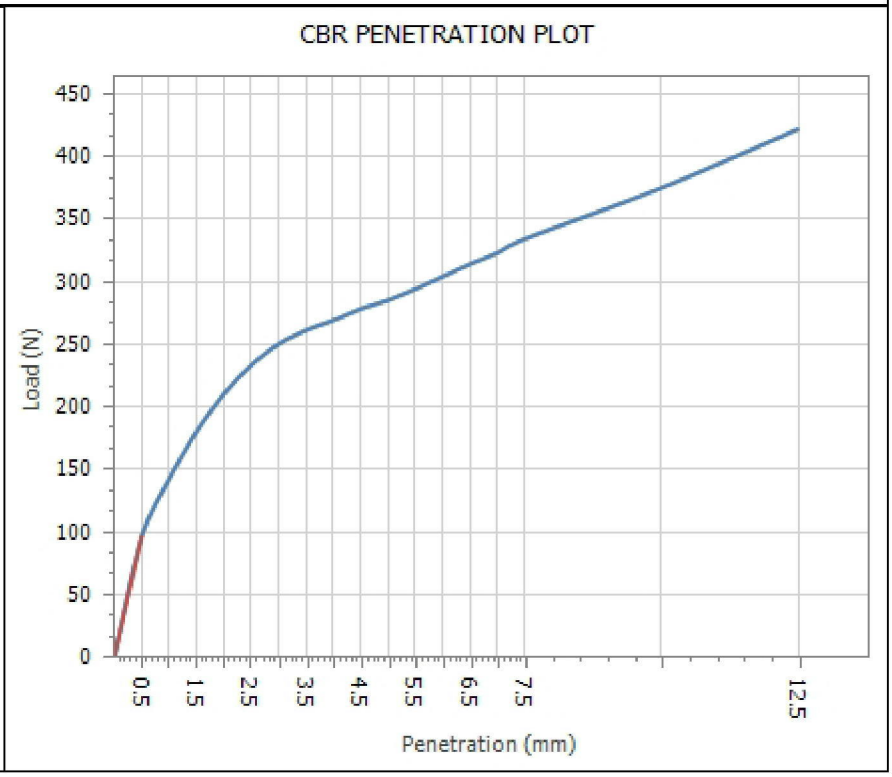
Client:	Construction Sciences Professional Services Seven Hills	Report Number:	10848/R/16240-1
Client Address:	31 Anvil Road, Seven Hills	Project Number:	10848/P/401
Project:	Material Testing - Seven Hills	Lot Number:	
Location:	Seven Hills	Internal Test Request:	10848/T/10037
Supplied To:	Construction Sciences Professional Services Seven Hills	Client Reference/s:	5017200065
Area Description:		Report Date / Page:	20/11/2019 Page 2 of 2

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1

Sample Number	10848/S/44164	Sample Location	
Sampling Method	Tested As Received	Client Sample ID	BH08 0.5-1m
Date Sampled	7/11/2019		
Sampled By	Client Sampled		
Date Tested	19/11/2019		
Material Source	Insitu	Material Limit Start	-
Material Type	Silty CLAY	Material Limit End	-
Client Reference	-	Compactive Effort	Standard

Material Description	Silty CLAY

Maximum Dry Density (t/m³):	1.85
Optimum Moisture Content (%):	11.5
Field Moisture Content (%):	9.3
Sample Percent Oversize (%)	0.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	95
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.75
Placement Dry Density Ratio (%):	95.0
Placement Moisture Content (%):	11.4
Placement Moisture Ratio (%):	100.0
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.72
Total Curing Time (hrs)	48
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	18.3
Moisture (remainder) After Soak (%)	18.6
CBR Swell (%):	2.0
Minimum CBR Specification (%):	-
CBR Value @ 2.5mm (%):	**2.0**



Remarks	Results apply to the sample/s as received.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 10848

Approved Signatory: Chris Newman
Form ID: W2ASRep Rev2

Construction Sciences

VARIABLE HEAD PERMEABILITY TEST

SITE	BH01	Report Revision:	1
PROJECT	St Mary's Basins	Piezometer Depth:	4.50 mBGL

INITIAL CONDITIONS

Test Carried out on	Standpipe	
Base of Standpipe	4.50	mBGL
Top of Standpipe	-1.00	mBGL
Top of Screen (Top Response Zone)	1.00	mBGL
Bottom of Screen (Bottom Response Zone)	4.50	mBGL
Diameter of Borehole	110.00	mm
Diameter of Casing	50.00	mm
Elevation of Surface	-	m RL
Groundwater Level (Below Top of Pipe)	4.20	m

Operator	JB
Date	7/11/2019
Checked by	AT
Time	2pm
Weather	Sunny
Response Length	3.50 m
Response Zone Materials	Clay

TEST CALCULATION

Intake Factor, F

F= 4.45 (i)

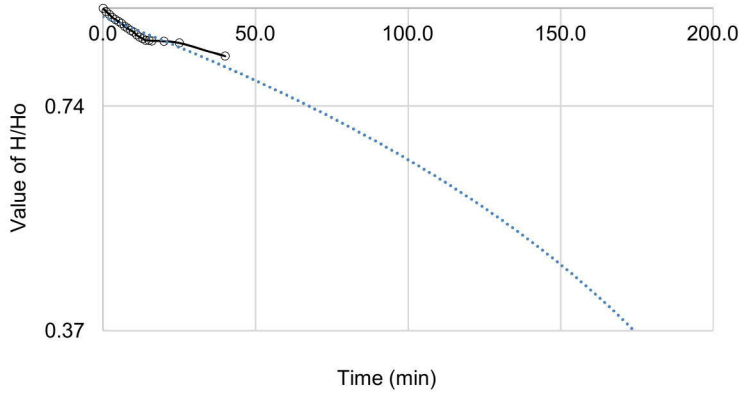
Permeability, K

$$K=\frac{A}{F.T} \quad \text{(iii)}$$

Where T is the Basic Time Lag Factor
corresponding to an H/Ho value of 0.37
BS 5930: 1999 Figure 8

