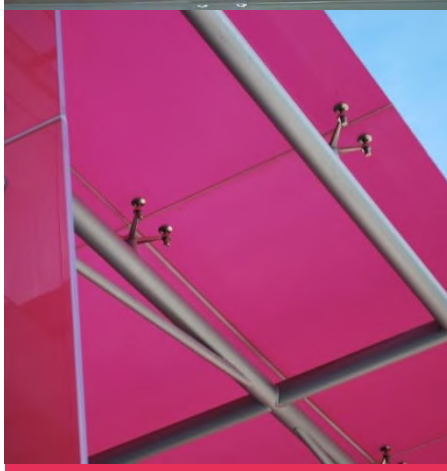

St. Johns, Manchester

Phase 2 Site Investigation

Curtins Ref: 065330-CUR-00-XX-RP-GE-001-V02

Revision: V02

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Rev	Description	Issued by	Checked	Date
V02	*Groundwater Assessment*	MH	JJ	20/09/2018

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Executive Summary

Appointment	In February 2018, Curtins were instructed by Manchester Quays Ltd to undertake a Phase 2 Intrusive Investigation at the St. John's development site in Manchester city centre. The site is approximately centred on NGR 383110, 398029, and covers an area of approximately 5.4 ha. This investigation addresses recommendations as presented in previous Phase 1 reports, with the aim of the Phase 2 works to characterise geo-environmental conditions prior to redevelopment as generally high rise (up to 52-storeys) buildings comprising residential apartments with retail, leisure and commercial spaces, and dual storey basements.
Current Site Status	The development site is located in Manchester City Centre, in the Spinningfields area of the city. The site is currently occupied by the Old Granada Studios (central) with hardstanding external surfaces currently used for car parking. Beyond Quay Street at the north of the site, a small disused warehouse and hardstanding surfacing, is boarded by fencing, beyond which is a small area of soft landscaping directly south of New Quay Street. The south of the site is currently undergoing demolition.
Summary of Phase 1	The relatively flat and level site is currently occupied by the Old Granada Studios (Central) a disused warehouse (north) and recently demolished buildings (south) with hardstanding surfaces. The site was historically used for a range of commercial and industrial buildings and warehouses, with a former railway line in the south of the site. The site is underlain by Alluvium (west) and the Chester Pebble Beds Formation, with associated Secondary A and Principal Aquifer designations respectively. Two groundwater abstractions are located within 250m of the site, to the northeast, though neither are used for potable water supplies. The River Irwell is located approximately 60m west of the site, flowing from northeast to southwest. Seven discharge consents are located between the site and the River Irwell, all relating to storm water/storm sewage overflows. UXO Mitigation measures are required for all intrusive investigation works. Primary potential risks to be investigated during the Phase 2, as well as establishing ground conditions for geotechnical design, included; risks to human health and controlled waters, and potential for ground gas.
Fieldworks Undertaken	Fieldworks were carried out between 3rd April and 13th July 2018 and comprised eight window sample boreholes to maximum depth of 4.31m bgl, three cable percussive boreholes (4.00m - 4.70m) and five rotary open hole boreholes (4.20m - 5.00m), each with rotary cored follow on, to maximum depth of 55.00m bgl. Ground gas and groundwater monitoring standpipes or piezometers were installed in selected boreholes. Selected soil and rock samples were scheduled for chemical and geotechnical analysis. To date, three of six return ground gas monitoring visits have been undertaken. Groundwater samples have been scheduled to be obtained to allow for chemical assessment.
Encountered Ground Conditions	Made Ground deposits were encountered in all exploratory holes across the site, ranging in thicknesses between 0.60m to 6.25m, though typically reached a maximum thickness of 3.40m. Deposits comprise a thin layer of tarmacadam or concrete, underlain by loose brown, dark brown and blackish brown clayey gravelly fine to coarse sand, and soft to firm orangish brown, brown, grey or black slightly gravelly sandy clay, with various anthropogenic fragments. A hydrocarbon odour was recorded in WS03 at depths of between 0.10 – 1.20m bgl. A suspected infilled canal wall was identified in RBH02 from 0.40m – 6.25m bgl. These are underlain by up to 5.32m of superficial soils comprising firm dark brown slightly sandy slightly gravelly clay and loose to dense orangish and reddish brown gravelly fine to coarse sand. A limited thickness (0.20m) of black spongey peat was identified in RBH03 at 2.00m bgl. Bedrock (Chester Pebble Beds Formation) was encountered at depths between 3.05m to 7.45m bgl and comprised extremely weak to very strong thinly laminated to thickly bedded reddish brown fine and medium grained sandstone, with interbedded bands of mudstone and siltstone. The top of the bedrock is highly weathered, and often recovered as sand and gravel. Arisings from shallow exploratory holes were typically recovered as dry. Groundwater strike was unable to be recorded in deep cored boreholes due to the use of water flush drilling techniques.
Environmental Laboratory Testing and Ground Gas Monitoring Results	Soil chemical analysis results did not identify any exceedances when compared with Tier 1 screening thresholds for a 'Commercial' end use scenario. Asbestos boarding was identified in archaeological trenches undertaken at the same time as this investigation. No samples were scheduled for analysis. Groundwater chemical analysis identified exceedances of heavy metals and PAH concentrations when compared with EU DWS and WFD WQS thresholds. During ground gas monitoring, a maximum concentration of 4.0% v/v carbon dioxide (CO_2) was recorded in BH02 on the third visit. A maximum recorded steady state flow rate of 1.0l/hr was recorded in RBH02 on the third monitoring visit. Concentrations of methane (CH_4) carbon monoxide (CO) and hydrogen sulphide (H_2S) have been recorded below the instruments limit of detection. This maximum recorded level of CO_2 results in a calculated 'worst case' Gas Screening Value (GSV) of 0.0400 l/hr, if maximum flow is taken as 1.0 l/hr.

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Ground Contamination and Ground Gas Assessment	Risks to human health have been assessed as **low** on the basis that all Made Ground soils are to be removed from site to facilitate the construction of a dual storey basement. Risks to controlled waters (groundwater and surface water) have been assessed as **low** on the basis that all Made Ground soils are to be removed from site to facilitate the construction of a dual storey basement. Elevated concentrations identified in groundwater samples may be representative of background conditions. With reference to Situation A non-traditional construction as defined by the NHBC and the modified Wilson & Card classification as contained within CIRIA C665, the maximum methane and carbon dioxide concentrations and respective gas screening values indicate a Gas Characterisation Situation 1 (CS1) gas regime, requiring no gas protection measures for the proposed new development. Due to the proposed basement features, the advice of a specialist radon assessor should be obtained.
Preliminary Material Classification and Soils Reuse	If soil arisings are required to be disposed off-site, an initial assessment of shallow soils was carried out using a proprietary waste characterisation assessment tool. Results of nineteen Made Ground soil samples identified that seventeen samples indicated to be non-hazardous for off-site disposal. Two samples indicated to be hazardous owing to the concentrations of copper and copper (RBH06 at 0.40m) and benzo(a)anthracene, diesel, copper, lead and zinc (WS03 at 0.30m bgl). In addition, asbestos board was identified in archaeological trenches, which should be appropriately managed and disposed by an appropriately licensed contractor. The initial assessment of the seven natural soil samples tested may be considered non-hazardous waste for off-site disposal. Where natural soils are being considered for off-site disposal as inert waste, Waste Acceptance Criteria (WAC) testing should first be undertaken with confirmation of acceptability from the receiving landfill. The Contractors should satisfy themselves regarding the classification of any waste arisings. Confirmation of acceptability should be sought from the receiving landfill or treatment facility via the issue of laboratory chemical testing results.
Geotechnical Assessment	The Made Ground and the superficial deposits are not considered to be suitable founding stratums due to the likely significant loadings for a high-rise building and it is considered that a piled foundation solution is adopted designed as end bearing in the sandstone bedrock. However, pad foundations for the low-rise buildings may be suitable founding in the superficial deposits /completely weathered sandstone. Square pad foundations maybe suitable for the low-rise buildings with a presumed bearing resistance of approximately 400-600kN/m2 founding at 4.5m bgl in the weathered Sandstone increasing to approximately 600 - 1000 kN/m2 at 8.0m bgl founding in the partially weathered sandstone. For the high-rise buildings it is considered that a piled foundation be adopted to accommodate the significant loads. Initial estimates in accordance with Eurocode 7 (Ref.7) indicate that a bored pile of 750mm diameter and 16m length would provide a total design resistance of 11,025 kN for combination 1 and 6228 kN for combination 2. Increasing to 14,502 kN combination 1 and 8110 kN combination 2 for a 900mm diameter bored pile of 16m length. Due to the likely presence of groundwater into excavations once rockhead is penetrated a contiguous pile or secant piled foundation should be considered to reduce groundwater flow into excavations to enable basements to be constructed. It is recommended that all ground slabs should be suspended to account for the high structural loads and any potential hydrostatic uplift. Basement slabs should be developed to span between foundations to resist buoyancy. The potential risk of floatation should be considered in the temporary condition during construction. Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. An allowance should be made for breaking out and removing any encountered concrete obstructions associated with existing foundations. Temporary earthworks support is envisaged to allow the proposed construction within the Made Ground outside the permanent basement wall, which may be in the form of sheet piled walls, subject to design by a temporary works engineer.
Recommendations	Based on the findings of the ground investigation, the following recommendations are made: 1) It is anticipated that all Made Ground soils are to be removed from site to facilitate the construction of a dual storey basement. It is considered unlikely that a remediation strategy will be required for this development; 2) Further numerical analysis be undertaken to model the pile interaction with the sandstone in order to obtain a greater understanding of the pile carrying capacity and settlement; and 3) Notwithstanding, appropriate PPE should be supplied to and worn by all groundwork and construction personnel during the basement excavation, and other groundwork and construction activities, with reference to the environmental testing results presented herein and within Appendix C.