L=	3.50	m	
D=	0.050	m	
L/D=	70		
A=	0.00196	m^2	
F=	4.45		From (i)
T=	10230	s	corresponding to an H/Ho value of 0.37
K=	**4.32E-08**	m/s	From (iii)

Remarks



Elapsed (minutes)	Total seconds	Water Depth (m) (from top of pipe)	Head (metres)	H/Ho
0.0	0	0	4.20	1.00
1.0	60	0.04	4.16	0.99
2.0	120	0.075	4.13	0.98
3.0	180	0.115	4.09	0.97
4.0	240	0.14	4.06	0.97
5.0	300	0.165	4.04	0.96
6.0	360	0.19	4.01	0.95
7.0	420	0.225	3.98	0.95
8.0	480	0.25	3.95	0.94
9.0	540	0.275	3.93	0.93
10.0	600	0.295	3.91	0.93
11.0	660	0.33	3.87	0.92
12.0	720	0.355	3.85	0.92
13.0	780	0.375	3.83	0.91
14.0	840	0.395	3.81	0.91
15.0	900	0.395	3.81	0.91
16.0	960	0.4	3.80	0.90
20.0	1200	0.405	3.80	0.90
25.0	1500	0.425	3.78	0.90
40.0	2400	0.575	3.63	0.86

VARIABLE HEAD PERMEABILITY TEST

SITE	BH03	Report Revision:	1
PROJECT	St Mary's Basins	Piezometer Depth:	4.50 mBGL

INITIAL CONDITIONS

Test Carried out on	Standpipe	
Base of Standpipe	4.50	mBGL
Top of Standpipe	-1.35	mBGL
Top of Screen (Top Response Zone)	1.00	mBGL
Bottom of Screen (Bottom Response Zone)	4.50	mBGL
Diameter of Borehole	110.00	mm
Diameter of Casing	50.00	mm
Elevation of Surface	-	m RL
Groundwater Level (Below Top of Pipe)	4.90	m

Operator	JB	
Date	7/11/2019	
Checked by	AT	
Time	2pm	
Weather	Sunny	
Response Length	3.50	m
Response Zone Materials	Clay	

TEST CALCULATION

Intake Factor, F

F= 4.45 (i)

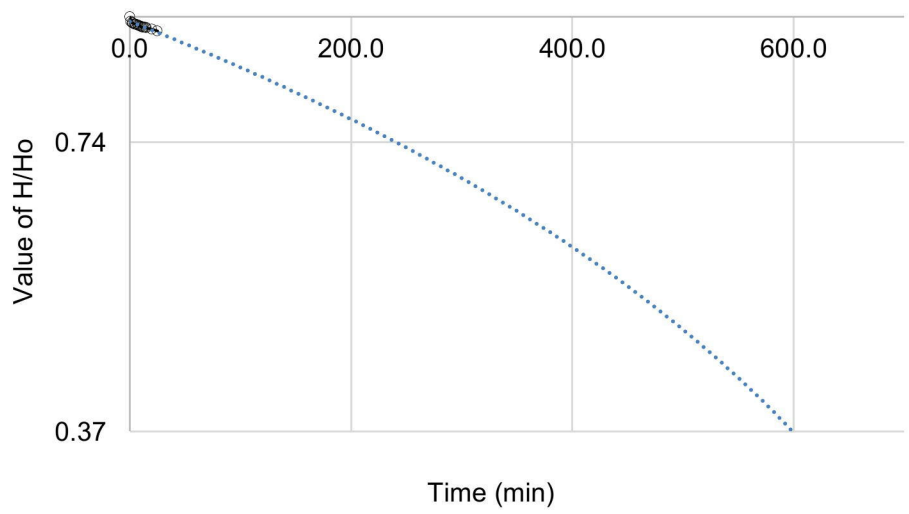
Permeability, K

$$K=\frac{A}{F.T} \quad \text{(iii)}$$

Where T is the Basic Time Lag Factor
corresponding to an H/Ho value of 0.37
BS 5930: 1999 Figure 8

L=	3.50	m	
D=	0.050	m	
L/D=	70		
A=	0.00196	m^2	
F=	4.45		From (i)
T=	36000	s	corresponding to an H/Ho value of 0.37
K=	**1.23E-08**	m/s	From (iii)

Remarks



Elapsed (minutes)	Total seconds	Water Depth (m) (from top of pipe)	Head (metres)	H/Ho
0.0	0	0	4.90	1.00
1.0	60	0.055	4.85	0.99
2.0	120	0.07	4.83	0.99
3.0	180	0.075	4.83	0.98
4.0	240	0.085	4.82	0.98
5.0	300	0.09	4.81	0.98
6.0	360	0.095	4.81	0.98
7.0	420	0.1	4.80	0.98
8.0	480	0.105	4.80	0.98
9.0	540	0.11	4.79	0.98
10.0	600	0.115	4.79	0.98
11.0	660	0.12	4.78	0.98
12.0	720	0.125	4.78	0.97
13.0	780	0.125	4.78	0.97
14.0	840	0.125	4.78	0.97
15.0	900	0.13	4.77	0.97
20.0	1200	0.145	4.76	0.97
25.0	1500	0.165	4.74	0.97

36000

St Marys Detention Basins C and V6

APPENDIX

D

ENVIRONMENTAL LABORATORY TEST CERTIFICATES

Construction Sciences

Construction Sciences Pty Ltd
2/4 Kellogg Rd
Glendenning
NSW 2761

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Jhan-Paule Arbizo**

Report **687081-S**
Project name ST MARY BASINS GEOTECHNICAL INVESTIGATION
Project ID 5017200065
Received Date Nov 08, 2019