Table of Contents

1.0 Introduction 1

1.1 Project Background 1

1.2 Scope of Services 1

2.0 Phase 1 Preliminary Site Assessment Summary 2

2.1 Current Setting 2

2.2 Previous Site Use 3

2.3 Published Geology 4

2.3.1 Made Ground Deposits 4

2.3.2 Superficial Deposits 4

2.3.3 Bedrock Deposits 4

2.3.4 Mining and Quarrying 5

2.3.5 Other Pertinent Geological Existing Geological Records 5

2.4 Hydrogeology and Hydrology 5

2.5 Landfill 6

2.6 Unexploded Ordnance (UXO) Risk Assessment 6

2.7 Summary of Phase 1 PCSM 7

3.0 Phase 2 Investigation Scope of Works 9

3.1 Soil Logging and Sampling 10

3.2 Monitoring Well Installations 10

3.3 Post-Investigation Monitoring 11

3.3.1 Ground Gas Monitoring 11

3.3.2 Groundwater Sampling 11

4.0 Laboratory Analysis 12

4.1 Soil Analysis 12

4.2 Groundwater Analysis 13

4.3 QA/QC 13

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4.4 Geotechnical Analysis ... 13
5.0 Encountered Ground Conditions ... 15
5.1 General ... 15
5.2 Made Ground ... 15
5.3 Superficial Deposits ... 16
5.3.1 Granular Soils ... 16
5.3.2 Cohesive Soils ... 17
5.4 Bedrock Deposits ... 18
5.5 Observed Potential Contamination ... 22
5.6 Obstructions Encountered ... 22
5.7 Groundwater ... 22
5.8 Aggressive Ground Conditions ... 23
6.0 Ground and Groundwater Contamination Assessment ... 24
6.1 Human Health GQRA ... 24
6.1.1 Adopted Soil Human Health GACs Screening Methodology ... 25
6.1.2 Generic Assessment Criteria Screening of Soil Laboratory Results ... 26
6.2 Controlled Waters GQRA ... 27
6.2.1 Adopted Controlled Waters Tier 1 Screening Values and Methodology ... 27
6.2.2 Tier 1 Screening of Groundwater Laboratory Results ... 27
6.3 Water Supply Pipe Assessment ... 28
6.4 Materials Management ... 29
6.4.1 Re-use of Site Soils ... 29
6.4.2 Material Classification ... 29
7.0 Ground Gas Assessment ... 31
7.1 Ground Gas Monitoring Results ... 31
7.2 Ground Gas Assessment ... 32
8.0 Revised Conceptual Site Model ... 34
8.1 Summary of Significant Pollutant Linkages ... 37

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9.0 Engineering Assessment and Recommendations 38

9.1 Introduction 38

9.2 Summary of Ground Conditions 38

9.3 Excavation and Support 39

9.4 Foundation Design 39

9.5 Ground Floor slabs 41

10.0 Conclusions & Recommendations 42

10.1 Conclusions 42

10.1.1 Geotechnical Assessment 42

10.1.2 Ground and Groundwater Contamination 43

10.1.3 Ground Gas Assessment 43

10.1.4 Additional Considerations 44

10.2 Recommendations 44

11.0 References 46

Appendices

Appendix A - Drawings

Appendix B - Exploratory Hole Logs

Appendix C - Chemical Laboratory Testing Results

Appendix D - Geotechnical Laboratory Testing Results

Appendix E - Ground Gas and Groundwater Monitoring Results

Appendix F - GAC Screening Thresholds

Appendix G - Risk Assessment Methodology

1.0 Introduction

1.1 Project Background

In February 2018 Curtins were instructed by Manchester Quays Limited to undertake a Phase 2 Intrusive Investigation at the St. Johns site in Manchester city centre. The site is approximately centred on NGR 383110, 398029, and covers an area of approximately 5.4 ha. A site location plan is presented as *Figure 2.1*.

1.2 Scope of Services

This investigation addresses recommendations as presented in previous Curtins Phase 1 reports (refs. 1-4), with the aim of the Phase 2 works to characterise geo-environmental conditions prior to redevelopment as generally high rise (up to 52-storeys) buildings comprising residential apartments with retail, leisure and commercial spaces with a dual storey basement. The current development plans for which can be referred to within *Appendix A* of this report.

Specifically, the Phase 2 report is intended to determine:

a) If there is a risk of the proposed end user being adversely impacted upon by potential contamination in shallow site soils that may be present on the site due to its known current, recent and historical use;

b) If there is a risk of groundwater and/or surface water being adversely impacted upon by potential contamination that may be present on the site due to its known current, recent and historical use;

c) If there is a risk to the end user from soil gases including methane, carbon dioxide, carbon monoxide and hydrogen sulphide;

d) Preliminary recommendations for the design of basement walls and foundation design; and

e) Recommendations for the specification of sub-structure concrete and water supply pipes.

Consideration of detailed flood risk, ecology and archaeological issues are outside of the scope of this report.

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2.0 Phase 1 Preliminary Site Assessment Summary

This section presents a summary of the current site setting, history, geology and hydrogeology/hydrology, as presented in the following Phase 1 Reports:

- Curtins Phase 1 Preliminary Site Assessment for Bonded Warehouse and Energy Centre (Report ref. B049241/JJ/6744) dated 24th May 2018 (Ref. 1);
- Curtins Phase 1 Preliminary Site Assessment for St. John's Place, Manchester (Report ref. B049228/JJ/6743) dated 24th May 2018 (Ref. 2);
- Curtins Phase 1 Preliminary Site Assessment for Central Village, Manchester (Report ref. B061604.010)/JJ/6923) dated 12th July 2016 (Ref. 3); and
- Curtins Phase 1 Preliminary Site Assessment for Old Granada Studios, Manchester (Report ref. B049242/JJ/6736 Rev. A) dated 19th June 2017 (Ref. 4).

It is not the intention of this report to duplicate the information within the above documentation, rather the information below providing the background information to support the revised post Phase 2 siteworks Conceptual Site Model (CSM), as presented in *Section 8.0*.

2.1 Current Setting

The development site is located in Manchester City Centre, located off Quay Street in the Spinningfields area of the city. Figure 2.1, overleaf, outlines the location of the proposed development.