Client Sample ID			**BH01 0.5**	**BH01 3.5**	**BH02 2.5**	**BH03 2.0**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**S19-No11341**	**S19-No11342**	**S19-No11343**	**S19-No11344**
Date Sampled			**Nov 07, 2019**	**Nov 07, 2019**	**Nov 07, 2019**	**Nov 07, 2019**
Test/Reference	LOR	Unit				
Chloride	5	mg/kg	670	3100	1400	1000
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	360	870	660	840
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	6.5	7.6	7.9	8.7
Resistivity*	0.5	ohm.m	28	11	15	12
Sulphate (as SO4)	30	mg/kg	130	160	200	170
Exchangeable Sodium Percentage (ESP)	0.1	%	33	38	35	20
Magnesium (exchangeable)	0.1	meq/100g	2.7	3.5	4.7	7.4
Potassium (exchangeable)	0.1	meq/100g	< 0.1	< 0.1	0.1	0.1
Sodium (exchangeable)	0.1	meq/100g	1.4	2.2	2.7	2.8
% Moisture	1	%	24	12	9.1	13
Cation Exchange Capacity						
Calcium (exchangeable)	0.1	meq/100g	0.3	0.1	0.1	3.4
Cation Exchange Capacity	0.05	meq/100g	4.3	5.8	7.6	14

Client Sample ID			**BH04 4.0**	**BH05 0.1**	**BH05 1.5**	**BH05 2.5**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**S19-No11345**	**S19-No11346**	**S19-No11347**	**S19-No11348**
Date Sampled			**Nov 07, 2019**	**Nov 07, 2019**	**Nov 07, 2019**	**Nov 07, 2019**
Test/Reference	LOR	Unit				
Chloride	5	mg/kg	2100	1100	710	1200
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	1300	480	430	640
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	7.5	7.2	8.3	7.5
Resistivity*	0.5	ohm.m	7.7	21	23	16
Sulphate (as SO4)	30	mg/kg	280	260	180	190
Exchangeable Sodium Percentage (ESP)	0.1	%	33	26	33	27
Magnesium (exchangeable)	0.1	meq/100g	5.5	7.5	5.9	7.3
Potassium (exchangeable)	0.1	meq/100g	< 0.1	0.2	< 0.1	< 0.1
Sodium (exchangeable)	0.1	meq/100g	3.2	3.1	3.4	3.3
% Moisture	1	%	13	29	24	35
Cation Exchange Capacity						
Calcium (exchangeable)	0.1	meq/100g	1.0	1.0	1.0	1.3
Cation Exchange Capacity	0.05	meq/100g	9.7	12	10	12

Client Sample ID			BH06 0.5
Sample Matrix			Soil
Eurofins Sample No.			S19-No11349
Date Sampled			Nov 07, 2019
Test/Reference	LOR	Unit	
Chloride	5	mg/kg	10
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	16
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	7.7
Resistivity*	0.5	ohm.m	640
Sulphate (as SO4)	30	mg/kg	63
Exchangeable Sodium Percentage (ESP)	0.1	%	3.9
Magnesium (exchangeable)	0.1	meq/100g	4.6
Potassium (exchangeable)	0.1	meq/100g	0.2
Sodium (exchangeable)	0.1	meq/100g	0.4
% Moisture	1	%	19
Cation Exchange Capacity			
Calcium (exchangeable)	0.1	meq/100g	5.9
Cation Exchange Capacity	0.05	meq/100g	11

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Melbourne	Nov 12, 2019	28 Days
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
pH (1:5 Aqueous extract at 25°C as rec.)	Melbourne	Nov 12, 2019	7 Days
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Melbourne	Nov 12, 2019	28 Days
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Nov 12, 2019	7 Days
- Method: LTM-INO-4030 Conductivity			
Magnesium (exchangeable)	Melbourne	Nov 13, 2019	180 Days
- Method: LTM-MET-3060 Cation Exchange Capacity and ESP			
Potassium (exchangeable)	Melbourne	Nov 13, 2019	180 Days
- Method: LTM-MET-3060 Cation Exchange Capacity and ESP			
Sodium (exchangeable)	Melbourne	Nov 13, 2019	180 Days
- Method: LTM-MET-3060 Cation Exchange Capacity and ESP			
Cation Exchange Capacity	Melbourne	Nov 13, 2019	180 Days
- Method: LTM-MET-3060 Cation Exchange Capacity by bases & Exchangeable Sodium Percentage			
Exchangeable Sodium Percentage (ESP)	Melbourne	Nov 13, 2019	28 Days
- Method: LTM-MET-3060 - Cation Exchange Capacity (CEC) & Exchangeable Sodium Percentage (ESP)			
% Moisture	Melbourne	Nov 08, 2019	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Construction Sciences Pty Ltd
Address: 2/4 Kellogg Rd
Glendenning
NSW 2761

Project Name: ST MARY BASINS GEOTECHNICAL INVESTIGATION
Project ID: 5017200065

Order No.:
Report #: 687081
Phone: 02 9854 1700
Fax:

Received: Nov 8, 2019 1:24 PM
Due: Nov 15, 2019
Priority: 5 Day
Contact Name: Jhan-Paule Arbizo

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						HOLD	Aggressivity Soil Set	Eurofins | mgt Suite B20	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							X	X	X
Sydney Laboratory - NATA Site # 18217						X			
Brisbane Laboratory - NATA Site # 20794									
Perth Laboratory - NATA Site # 23736									
External Laboratory									
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**				
1	BH01 0.5	Nov 07, 2019		Soil	S19-No11341		X	X	X
2	BH01 3.5	Nov 07, 2019		Soil	S19-No11342		X	X	X
3	BH02 2.5	Nov 07, 2019		Soil	S19-No11343		X	X	X
4	BH03 2.0	Nov 07, 2019		Soil	S19-No11344		X	X	X
5	BH04 4.0	Nov 07, 2019		Soil	S19-No11345		X	X	X
6	BH05 0.1	Nov 07, 2019		Soil	S19-No11346		X	X	X
7	BH05 1.5	Nov 07, 2019		Soil	S19-No11347		X	X	X
8	BH05 2.5	Nov 07, 2019		Soil	S19-No11348		X	X	X
9	BH06 0.5	Nov 07, 2019		Soil	S19-No11349		X	X	X

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Construction Sciences Pty Ltd
Address: 2/4 Kellogg Rd
Glendenning
NSW 2761

Project Name: ST MARY BASINS GEOTECHNICAL INVESTIGATION
Project ID: 5017200065

Order No.:
Report #: 687081
Phone: 02 9854 1700
Fax:

Received: Nov 8, 2019 1:24 PM
Due: Nov 15, 2019
Priority: 5 Day
Contact Name: Jhan-Paule Arbizo

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						HOLD	Aggressivity Soil Set	Eurofins | mgt Suite B20	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							X	X	X
Sydney Laboratory - NATA Site # 18217						X			
Brisbane Laboratory - NATA Site # 20794									
Perth Laboratory - NATA Site # 23736									
10	BH04 0.5	Nov 07, 2019		Soil	S19-No11350	X			
Test Counts						1	9	9	9

eurofins | Environment Testing

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

**NOTE: pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
ug/L: micrograms per litre
ppm: Parts per million
ppb: Parts per billion
%: Percentage
org/100mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/kg	< 5			5	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	uS/cm	< 10			10	Pass	
Sulphate (as SO4)	mg/kg	< 30			30	Pass	
Exchangeable Sodium Percentage (ESP)	%	< 0.1			0.1	Pass	
Magnesium (exchangeable)	meq/100g	< 0.1			0.1	Pass	
Potassium (exchangeable)	meq/100g	< 0.1			0.1	Pass	
Sodium (exchangeable)	meq/100g	< 0.1			0.1	Pass	
Method Blank							
Cation Exchange Capacity							
Calcium (exchangeable)	meq/100g	< 0.1			0.1	Pass	
Cation Exchange Capacity	meq/100g	< 0.05			0.05	Pass	
LCS - % Recovery							
Chloride	%	116			70-130	Pass	
Sulphate (as SO4)	%	92			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Sulphate (as SO4)	B19-No14414	NCP	%	83			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	B19-No14413	NCP	mg/kg	230	240	4.0	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	S19-No11341	CP	uS/cm	360	410	15	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	S19-No11341	CP	pH Units	6.5	6.4	pass	30%	Pass	
Resistivity*	S19-No11341	CP	ohm.m	28	24	15	30%	Pass	
Sulphate (as SO4)	B19-No14413	NCP	mg/kg	< 30	< 30	<1	30%	Pass	
% Moisture	B19-No08231	NCP	%	5.8	5.7	2.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (1:5 aqueous extract at 25°C as rec.)	S19-No11347	CP	uS/cm	430	440	1.0	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	S19-No11347	CP	pH Units	8.3	8.1	pass	30%	Pass	
Resistivity*	S19-No11347	CP	ohm.m	23	23	1.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Ursula Long	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Julie Kay	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Cardno (NSW/ACT) Pty Ltd
Level 9, 203 Pacific Highway
St Leonards
NSW 2065

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Ben Withnall**

Report **687087-S**
Project name JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID 89914020
Received Date Nov 08, 2019

Client Sample ID			BH01_0.5	BH01_1.5	BH01_2.5	BH01_3.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11385	S19-No11387	S19-No11389	S19-No11391
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	6.9	7.7	7.8	7.8
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	4.8	6.8	7.1	7.1
Reaction Ratings*[S05]		comment	2.0	4.0	4.0	4.0

Client Sample ID			BH01_4.5	BH02_0.5	BH02_1.5	BH02_2.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11393	S19-No11395	S19-No11397	S19-No11399
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	7.9	6.2	7.3	7.2
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	7.8	5.9	6.8	6.3
Reaction Ratings*[S05]		comment	4.0	4.0	4.0	4.0

Client Sample ID			BH02_3.5	BH02_4.5	BH03_0.5	BH03_1.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11401	S19-No11403	S19-No11405	S19-No11406
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	7.1	7.5	6.7	8.4
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	5.9	6.1	6.0	8.5
Reaction Ratings*[S05]		comment	4.0	4.0	4.0	4.0

Client Sample ID			BH03_2.0	BH03_3.0	BH03_4.0	BH04_0.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11408	S19-No11410	S19-No11412	S19-No11415
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	8.8	9.3	9.0	8.5
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	8.7	9.4	9.2	8.7
Reaction Ratings*[S05]		comment	4.0	4.0	4.0	4.0

Client Sample ID			BH04_1.5	BH04_2.5	BH04_3.5	BH05_0.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11417	S19-No11419	S19-No11421	S19-No11423
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	8.4	8.6	8.6	7.1
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	8.9	8.7	8.8	4.5
Reaction Ratings*[S05]		comment	4.0	4.0	4.0	4.0

Client Sample ID			BH05_0.5	BH05_1.5	BH05_2.5	BH05_3.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11424	S19-No11426	S19-No11428	S19-No11430
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	7.7	8.1	8.4	8.5
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	6.6	8.2	8.6	8.8
Reaction Ratings*[S05]		comment	4.0	4.0	4.0	4.0

Client Sample ID			BH05_4.5	BH06_0.5	BH06_1.0	BH06_1.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			S19-No11432	S19-No11434	S19-No11435	S19-No11436
Date Sampled			Nov 07, 2019	Nov 07, 2019	Nov 07, 2019	Nov 07, 2019
Test/Reference	LOR	Unit				
Acid Sulfate Soils Field pH Test						
pH-F (Field pH test)*	0.1	pH Units	8.6	7.9	7.7	7.2
pH-FOX (Field pH Peroxide test)*	0.1	pH Units	8.8	5.7	6.5	5.3
Reaction Ratings*[S05]		comment	4.0	4.0	4.0	4.0