Surface cover across the site is predominantly tarmac roads and hardstanding surfaces, with concrete surfaces within existing buildings. The site is currently occupied by the following:

Table 2.1 – *Summary of the Existing Land Use On-Site*

Location	Description
North (New Quay Street to Quay Street)	Disused warehouse and low-rise office building Small area of soft landscaping directly south of New Quay Street.
Central Portion (South of Quay Street, East of Water Street)	Old Granada TV Film Studios and hardstanding surfaces for car parking. Studios comprise warehouses and office facilities
South (Grape Street)	Two existing buildings with hardstanding external surfaces. Demolition works currently being undertaken.
West (West of Water Street)	Vacant Land

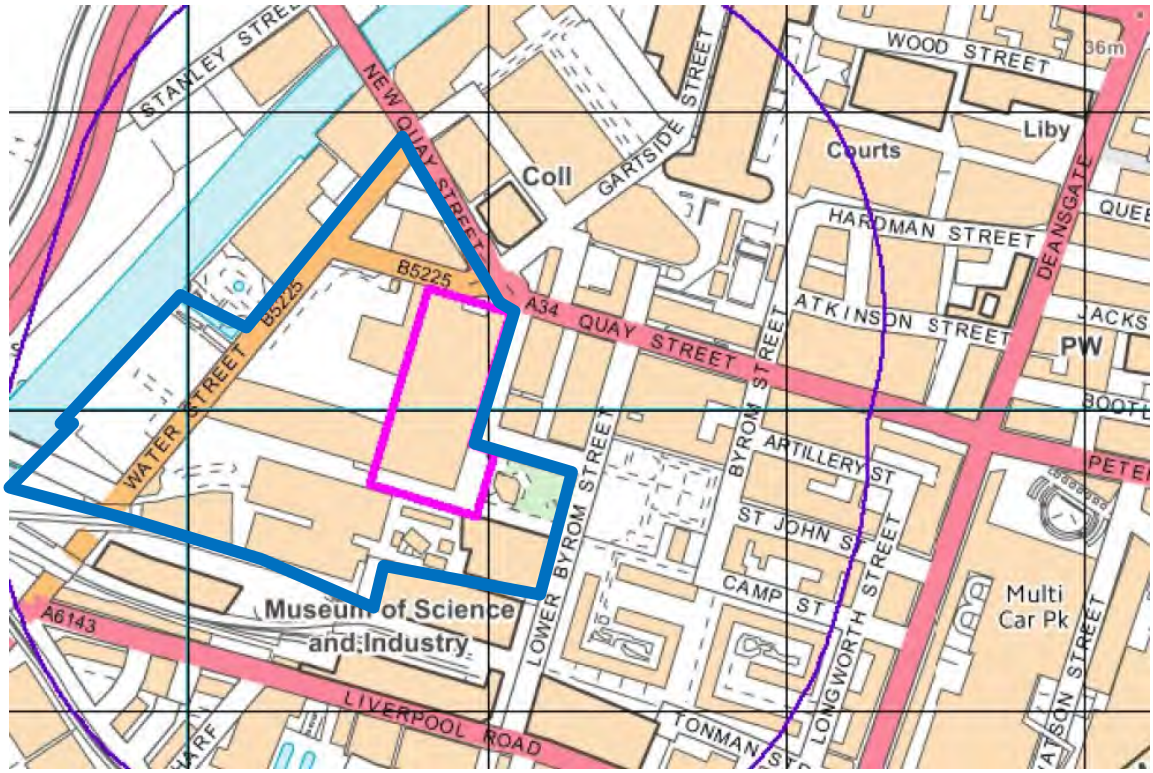

Figure 2.1 – *Site Location Plan, approximate site boundary shown in* ***blue***
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2.2 Previous Site Use

A review of the available historical mapping information for the site as presented within the previous Curtins Phase 1 reports (Ref.1-4) has been undertaken with specific reference to potential sources of contamination. *Table 2.2* summarises the findings.

Table 2.2 – *Summary of on-site historical land use.*

Date	Description
1848	**North** • The site was occupied by commercial/industrial land comprising multiple warehouses including dye house, cotton and wool mills and timber yards. **Central** • Mixed use residential and commercial including timber yard and gasometer. Site intersected by canal associated with dry dock. **South** • Commercial/industrial land use including timber yard, crane, cotton storage and railway sidings. Railway to the south of the site.
1891-1908	**North/Central** • Demolition of previous structures and construction of newer commercial/industrial **South** • Numerous railway lines build on site as part of the Liverpool Road & Salford Goods Station

1940s	Major construction across northern and central areas of the site following WWII. Potential for UXO from Luftwaffe bombing at this time. **North** • Construction of an automobile and electrical engineering workshop. **Central** • Construction of an engineering works in the west and eastern boundary of the site. Warehouses and compound works also identified.
1950s	**Central** • Additional construction at west and central portion. Tank noted at the western boundary associated with engineering works.
1960s – 1970s	**Central** • Construction of the Granada Television Centre with associated car parking centrally within the site. **South** • Liverpool Road goods Depot railway line noted as being disused. Railway lines no longer shown on site by 1990.
1992	**North** • Demolition of Albert Shed Warehouse and subsequent conversion to a car park (now disused)
1999	**South** • New structure build at the south of the site in area previously occupied by railway lines.

2.3 Published Geology

A study of the Envirocheck, BGS borehole records and BGS 1:50,000 mapping (Solid and Superficial Editions) for Manchester (Sheet 085) indicates the following geological succession underlying the site:

- Alluvium of *Flandrian Age*; and
- Chester Pebble Beds Formation of *Early Triassic Age*.

2.3.1 Made Ground Deposits

Made Ground deposits are not indicated to be present on the site. However, given the substantial historical development that has occurred on the site, and suspected infilled canal in the west of the site, it is anticipated that Made Ground deposits, of unknown composition, may be encountered during the investigation.

2.3.2 Superficial Deposits

Alluvium deposits comprising clay, silt, sand and gravel are identified at the west of the site. Elsewhere on site, superficial deposits are not recorded to be present.

2.3.3 Bedrock Deposits

Bedrock deposits are present as Chester Pebble Beds Formation of *Early Triassic Age,* comprising sandstone.

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There are three BGS fault lines located within 1 kilometre (km) of the site, with the closest being approximately 100m to the northwest, orientated northwest to southeast.

2.3.4 Mining and Quarrying

The previous reports did not identify evidence of historic mining activities in historic mapping within or in the area immediately adjacent to the site. The Coal Authority's online interactive mapping confirms that the site is located within a coal mining referral area.

It is considered unlikely that relic mining features are present on site and as such, have not been considered any further.

2.3.5 Other Pertinent Geological Existing Geological Records

The previous reports identified a low risk to no hazard from the following ground stability hazards on and around the site; running sands, collapsible ground, landslides, shrinking or swelling cl\ay, compressible ground and ground dissolution.

UK Radon Mapping confirms the site is situated in an area where less than 1% of homes are above the radon action level. The new development incorporates a basement and so the advice of a specialist Radon assessor must be obtained.

2.4 Hydrogeology and Hydrology

Environment Agency data indicates that the site, corresponding with the underlying bedrock geology, overlies a Principal Aquifer. These are;

Layers of rock or drift deposits that have high intergranular and/or fracture permeability meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, Principal Aquifers are aquifers previously designated as Major Aquifers.

Where Alluvium superficial soils are recorded, it is identified as a Secondary A Aquifer. These are;

Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

The site is not situated within a designated Source Protection Zone (SPZ). The Groundwater Vulnerability Map presented in the Envirocheck Report indicates a highly permeable principal aquifer underlies the site, with high vulnerability.

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There are two groundwater abstractions within 250m of the site, both at Gartside Street, Manchester, and are operated by Bovis Lend Lease Ltd. The Envirocheck Report identifies the groundwater abstraction for non-evaporative cooling purposes.

The nearest surface water feature is the River Irwell directly west of site, which flows from N to S. No water quality data is available for this feature. There are no surface water abstractions within 1000 m of the site.

There are seven discharge consents directly west of the site into the River Irwell, all relating to storm water/storm sewage overflows.

2.5 Landfill

There are no licensed landfills located within 250 m of the site.

The nearest identified historical landfill (Wilburn Street) is located approximately 200m west of the site.