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Acid Sulfate Soils Field pH Test	Brisbane	Nov 12, 2019	7 Days

- Method: LTM-GEN-7060 Determination of field pH (pHF) and field pH peroxide (pHFOX) tests

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Project Name: JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID: 89914020

Order No.:
Report #: 687087
Phone: 0294967700
Fax: 02 9499 3902

Received: Nov 8, 2019 5:14 PM
Due: Nov 12, 2019
Priority: 2 Day
Contact Name: Ben Withnall

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						CANCELLED	HOLD	Acid Sulfate Soils Field pH Test
Melbourne Laboratory - NATA Site # 1254 & 14271								
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794						X	X	X
Perth Laboratory - NATA Site # 23736								
External Laboratory								
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**			
1	BH01_0.0	Nov 07, 2019		Soil	S19-No11384		X	
2	BH01_0.5	Nov 07, 2019		Soil	S19-No11385			X
3	BH01_1.0	Nov 07, 2019		Soil	S19-No11386		X	
4	BH01_1.5	Nov 07, 2019		Soil	S19-No11387			X
5	BH01_2.0	Nov 07, 2019		Soil	S19-No11388		X	
6	BH01_2.5	Nov 07, 2019		Soil	S19-No11389			X
7	BH01_3.0	Nov 07, 2019		Soil	S19-No11390		X	
8	BH01_3.5	Nov 07, 2019		Soil	S19-No11391			X
9	BH01_4.0	Nov 07, 2019		Soil	S19-No11392		X	

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Order No.:
Report #: 687087
Phone: 0294967700
Fax: 02 9499 3902

Received: Nov 8, 2019 5:14 PM
Due: Nov 12, 2019
Priority: 2 Day
Contact Name: Ben Withnall

Project Name: JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID: 89914020

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						CANCELLED	HOLD	Acid Sulfate Soils Field pH Test
Melbourne Laboratory - NATA Site # 1254 & 14271								
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794						X	X	X
Perth Laboratory - NATA Site # 23736								
10	BH01_4.5	Nov 07, 2019		Soil	S19-No11393			X
11	BH02_0.0	Nov 07, 2019		Soil	S19-No11394		X	
12	BH02_0.5	Nov 07, 2019		Soil	S19-No11395			X
13	BH02_1.0	Nov 07, 2019		Soil	S19-No11396		X	
14	BH02_1.5	Nov 07, 2019		Soil	S19-No11397			X
15	BH02_2.0	Nov 07, 2019		Soil	S19-No11398		X	
16	BH02_2.5	Nov 07, 2019		Soil	S19-No11399			X
17	BH02_3.0	Nov 07, 2019		Soil	S19-No11400		X	
18	BH02_3.5	Nov 07, 2019		Soil	S19-No11401			X
19	BH02_4.0	Nov 07, 2019		Soil	S19-No11402		X	
20	BH02_4.5	Nov 07, 2019		Soil	S19-No11403			X
21	BH03_0.0	Nov 07, 2019		Soil	S19-No11404		X	

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Project Name: JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID: 89914020

Order No.:
Report #: 687087
Phone: 0294967700
Fax: 02 9499 3902

Received: Nov 8, 2019 5:14 PM
Due: Nov 12, 2019
Priority: 2 Day
Contact Name: Ben Withnall

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						CANCELLED	HOLD	Acid Sulfate Soils Field pH Test
Melbourne Laboratory - NATA Site # 1254 & 14271								
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794						X	X	X
Perth Laboratory - NATA Site # 23736								
22	BH03_0.5	Nov 07, 2019		Soil	S19-No11405			X
23	BH03_1.0	Nov 07, 2019		Soil	S19-No11406			X
24	BH03_1.5	Nov 07, 2019		Soil	S19-No11407		X	
25	BH03_2.0	Nov 07, 2019		Soil	S19-No11408			X
26	BH03_2.5	Nov 07, 2019		Soil	S19-No11409		X	
27	BH03_3.0	Nov 07, 2019		Soil	S19-No11410			X
28	BH03_3.5	Nov 07, 2019		Soil	S19-No11411		X	
29	BH03_4.0	Nov 07, 2019		Soil	S19-No11412			X
30	BH03_4.5	Nov 07, 2019		Soil	S19-No11413		X	
31	BH04_0.0	Nov 07, 2019		Soil	S19-No11414		X	
32	BH04_0.5	Nov 07, 2019		Soil	S19-No11415			X
33	BH04_1.0	Nov 07, 2019		Soil	S19-No11416		X	

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Project Name: JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID: 89914020

Order No.:
Report #: 687087
Phone: 0294967700
Fax: 02 9499 3902

Received: Nov 8, 2019 5:14 PM
Due: Nov 12, 2019
Priority: 2 Day
Contact Name: Ben Withnall

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						CANCELLED	HOLD	Acid Sulfate Soils Field pH Test
Melbourne Laboratory - NATA Site # 1254 & 14271								
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794						X	X	X
Perth Laboratory - NATA Site # 23736								
34	BH04_1.5	Nov 07, 2019		Soil	S19-No11417			X
35	BH04_2.0	Nov 07, 2019		Soil	S19-No11418		X	
36	BH04_2.5	Nov 07, 2019		Soil	S19-No11419			X
37	BH04_3.0	Nov 07, 2019		Soil	S19-No11420		X	
38	BH04_3.5	Nov 07, 2019		Soil	S19-No11421			X
39	BH04_4.0	Nov 07, 2019		Soil	S19-No11422		X	
40	BH05_0.0	Nov 07, 2019		Soil	S19-No11423			X
41	BH05_0.5	Nov 07, 2019		Soil	S19-No11424			X
42	BH05_1.0	Nov 07, 2019		Soil	S19-No11425		X	
43	BH05_1.5	Nov 07, 2019		Soil	S19-No11426			X
44	BH05_2.0	Nov 07, 2019		Soil	S19-No11427		X	
45	BH05_2.5	Nov 07, 2019		Soil	S19-No11428			X

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Cardno (NSW/ACT) Pty Ltd
Address: Level 9, 203 Pacific Highway
St Leonards
NSW 2065

Project Name: JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID: 89914020

Order No.:
Report #: 687087
Phone: 0294967700
Fax: 02 9499 3902

Received: Nov 8, 2019 5:14 PM
Due: Nov 12, 2019
Priority: 2 Day
Contact Name: Ben Withnall

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						CANCELLED	HOLD	Acid Sulfate Soils Field pH Test
Melbourne Laboratory - NATA Site # 1254 & 14271								
Sydney Laboratory - NATA Site # 18217								
Brisbane Laboratory - NATA Site # 20794						X	X	X
Perth Laboratory - NATA Site # 23736								
46	BH05_3.0	Nov 07, 2019		Soil	S19-No11429		X	
47	BH05_3.5	Nov 07, 2019		Soil	S19-No11430			X
48	BH05_4.0	Nov 07, 2019		Soil	S19-No11431		X	
49	BH05_4.5	Nov 07, 2019		Soil	S19-No11432			X
50	BH06_0.0	Nov 07, 2019		Soil	S19-No11433		X	
51	BH06_0.5	Nov 07, 2019		Soil	S19-No11434			X
52	BH06_1.0	Nov 07, 2019		Soil	S19-No11435			X
53	BH06_1.5	Nov 07, 2019		Soil	S19-No11436			X
54	BH06_2.0	Nov 07, 2019		Soil	S19-No11437	X		
55	BH06_2.5	Nov 07, 2019		Soil	S19-No11438	X		
Test Counts						2	25	28

eurofins | Environment Testing

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

**NOTE: pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
ug/L: micrograms per litre
ppm: Parts per million
ppb: Parts per billion
%: Percentage
org/100mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Acid Sulfate Soils Field pH Test				Result 1	Result 2	RPD			
pH-F (Field pH test)*	S19-No11385	CP	pH Units	6.9	6.8	pass	30%	Pass	
Reaction Ratings*	S19-No11385	CP	comment	2.0	2.0	pass	30%	Pass	
Duplicate									
Acid Sulfate Soils Field pH Test				Result 1	Result 2	RPD			
pH-F (Field pH test)*	S19-No11405	CP	pH Units	6.7	6.7	pass	30%	Pass	
Reaction Ratings*	S19-No11405	CP	comment	4.0	4.0	pass	30%	Pass	
Duplicate									
Acid Sulfate Soils Field pH Test				Result 1	Result 2	RPD			
pH-F (Field pH test)*	S19-No11424	CP	pH Units	7.7	7.7	pass	30%	Pass	
Reaction Ratings*	S19-No11424	CP	comment	4.0	4.0	pass	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
S05	Field Screen uses the following fizz rating to classify the rate the samples reacted to the peroxide: 1.0; No reaction to slight. 2.0; Moderate reaction. 3.0; Strong reaction with persistent froth. 4.0; Extreme reaction.

Authorised By

Ursula Long	Analytical Services Manager
Myles Clark	Senior Analyst-SPOCAS (QLD)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Cardno (NSW/ACT) Pty Ltd
Level 9, 203 Pacific Highway
St Leonards
NSW 2065

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Ben Withnall**

Report **688210-S**
Project name JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT
Project ID 89914020
Received Date Nov 15, 2019

Client Sample ID			**BH01_0.5**	**BH05_0.0**
Sample Matrix			**Soil**	**Soil**
Eurofins Sample No.			**B19-No21134**	**B19-No21135**
Date Sampled			**Nov 07, 2019**	**Nov 07, 2019**
Test/Reference	LOR	Unit		
Chromium Suite				
pH-KCL	0.1	pH Units	5.1	5.8
Acid trail - Titratable Actual Acidity	2	mol H+/t	13	5.4
sulfidic - TAA equiv. S% pyrite	0.003	% pyrite S	0.020	0.010
Chromium Reducible Sulfur[S04]	0.005	% S	< 0.005	< 0.005
Chromium Reducible Sulfur -acidity units	3	mol H+/t	< 3	< 3
Sulfur - KCl Extractable	0.02	% S	n/a	n/a
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0
HCl Extractable Sulfur	0.02	% S	n/a	n/a
Net Acid soluble sulfur	0.02	% S	n/a	n/a
Net Acid soluble sulfur - acidity units	10	mol H+/t	n/a	n/a
Net Acid soluble sulfur - equivalent S% pyrite[S02]	0.02	% S	n/a	n/a
Acid Neutralising Capacity (ANCbt)	0.01	% CaCO3	n/a	n/a
Acid Neutralising Capacity - acidity (a-ANCbt)	2	mol H+/t	n/a	n/a
Acid Neutralising Capacity - equivalent S% pyrite (s-ANCbt)[S03]	0.02	% S	n/a	n/a
ANC Fineness Factor		factor	1.5	1.5
CRS Suite - Net Acidity (Sulfur Units)	0.02	% S	0.02	< 0.02
CRS Suite - Net Acidity (Acidity Units)	10	mol H+/t	13	< 10
CRS Suite - Liming Rate[S01]	1	kg CaCO3/t	< 1	< 1
Extraneous Material				
<2mm Fraction	0.005	g	36	28
>2mm Fraction	0.005	g	2.4	3.4
Analysed Material	0.1	%	94	89
Extraneous Material	0.1	%	6.2	11
% Moisture	1	%	11	11