2.6 Unexploded Ordnance (UXO) Risk Assessment

The site of interest is in Manchester City Centre. Risk mapping for UXOs has placed the site within a High-risk area. High-risk regions are those that show a bomb density of >50 bombs per 1000 acres and abundant potential WWII targets.

A review of historical maps (Ref. 5) indicate bomb ruins within the south-eastern corner of the site, with damaged and demolished buildings in the vicinity to the east, north and south. Several fire bombs and high explosives were dropped in the vicinity of the site. *Figure 2.6* overleaf shows the impacted land during WWII.

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Figure 2.6 – *Historic Records showing bombing incidents during WWII. Site boundary marked in* ***Blue****.* ***Red*** *circles indicate fire bombs,* ***Blue*** *circles indicate high explosives,* ***Pink*** *shading indicates damaged buildings,* ***Red*** *shading indicates demolished buildings,* ***Green*** *marks indicate line mines.*

An Explosive Ordnance Threat Assessment (Ref. 6) was undertaken by Planit in March 2016 (for the larger overall St. John's development area) and concluded the threat level with portions of the Site are at Medium threat levels and therefore a UXO Threat Mitigation Strategy is required prior to intrusive engineering works. Details of the mitigation strategy can be found within the assessment.

2.7 Summary of Phase 1 PCSM

A summary of potential pollutant linkages at the development site identified in the previous Phase 1 reports referenced in *Section 2.0* is presented in *Table 2.8*, overleaf, were identified as requiring further investigation to enable the safe redevelopment of the site.

Table 2.7 – *Preliminary Conceptual Site Model*

Source	Pathway	Receptor	Risk
Made Ground of unknown composition from: • Historic development on, and near the site; • Leaks and spills of petrol and diesel from plant/engineering activities, car parking and depot vehicles, and warehouse/factory processes; • Potential use of asbestos containing materials in historic buildings; • Adjacent railway tracks and stations near historic engineering works; • Manufacturing/Treatment processes associated with historic timber yard; • Dock and motor repair works and electrical substation adjacent to the site;	Direct contact/ ingestion and inhalation	**Future site-users** (Commercial Development)	**Moderate**
	Horizontal and vertical migration of contaminants through superficial soils	**Groundwater** (Principal Aquifer)	**Low**
		Groundwater (Secondary A Aquifer)	**Low**
		Surface Water (River Irwell)	**Low**
Production of ground generating gases from: • Made Ground deposits containing organic/ putrescible content; • Infilling of canal basin directly beneath the site; • Historic St. Johns Church Graveyard.	Vertical and horizontal migration through existing service corridors and the underlying superficial deposits	**Future site-users**	**High**

Potential contaminants of concern associated with any Made Ground present include, amongst others; broad range aliphatic and aromatic hydrocarbons present within any fuel oils; semi-volatile and volatile organic contamination; polycyclic aromatic hydrocarbons (PAHs); inorganic compounds including heavy metals; and asbestos present in discarded building materials.

The qualitative risk assessment determined the above risks associated with the proposed development of the site warrant further investigation.

It was recommended that a ground investigation is conducted to both confirm this assessment and provide data in support of the structural and civil engineering design. The scope of the investigation undertaken in detailed in *Section 3.0*.

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3.0 Phase 2 Investigation Scope of Works

Site investigation works were undertaken between the 3rd April and 13th July 2018.

The scope of the ground investigation was designed in general accordance with current UK guidance including CLR11 (Ref. 7), British Standard (BS) 10175 (Ref. 8), BS5930:2015 (Ref. 9), and BSEN1997: Part 2:2007 Eurocode 7 (Ref. 10). A summary of the scope and rationale are summarised in *Table 3.0* below.

Table 3.0 – Scope and Rationale of Fieldwork Undertaken

Exploratory Hole Type	Exploratory Hole Reference	Exploratory Hole Depth (m bgl)	Rationale
Window Sample Boreholes	**WS01** **WS02** **WS03** **WS04** **WS05** **WS06** **WS07** **WS08** **WS09** **WS10** **WS11** **WS12** **WS13**	**-** **0.80** **1.20** **3.39** **3.30** **3.41** **-** **3.38** **-** **4.31** **4.30** **-** **-**	Confirm ground conditions. Collect soil and water samples for chemical and geotechnical analysis. Undertake in-situ testing Gas and groundwater monitoring Determine geotechnical parameters
Cable Percussive Boreholes	**BH02** **BH03** **BH04**	**4.70** **4.70** **4.00**	Confirm ground conditions. Collect soil and water samples for chemical and geotechnical analysis. Undertake in-situ testing Gas and groundwater monitoring Determine geotechnical parameters Facilitate subsequent rotary cored boreholes
Rotary Open Hole Boreholes	**RBH01** **RBH02** **RBH03** **RBH04** **RBH05** **RBH06**	**-** **5.00** **4.20** **4.30** **5.00** **4.50**	Confirm shallow ground conditions Undertake in-situ testing Gas and groundwater monitoring Facilitate subsequent rotary cored boreholes
Rotary Cored Boreholes	**BH02** **BH03** **BH04** **RBH01** **RBH02** **RBH03** **RBH04/A/B** **RBH05** **RBH06**	**25.20** **25.20** **25.10** **-** **40.00** **40.30** **40.50** **40.00** **55.00**	Confirm deep ground conditions including presence of voids. Collect rock samples for geotechnical analysis. Undertake in-situ testing Gas and groundwater monitoring Determine geotechnical parameters

* Exploratory boreholes marked in red are yet to be undertaken.

Several exploratory boreholes, at the time of writing, have not been undertaken. These are outlined below:

- WS01 – Located over basement of existing building;
- WS07 – Located within a demolition exclusion zone;

- WS09 – Located within a demolition exclusion zone;
- BH06 – Located within a demolition exclusion zone; and
- Slip Trenches – Located within a demolition exclusion zone.

Exploratory hole locations were surveyed on completion.

Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20059-A records the locations of the exploratory holes, a copy of which is contained within *Appendix A*.

3.1 Soil Logging and Sampling

Exploratory window sample hole, rotary hole and manually excavated hand pit arisings were logged on site by a qualified Engineer. All exploratory holes were logged in accordance with the requirements of BS5930 (Ref. 9), including recording observed visual and olfactory indications of contamination. Exploratory hole logs are provided in *Appendix B*.

3.2 Monitoring Well Installations

Ground gas and groundwater monitoring installations (50mm diameter) were installed within six window sample borehole locations and four rotary cored borehole locations. A bentonite seal was placed above and below the screened section of the borehole to minimise the potential for downward migration of contaminants, and the creation of a preferential migratory pathway. A gravel surround was installed in the annulus between the sides of the borehole and the slotted sections of pipe.

The 50 mm diameter monitoring wells were primarily designed to assess the potential for ground gas and strata likely to have the highest permeability and as such the screened section focussed on granular superficial strata, or the underlying bedrock.

Piezometers (19mm) were installed within four rotary cored borehole locations. A gravel and sand surround was installed in the annulus between the sides of the borehole, and approximately +/- 1m above and below the resting point of the piezometer. A bentonite seal was placed above and below the screened section of the borehole to minimise the potential for downward migration of contaminants, and the creation of a preferential migratory pathway.

These were installed at 2.00m below the vertical extent of the proposed basement floor to assess the potential ingress of water from fractures below the basement.

A summary of the response zones is presented in *Table 3.2* overleaf.

Table 3.2 – *Monitoring Well Response Zones*

Borehole Reference	Response Zone(s) (m bgl)	Standpipe/ Piezometer	Strata Description(s)
WS04	2.00 – 3.00	Standpipe (50mm)	CLAY and SAND
WS05	2.00 – 3.00	Standpipe (50mm)	SAND
WS06	2.00 – 3.00	Standpipe (50mm)	SAND
WS08	2.00 – 3.00	Standpipe (50mm)	SAND
WS10	2.00 – 4.00	Standpipe (50mm)	SAND
WS11	1.50 – 3.50	Standpipe (50mm)	SAND
BH02	5.00 – 20.00	Standpipe (50mm)	SANDSTONE (Bands of mudstone and siltstone)
BH03	8.80 – 10.00	Piezometer (19mm)	SANDSTONE
BH04B	5.00 – 20.00	Standpipe (50mm)	SANDSTONE
RBH02	6.30 – 20.00	Standpipe (50mm)	SANDSTONE (Bands of mudstone)
RBH03	14.50 – 16.50	Piezometer (19mm)	SANDSTONE
RBH04	9.20 – 10.20	Piezometer (19mm)	SANDSTONE
RBH05	5.00 – 20.00	Standpipe (50mm)	SANDSTONE
RBH06	10.20 – 10.50	Piezometer (19mm)	SANDSTONE

Copies of borehole logs can be referred to in *Appendix B* of this report.

3.3 Post-Investigation Monitoring

3.3.1 Ground Gas Monitoring

An initial programme of six gas monitoring visits over three months was proposed to assess ground gas conditions as identified in the Preliminary Conceptual Site Model. Three visits have been undertaken to date.

3.3.2 Groundwater Sampling

Groundwater samples from rotary boreholes RBH02, BH02 and BH04, and window sample borehole WS10.

4.0 Laboratory Analysis

Representative soil samples were selected for laboratory chemical analysis, based on field observations and to provide a characterisation of the Made Ground and natural strata encountered. Selected soil samples were placed in laboratory provided containers and stored in cool boxes prior to being transported to the nominated laboratory under the laboratory's chain of custody documentation. The laboratory selected by Curtins for chemical analysis of soil and groundwater samples was Envirolab, a UKAS and MCERTS accredited laboratory.

Given the potential site wide source of contamination (Made Ground) the sampling positions (boreholes) were generally located in a non-targeted, systematic array to give adequate and representative coverage of the site accounting for the historical site use, proposed end use and the immediate environmental setting.

4.1 Soil Analysis

The contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), heavy metals, volatile and semi-volatile organic compounds and asbestos, the extent of which is captured by the broad environmental testing suite listed in *Table 4.1* below.

***Table 4.1** – Environmental Chemistry Analysis Suite: Soils*

Suite Ref.	Analyte	LOD
Soils Suite A	Asbestos Screen, pH and Soil Organic Matter (SOM)	-
	Arsenic, Chromium, Chromium VI, Copper, Lead, Selenium, Zinc, Nickel	1 - 5 mg/kg
	Boron (water soluble)	1 mg/kg
	Cadmium	0.5 mg/kg
	Mercury	0.17 mg/kg
	Cyanide (total)	1 mg/kg
	Phenols (screen)	0.2 mg/kg
	PAHs (USEPA 16)	0.1 mg/kg
	TPH (Aro/Ali Split)	0.01 to 0.1 mg/kg
SVOCs	SVOC Suite (Excluding PAH-16)	100 – 500 µg/kg
VOCs	VOC Suite	1 – 10 µg/kg

Nineteen soil samples were taken from Made Ground soils across the site and tested for Soils Suite A. Additionally, seven soil samples were taken from within natural soils and tested for Soils Suite A.

Nine Made Ground soil samples and a single natural soil sample were tested for SVOCs, and one Made Ground soil sample was tested for VOCs.

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Copies of the environmental chemistry testing certificates are presented in *Appendix C*.

4.2 Groundwater Analysis

The contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), volatile organic compounds, and heavy metals the extent of which is captured by the broad environmental testing suite listed in *Table 4.2* below.

Table 4.2 – Environmental Chemistry Analysis Suite: Waters

Suite Ref.	Analyte	LOD
Water Suite A	pH	-
	Total Hardness	2 mg/l
	Arsenic, Lead, Nickel, Selenium, Zinc	1 µg/l
	Boron (water soluble), Chromium, Copper, Mercury, Phenols (screen)	0.01 - 10 µg/l
	Cadmium	0.2 µg/l
	Cyanide, Sulphide	0.005 – 0.1 mg/l
	Sulphate	1 mg/l
	PAHs (USEPA16)	0.01 µg/l
	TPH (Aro/Ali Split)	1 – 5 µg/l
VOCs	VOC Suite (Excluding PAH-16)	1 – 10 µg/l
SVOCs	SVOC Suite	1 – 10 µg/l

Water samples were taken from rotary boreholes RBH02, BH02 and BH04, and window sample borehole WS10.

Copies of the environmental chemistry testing certificates are presented in *Appendix C*.

4.3 QA/QC

The Envirolab Deviating Samples Reports (1802606, 1805180, 185337, 1805734 and 1805735) did not record any deviations.

All analysis reports are enclosed within *Appendix C*.

4.4 Geotechnical Analysis

Rock samples for geotechnical testing were prepared and tested in accordance with ISRM Suggested Methods. The following tests were carried out:

- 119 No. Point Load Index Test (PLT) – Axial Plane;
- 100 No. PLT – Diametral Plane;

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- 80 No. Uniaxial Compressive Strength (UCS);
- 50 No. Natural Rock Water Content;
- 40 No. Rock Porosity Density;
- 10 No. Brazilian Tests;
- 13 No. Sound Velocity Tests (P and S Wave)
- 8 No. Hoek Triaxial Compression Tests
- 10 No. Hoek Shear Box Tests;

Copies of the geotechnical testing certificates are presented in *Appendix D*.

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5.0 Encountered Ground Conditions

5.1 General

A summary of the ground conditions encountered during the site investigation works is presented below, with detailed information presented in the exploratory hole logs included in *Appendix B* and a summary of each strata presented in subsequent sections.

Table 5.1 – *Summary of Ground Conditions Encountered*

Stratum	Depth to top of strata m bgl (mAOD)	Thickness (m)		Description
		Min	Max	
Made Ground	0.00 (27.27)	0.60	6.25	MADE GROUND of Tarmacadam and concrete/limestone sub-base, or concrete, underlain by loose brown, dark brown blackish-brown clayey, gravelly fine to coarse SAND, and soft to firm orangish brown, brown, grey or black sandy slightly gravelly CLAY. Possible canal wall identified in RBH02 between 0.40m – 6.25m bgl.
Superficial Soils[1]	0.60 (26.67)	0.25*	5.32	Firm dark brown slightly sandy slightly gravelly CLAY. Loose to dense orangish and reddish-brown gravelly fine to coarse SAND. RBH03 recorded spongey peat at 2.00 – 2.20m bgl.
Chester Pebble Beds Formation	3.05 (23.07)	>20.70**	>50.35**	Extremely weak to strong reddish-brown SANDSTONE. Top of strata weathered. Bands of sandy coarse gravel at the surface. Rare interbedded mudstone and siltstone.

1 BGS geological mapping does not record the presence of superficial soils beneath the site
* Where encountered
** Thickness not proved

5.2 Made Ground

Made Ground deposits were encountered in all exploratory holes, to depths of between 0.60m bgl and 6.25m bgl. The deepest Made Ground was encountered in RBH02, where deposits comprise a red brick wall, underlain by well bonded brick and concrete. It is likely that the wall is associated with a historic canal which historically underlies the site. Elsewhere, a maximum thickness of 3.40m was recorded in BH04B.

Deposits typically comprise a surface cover of a limited thickness of tarmacadam, often with concrete subbase, or concrete. BH02 and RBH05 recorded up to 0.30m of topsoil, with frequent rootlets.

The surface cover is typically underlain by granular deposits comprising brown, orangish brown, and reddish brown gravelly sand with occasional cobbles. Dark brown and brownish black, slightly clayey

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gravelly sand, with occasional cobbles, was also encountered. Anthropogenic fragments within these soils included: brick, concrete, slag, slate, tile, glass, asphalt, plastic, porcelain and wood fragments, in addition to mixed lithologies of sandstone, mudstone and limestone. Thicknesses of the upper granular Made Ground strata are variable across the site, ranging between 0.17m (RBH06) – 3.05m (BH04). A strong diesel odour was noted within WS03.