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chromium Reducible Sulfur Suite			
Chromium Suite	Brisbane	Nov 15, 2019	6 Week
- Method: LTM-GEN-7070			
Extraneous Material	Brisbane	Nov 15, 2019	6 Week
- Method: LTM-GEN-7050/7070			
% Moisture	Brisbane	Nov 15, 2019	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name:	Cardno (NSW/ACT) Pty Ltd	**Order No.:**		**Received:**	Nov 15, 2019 8:30 AM
Address:	Level 9, 203 Pacific Highway St Leonards NSW 2065	**Report #:**	688210	**Due:**	Nov 20, 2019
		Phone:	0294967700	**Priority:**	3 Day
		Fax:	02 9499 3902	**Contact Name:**	Ben Withnall
Project Name:	JORDAN SPRINGS VILLAGE 6 NINTH AVE PRECINCT				
Project ID:	89914020				

Eurofins Analytical Services Manager : Ursula Long

Sample Detail						Chromium Reducible Sulfur Suite	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794						X	X
Perth Laboratory - NATA Site # 23736							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH01_0.5	Nov 07, 2019		Soil	B19-No21134	X	X
2	BH05_0.0	Nov 07, 2019		Soil	B19-No21135	X	X
Test Counts						2	2

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

**NOTE: pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
ug/L: micrograms per litre
ppm: Parts per million
ppb: Parts per billion
%: Percentage
org/100mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
LCS - % Recovery									
Chromium Suite									
Chromium Reducible Sulfur			%	103			70-130	Pass	
Acid Neutralising Capacity (ANCbt)			%	103			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Chromium Suite				Result 1	Result 2	RPD			
pH-KCL	B19-No21514	NCP	pH Units	7.5	7.5	<1	30%	Pass	
Acid trail - Titratable Actual Acidity	B19-No21514	NCP	mol H+/t	< 2	< 2	<1	30%	Pass	
sulfidic - TAA equiv. S% pyrite	B19-No21514	NCP	% pyrite S	< 0.003	< 0.003	<1	30%	Pass	
Chromium Reducible Sulfur	B19-No21514	NCP	% S	< 0.005	< 0.005	<1	30%	Pass	
Chromium Reducible Sulfur -acidity units	B19-No21514	NCP	mol H+/t	< 3	< 3	<1	30%	Pass	
Sulfur - KCl Extractable	B19-No21514	NCP	% S	n/a	n/a	n/a	30%	Pass	
Net Acid soluble sulfur	B19-No21514	NCP	% S	n/a	n/a	n/a	30%	Pass	
Net Acid soluble sulfur - acidity units	B19-No21514	NCP	mol H+/t	n/a	n/a	n/a	30%	Pass	
Net Acid soluble sulfur - equivalent S% pyrite	B19-No21514	NCP	% S	n/a	n/a	n/a	30%	Pass	
Acid Neutralising Capacity (ANCbt)	B19-No21514	NCP	% CaCO3	0.66	0.64	3.0	30%	Pass	
Acid Neutralising Capacity - equivalent S% pyrite (s-ANCbt)	B19-No21514	NCP	% S	0.21	0.21	3.0	30%	Pass	
ANC Fineness Factor	B19-No21514	NCP	factor	1.5	1.5	<1	30%	Pass	
CRS Suite - Net Acidity (Sulfur Units)	B19-No21514	NCP	% S	< 0.02	< 0.02	<1	30%	Pass	
CRS Suite - Net Acidity (Acidity Units)	B19-No21514	NCP	mol H+/t	< 10	< 10	<1	30%	Pass	
CRS Suite - Liming Rate	B19-No21514	NCP	kg CaCO3/t	< 1	< 1	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	S19-No20256	NCP	%	12	11	4.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
S01	Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil' multiply 'reported results' x 'wet bulk density of soil in t/m3'
S02	Retained Acidity is Reported when the pHKCl is less than pH 4.5
S03	Acid Neutralising Capacity is only required if the pHKCl if greater than or equal to pH 6.5
S04	Acid Sulfate Soil Samples have a 24 hour holding time unless frozen or dried within that period

Authorised By

Ursula Long	Analytical Services Manager
Myles Clark	Senior Analyst-SPOCAS (QLD)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