The granular deposits are underlain by cohesive soils in WS03, WS04, WS05, WS06, WS08, WS10, WS11 and RBH06, to a maximum depth of 3.10m bgl (RBH06), though typically to between 1.20m -0 1.70m bgl). Deposits within WS04, WS05, WS10, WS11, RBH06 comprised very soft to firm orangish brown, with black mottling (WS05 and WS10) slightly sandy to sandy gravelly clay. Soft black sandy clay was encountered in WS06 between 0.80m – 1.30m, and WS03 recorded very soft greenish grey sandy, gravelly clay with low cobble content, where a hydrocarbon odour was noted. Anthropogenic fragments included: concrete, sandstone, brick, slag, tile, mudstone and limestone.

5.3 Superficial Deposits

BGS geological mapping does not record the presence of superficial soils beneath the development area. This investigation encountered superficial soils all exploratory holes, except for RBH02 which recorded extensive Made Ground soils to 6.25m bgl, and generally comprised granular soils, though limited thicknesses of cohesive soil were also encountered.

5.3.1 Granular Soils

Granular superficial soils were encountered in all exploratory holes except for RBH02, with a maximum recorded thickness of 5.32m.

Deposits typically comprised light, yellowish, reddish or orangish brown medium dense to very dense slightly gravelly fine to coarse sand. Gravels are fine to coarse, sub angular to rounded of mixed lithologies of sandstone, mudstone, limestone, quartzite and rare coal. Rarely, deposits are slightly clayey, and clay bands are identified within shallow sand deposits.

Nineteen SPT ‘N’ Values were recorded to full penetration with values ranging between 8 – 41, generally increasing with depth, illustrated in Figure 5.3.1 overleaf

With exception of WS04 which progressed to bedrock, all window samples were terminated within the granular soils within very dense sand due to SPT refusal.

An organic odour was recorded in BH04B at 3.40m – 3.65m bgl, within grey sandy gravel deposits.

Table 5.3.1 and *Figure 5.3.1* overleaf summaries the geotechnical properties of the soils.

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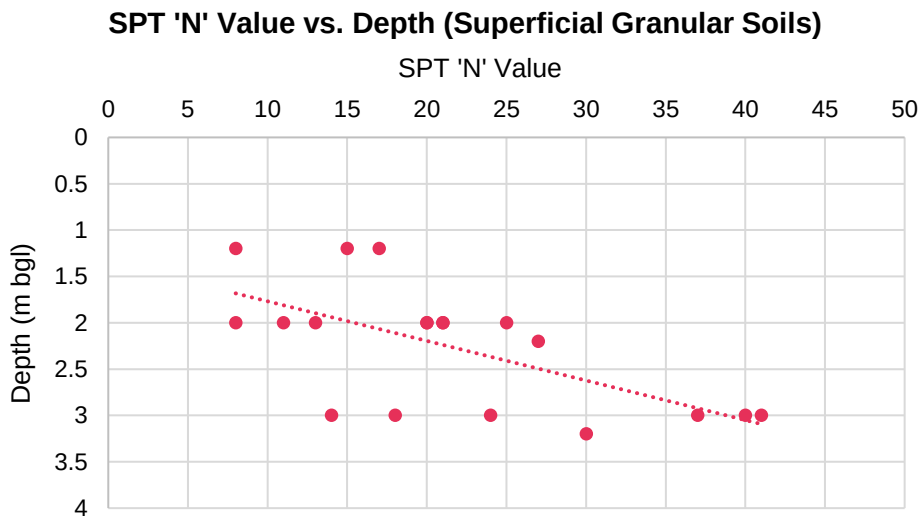
Table 5.3.1 – *Summary of geotechnical test results – granular superficial deposits*

Parameter	No. of tests	Minimum	Maximum	Average
pH	6	7.27	7.91	7.50
Water Soluble Sulphate (mg/l)	6	0.02	0.07	38
SPT 'N' Value (Full Penetration)	19	8	41	22
Organic Content (%)	6	0.2	1.5	0.82

Figure 5.3.1 – *Granular SPT 'N' Values Plotted Vs. Depth*



5.3.2 Cohesive Soils

Cohesive soils were encountered in four exploratory holes (WS04, WS06, WS08 and RBH04), ranging in thicknesses between 0.10m – 0.70m.

The shallow bands of clay recorded in WS04, WS06 and WS08 comprise firm light and dark brown, with occasional mottling, slightly gravelly sandy clay, with gravels of fine to medium sub angular to rounded sandstone and limestone. The deeper clay identified in RBH04 (5.70 – 5.80m bgl) recorded reddish brown slightly sandy very gravelly clay, with gravels of sub rounded to rounded granite and sandstone.

RBH03 recorded 0.20m of black, spongey peat at 2.00m bgl.

Table 5.3.2 – *Summary of geotechnical test results – cohesive superficial deposits*

Parameter	No. of tests	Minimum	Maximum	Average
pH	1	4.46		
Water Soluble Sulphate (mg/l)	1	200		
SPT 'N' Value (Full Penetration)	3	6	21	11
Organic Content (%)	1	0.3		

5.4 Bedrock Deposits

Bedrock was encountered in all exploratory holes each of the progressed cable percussive and rotary open hole boreholes, in addition to WS04, from depths of 3.05m bgl (WS04) to 7.45m bgl (RBH02), to a maximum recorded depth of >55.00m bgl.

Generally, deposits comprise extremely weak to very strong thinly laminated to thickly bedded reddish brown fine and medium grained, occasionally coarse grained, sandstone, with interbedded and small bands of mudstone and siltstone within. The base of the sandstone strata was not encountered during this investigation. The boreholes were terminated at depths of between 25.00m – 55.00m bgl.

The top of the strata is generally highly weathered and was recovered as sand and gravel in several locations, occasionally with clay lenses. Material recovered as rock was heavily fractured with very closely spaced, undulating and rough sand and gravel infilled fractures. The total core recovery (TCR) in the top 5m of rock (<10m bgl) was 62%, approximately 30% lower than the TCR between 10m – 15m bgl (91%), with corresponding average Rock Quality Designations (RQD) of 18 at depths <10m bgl and 43 between 10m – 15m bgl. The average TCR and RQD for rock at depths >15m were calculated to be 96 and 62 respectively. The above indicates that the rock at depths <10m bgl is of poor to very poor rock mass quality, increasing to poor to fair between 10m – 15m bgl. Rock at depths >15m bgl is generally of good rock mass quality. Generally, he RQD increases with depth, as shown in Figure 5.4.1 overleaf.

Full details of the lithologies, rock properties, and fracture notes are presented within exploratory borehole logs, attached within *Appendix B*.

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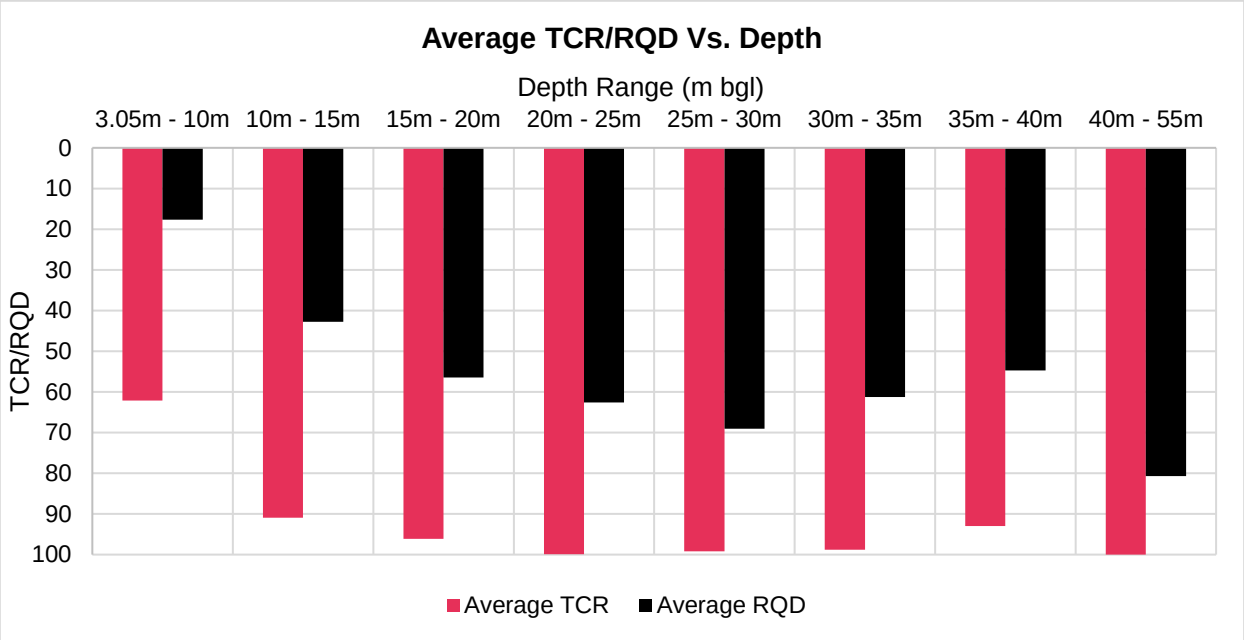

Figure 5.4.1 – *Average TCR and RQD Plotted Against Rock Depth*

A summary of the geotechnical test results recorded within the bedrock is presented in Table 5.4, below. Full details of the geotechnical test results recorded are presented in the exploratory borehole logs, in *Appendix B*, and test result certificates in *Appendix D*.

Table 5.4 – *Summary of Rock Testing Results, Bedrock*

Parameter		No. of tests	Minimum	Maximum	Average
Point Load Test (PLT) Is50 (MPa)	Axial	119	0.01	0.58	0.18
	Diametral	100	0.01	0.40	0.10
	All Tests	219	0.01	0.58	0.14
Estimated Unconfined Compressive Strength from PLT Is(50) Results (MPa)	Axial	119	0.20	11.60	3.59
	Diametral	100	0.20	8.00	1.93
	All Tests	219	0.20	11.60	2.83
Unconfined Compressive Strength (UCS) (MPa)		80	0.9	35.6	10.7
Bulk Density of Sandstone (Mg/m^3)		151	0.22	2.44	2.21
Dry Density of Sandstone (Mg/m^3)		50	1.87	2.22	2.03
Natural Water Content (%)		50	5.3	13.6	6.3
Porosity (%)		40	17	30.6	24.5
Tensile Strength by Brazilian Test (MPa)		10	0.370	1.100	0.639

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Parameter		No. of tests	Minimum	Maximum	Average
Hoek Shear Box Test **Angle of shearing resistance ϕ' (º) peak/residual** **Apparent cohesion c' (MPa) peak/residual**		10	8.5/4.5 18/8	45/40 533/354	25/18.5 235/167
Hoek Triaxial Compression Test **Internal friction angle ϕ (º)** **Apparent cohesion c' (MPa)**		8	20.5 3	40.9 7	33.6 5
Sound Velocity Test	**P Wave Travel Time (µs)**	13	48.5	126.5	76.3
	P Wave Compression (m/s)		1161	1994	1640
	S Wave Travel Time (µs)		82.5	219.4	136.0
	S Wave Compression (m/s)		642	1149	918

Overall 219 Point Load Tests (PLT) were carried out on samples of sandstone bedrock from rotary cores. PLT Is(50) values ranged between 0.01 MPa to 0.58 MPa. Comparison between the axial and diametral PLT tests indicates that, generally, the rock strength is greater when pressures are applied axially than diametrically, with maximum PLT Is(50) values of 0.58 MPa and 0.40 MPa recorded for axial and diametral tests respectively. The average PLT Is(50) value for axial and diametral tests identifies a similar trend, with values of 0.18 MPa and 0.10 MPa respectively.

An approximation of the unconfined compressive strength (UCS) of the rock may be derived from the following relationship:

PLT Is(50) x 20 = UCS.

In principle the correlation between point load test indices and UCS should be developed on a site-specific basis. Published literature indicates that a factor between 10 and 60 is possible; although a value of 20 – 25 is typical. The available dataset is not suitable to support a site-specific correlation because of the overall quantity of samples, and because of the unavoidable preferential sample selection across the available core. Consequently, a general factor of 20 has been applied (Hoek and Bray, 1981).

Using the above relationship, estimated UCS values with an overall range of between 0.20 MPa to 11.60 MPa may be derived, indicating the rock tested is Very Weak to Weak.

UCS testing was undertaken on 80 No. Rock samples, with UCS values ranging between 0.9 MPa to 35.6 MPa, indicating the sandstone samples are very weak to medium strong.

Estimates of characteristic compressive strength from PLT Is(50) values are significantly weaker than those recorded by direct UCS testing. This is likely to be due to the preferential selection of samples for the UCS testing, which given their more intact nature, are inherently stronger than those selected for point load tests. The combined dataset should provide a reasonable characterisation of the range of rock strengths encountered within the undertaken boreholes. Some variation beyond the findings of this investigation should be anticipated.

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Figure 5.4.2, below, indicates that, generally, the UCS, and estimated UCS, of the sandstone bedrock rock increases with depth.

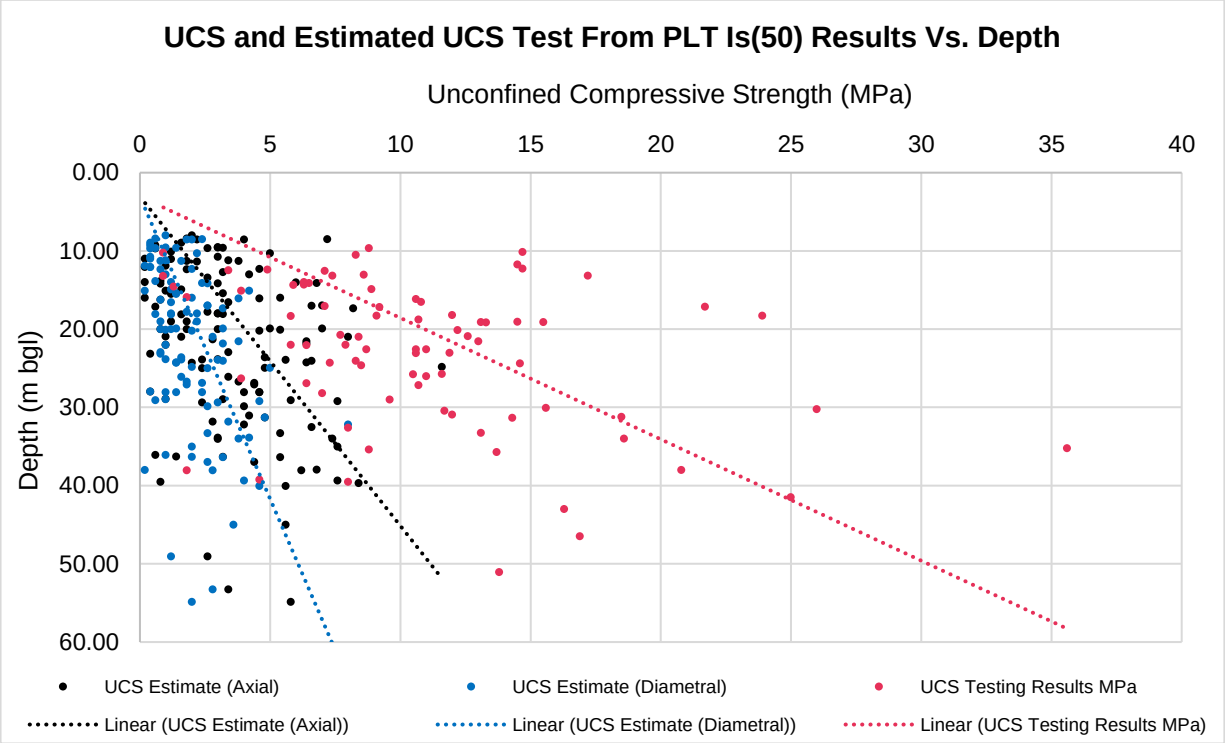

Figure 5.4.2 – *Variation of UCS Test and Estimated UCS Results with Depth*

Eight Hoek Triaxial Compression Tests were undertaken in sandstone bedrock at depths between 11.00m – 21.86m bgl. Test results indicate and internal angle of friction of between 20.5º -40.9º with an apparent cohesion of between 3 and 7 MPa.