St Marys Detention Basins C and V6

APPENDIX

E

TABULATED ANALYTICAL RESULTS

Construction Sciences

Location	Depth (m)	Date Sampled	Filling (F) / Natural (N)	Material Type	pH_F	pH_{FOX}	pH_F - pH_{FOX}	Reaction Rate	pH kcl	Chromium Reducible Sulfur	Acid Neutralising Capacity	Acid Trail	Net Acidity	Liming rate
					pH units	pH units	pH units		pH units	%S	%S	TAA Mole H+/t	%S	kg $CaCO_3$/t
BH01_0.5	0.5	20/08/2019	N	Silty CLAY	6.9	4.8	*2.1*	2	5.1	<0.005	N/A	13	0.02	N/A
BH01_1.5	1.5	20/08/2019	N	Silty CLAY	7.7	6.8	0.9	4						
BH01_2.5	2.5	20/08/2019	N	Silty CLAY	7.8	7.1	0.7	4						
BH01_3.5	3.5	20/08/2019	N	Silty CLAY	7.8	7.1	0.7	4						
BH01_4.5	4.5	20/08/2019	N	Silty CLAY	7.9	7.8	0.1	4						
BH02_0.5	0.5	20/08/2019	N	Silty CLAY	6.2	5.9	0.3	4						
BH02_1.5	1.5	20/08/2019	N	Silty CLAY	7.3	6.8	0.5	4						
BH02_2.5	2.5	20/08/2019	N	Silty CLAY	7.2	6.3	0.9	4						
BH02_3.5	3.5	20/08/2019	N	Silty CLAY	7.1	5.9	*1.2*	4						
BH02_4.5	4.5	20/08/2019	N	Silty CLAY	7.5	6.1	*1.4*	4						
BH03_0.5	0.5	20/08/2019	N	Silty CLAY	6.7	6	0.7	4						
BH03_1.0	1.0	20/08/2019	N	Silty CLAY	8.4	8.5	-0.1	4						
BH03_2.0	2.0	20/08/2019	N	Silty CLAY	8.8	8.7	0.1	4						
BH03_3.0	3.0	20/08/2019	N	Silty CLAY	9.3	9.4	-0.1	4						
BH03_4.0	4.0	20/08/2019	N	Silty CLAY	9	9.2	-0.2	4						
BH04_0.5	0.5	20/08/2019	N	Silty CLAY	8.5	8.7	-0.2	4						
BH04_1.5	1.5	20/08/2019	N	Silty CLAY	8.4	8.9	-0.5	4						
BH04_2.5	2.5	20/08/2019	N	Silty CLAY	8.6	8.7	-0.1	4						
BH04_3.5	3.5	20/08/2019	N	Silty CLAY	8.6	8.8	-0.2	4						
BH05_0.0	0.0	20/08/2019	N	Silty SAND	7.1	4.5	*2.6*	4	5.8	<0.005	N/A	5.4	<0.02	N/A
BH05_0.5	0.5	20/08/2019	N	Silty CLAY	7.7	6.6	*1.1*	4						
BH05_1.5	1.5	20/08/2019	N	Silty CLAY	8.1	8.2	-0.1	4						
BH05_2.5	2.5	20/08/2019	N	Silty CLAY	8.4	8.6	-0.2	4						
BH05_3.5	3.5	20/08/2019	N	Silty CLAY	8.5	8.8	-0.3	4						
BH05_4.5	4.5	20/08/2019	N	Silty CLAY	8.6	8.8	-0.2	4						
BH06_0.5	0.5	20/08/2019	N	Silty CLAY	7.9	5.7	*2.2*	4						
BH06_1.0	1.0	20/08/2019	N	Silty CLAY	7.7	6.5	*1.2*	4						
BH06_1.5	1.5	20/08/2019	N	Silty CLAY	7.2	5.3	*1.9*	4						
Guideline Value				**Eurofins LOR**	-	-	-	-	0.1	0.02	0.02	2	0.02	1
ASSMAC (1998) Potential Acid Sulfate Soil Indicator Value					4 - 5.5 [1]	< 4 [3]	1 [4]	-	-		-	-	-	-
ASSMAC (1998) Actual Acid Sulfate Soil Indicator Value					≤ 4 [2]	-	-	-	-		-	-	-	-
ASSMAC (1998) Action Criteria - Coarse Soils (1 - 1000 tonnes) 5					-	-	-	-	-	0.03	-	18	0.03	-
ASSMAC (1998) Action Criteria - Medium Soils (1 - 1000 tonnes) [6]					-	-	-	-	-	0.06	-	36	0.06	-
ASSMAC (1998) Action Criteria - Fine Soils (1 - 1000 tonnes) [7]					-	-	-	-	-	0.10	-	62	0.10	-
ASSMAC (1998) Action Criteria - Coarse Soils (>1000 tonnes) 5					-	-	-	-	-	0.03	-	18	0.03	-
ASSMAC (1998) Action Criteria - Medium Soils (>1000 tonnes) [6]					-	-	-	-	-	0.03	-	18	0.03	-
ASSMAC (1998) Action Criteria - Fine Soils (>1000 tonnes) [7]					-	-	-	-	-	0.03	-	18	0.03	-

Notes to Table:

1 - pH values >4 and <5.5 are acid and may be the result of some previous or limited oxidation of sulfides, but is not confirmatory of actual acid sulfate soils

2 - pH readings of pH≤4, indicates that actual acid sulfate soils are present with the sulfides having been oxidized in the past, resulting in acid soils (and soil pore water)

3 - The lower the final pH_{FOX} value is, the better the indication of a positive result.
» If the pH_{FOX} < 3 and there was a strong reaction to the peroxide, there is a high level of certainty of a potential acid sulfate soils. The more the pH_{FOX} drops below 3, the more positive the presence of sulfides.
» A pH_{FOX} 3-4 is less positive and laboratory analyses are needed to confirm if sulfides are present.
» For pH_{FOX} 4-5 the test is neither positive nor negative. Sulfides may be present either in small quantities and be poorly reactive under quick test field conditions.
» For pH_{FOX} >5 and little or no drop in pH from the field value, little net acid generating ability is indicated.

4 - If the pH_F value is at least one unit below field pH_{FOX}, it may indicate potential acid sulfate soils. The greater the difference between the two measurements, the more indicative the value is of a potential acid sulfate soils.

5 - coarse soils comprise sands to loamy sands - Approximate clay content (% < 0.002mm) ≤ 5%
6 - Medium soils comprise sandy loams to light clays - Approximate clay content (% < 0.002mm) between 5 and 40%
7 - Fine soils comprise medium to heavy clays and silty clays - Approximate clay content (% < 0.002mm) ≥ 40%
8 - NT - Not Tested
9 - 1.0; No reaction to slight. 2.0; Moderate reaction. 3.0; Strong reaction with persistent froth. 4.0; Extreme reaction.

Liming Rate: A Safety Factor of 1.5 has been incorporated to account for the mixing process

Acid Trail / Net Acidity - Indicates acidic soils, however may not indicate Acid Sulfate Soils

Contaminant Exceedance Indicators:

Bold	Indicates the laboratory result is within the specified range of the ASSMAC (1998) Actual Acid Sulfate Soil Indicator Values
Italics	Indicates the laboratory result either exceeds or is within the specified range of the ASSMAC (1998) Potential Acid Sulfate Soil Indicator Values
	Indicates exceedance of the ASSMAC (1998) Action Criteria triggering the need to prepare a ASS Management Plan
	Indicates the requirement for localised lime treatment of the material, that is, when the laboratory results for SPOS (%w/w) > 0.03 and the SPOS (mole H=/t) > 18