It should be noted that the in-situ strength characteristics of the rock will be affected by the aperture and spacing of discontinuities, in addition to the strength of the rock itself, particularly where the discontinuities are very closely spaced.

The indirect tensile strength of sandstone bedrock was assessed by undertaking ten Brazil tests. The tensile strength of the rock was recorded at values between 0.370 MPa to 1.100 MPa, accounting for rock samples obtained at depths of between 9.82m to 21.89m bgl. The average tensile strength of sandstone within this depth range was 0.639 MPa. Seven samples failed by axial split, two samples failed by curved split, and one sample fractured by wedge fracture.

5.5 Observed Potential Contamination

A hydrocarbon odour was identified in WS03 at depths of between 0.10m – 1.20m bgl. This was also identified in the chemical testing results. The source of the odour was not identified in this investigation.

An organic odour was identified in BH04B between 3.40m – 3.65m bgl within dark grey sandy gravel deposits.

5.6 Obstructions Encountered

Table 5.6 below summarises the obstructions encountered during this investigation.

Table 5.6 – *Obstructions Identified*

Exploratory Hole Ref.	Depth (m bgl)	Obstructions Encountered
WS02	0.80	Dense soils. Could not be penetrated further using hand excavation methods.
BH04/A	0.45	Concrete slab.

5.7 Groundwater

Groundwater strikes were not recorded in shallow window sample or cable percussive boreholes. Due to the use of water flush in rotary cored boreholes, it was not possible to determine water strikes within bedrock during the investigation.

Table 5.7, below, summarises the groundwater levels recorded during post investigation monitoring. Full details of the response zones within window sample borehole locations and rotary cored borehole locations are included in Appendix B. Full details of the recorded water levels during post investigation monitoring visits are presented in *Appendix E*.

Table 5.7 – *Groundwater Noted During Site Investigation*

Exploratory Hole Location Ref.	Monitored Water Levels			
	Installation Strata	Response Zone (m bgl)	Depth (m bgl)	Depth (mAOD)
WS04	CLAY and SAND	2.00 – 3.00	Dry	-
WS05	SAND	2.00 – 3.00	Dry	-
WS06	SAND	2.00 – 3.00	Dry	-
WS08	SAND	2.00 – 3.00	Dry	-
WS10	SAND	2.00 – 4.00	3.44 - 3.45	-
WS11	SAND	1.50 – 3.50	Dry	-
BH02	SANDSTONE (Bands of mudstone and siltstone)	5.00 – 20.00	4.25 - 4.26	23.01 - 23.02
BH03	SANDSTONE	8.80 – 10.00	1.97- 3.93	22.66 - 24.62

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BH04B	SANDSTONE	5.00 – 20.00	3.12 - 3.18	23.37 - 23.43
RBH02	SANDSTONE (Bands of mudstone)	6.30 – 20.00	3.38 - 3.63	22.79 - 23.04
RBH03	SANDSTONE	14.50 – 16.50	-	-
RBH04	SANDSTONE	9.20 – 10.20	4.06 - 4.44	22.06 - 22.44
RBH05	SANDSTONE	5.00 – 20.00	4.18	23.09
RBH06	SANDSTONE	10.20 – 10.50	3.90	-

Groundwater was encountered within superficial deposits in WS10 only, within granular soils. Each of the remaining installations within the window sample boreholes were recorded as dry during post investigation monitoring visits.

Groundwater levels within the bedrock deposits typically rose above the monitoring installation response zone, to depths of between 1.97m – 4.44m bgl.

5.8 Aggressive Ground Conditions

The classification of the site in terms of concrete in aggressive ground is based on the guidance provided in Table C2 of the Building Research Establishment (BRE) Special Digest 1, third edition of 2005. *Table 5.8* details the classification.

It is anticipated that Made Ground and superficial soils are to be removed from site as part of the development plans. As such, the Design Sulphate and AC classifications have not been assigned for these strata.

The Chester Pebble Beds Formation is not recorded in Box C6 of the Building Research Establishment (BRE) Special Digest 1, third edition of 2005, which describes the UK Geological Formations known to contain Pyrite. The ground investigation identified ground conditions which are unlikely to present a significant risk of degradation of concrete from chemical attack. Although no samples were obtained from the rock, an absence of evidence to show the site will be impacted by the presence of elevated sulphate concentrations, or low pH values, would suggest a Design Sulphate Classification, and ACEC classification of DS-1 and AC1 respectively. Considering the mobile groundwater condition for the scheme area.

Pile designers should satisfy themselves that the concrete used within the adopted piled foundation solution, and basement construction, is suitable for the ground conditions identified on site.

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6.0 Ground and Groundwater Contamination Assessment

This section of the report includes the assessment of the potential contamination, solid, liquid and gas, identified on the subject site which may present a risk to the proposed end users, associated utilities and the wider environment.

In guidance published by the Environment Agency, the risk to human health or controlled waters is determined through an assessment of pollutant linkages between a source of contamination (within the ground or groundwater either on or off site) and a sensitive receptor such as end users of the site, building materials, edible plants grown in gardens or groundwater abstracted for drinking. This is termed a source-pathway-receptor relationship. The same model is applied to the assessment of risk arising from ground gases as detailed within BS8576:2013 (Ref. 11).

These models have a common approach, which is one of a tiered assessment. At each stage of the assessment further detail can be applied to the conceptual site model to provide a detailed interpretation on a site by site basis. As part of the planning process this approach is adopted to establish either if the site is 'suitable for use' or whether additional work or else remedial work is required for the site to be deemed so.

The sub-sections hereafter therefore incorporate the first tier (Tier 1) of this approach otherwise referred to as the Generic Quantitative Risk Assessment (GQRA). The GQRA builds on the qualitative risk assessment presented in the Phase 1 Desk Study in conjunction with observations made during the ground investigation and is based solely on the results of the chemical and other testing data obtained as part of Curtins ground investigation. The GQRA is used to build/refine the Conceptual Site Model (CSM) for the site as detailed and presented in *Section 8.0* of this report.

The following sections present more detail on the risk assessment methodology rationale for the main receptors.

6.1 Human Health GQRA

Detailed guidance on human health risk assessment is available within several documents, published by both the Environment Agency and Defra. Guidance includes Contaminated Land Exposure Assessment (CLEA) v1.071 model (Ref. 12), Science Report 2 (Ref. 13) and Science Report 3 (Ref. 14).

A generic quantitative risk assessment (GQRA) has been carried out for the Potential Contaminant Linkages (PCLs) investigated by screening of soil contamination data against relevant Generic Assessment Criteria (GAC) where available, including:

i) **Soil Guideline Values (SGVs):** These have been published by the Environment Agency and are trigger values for screening out low risk areas of land contamination. SGV's give an indication of representative average concentrations of chemicals in soil, below which long-term health risks are likely to be minimal. SGVs have been published for several contaminants

including arsenic, cadmium, mercury, nickel, selenium, BTEX, phenols and dioxins, furans and dioxin-like PCB substances for land uses including residential, allotments and commercial. The SGVs have been developed for a sandy loam soil with 6% soil organic matter (SOM) content;

ii) **Supplementary Screening Values (SSVs):** In addition to the SGVs developed by the EA, other third party organisations have derived SSVs for a wider range of contaminants and land uses using the CLEA Model. Curtins have adopted these numbers where applicable, including those developed by Atkins AtriskSoil™, the LQM/CIEH Suitable for Use Levels (S4UL) and EIC/AGS/CL:AIRE published thresholds;

iii) **Category 4 Screening Levels (C4SLs):** In March 2014 Defra published C4SLs for arsenic, benzene, benzo(a)pyrene, cadmium, hexavalent chromium and lead. These values were derived to support the revised Part 2A Statutory Guidance issued in 2012 (Ref.15) in which four categories of contaminated land are included, ranging from Category 1 (significant/high risk) to Category 4 (low risk). C4SLs are not representative of significant possibility of significant harm (SPoSH) and are low risk levels which, and therefore where the C4SLs are not exceeded, land can be demonstrated to be in Category 4 and cannot be determined as contaminated land.

6.1.1 Adopted Soil Human Health GACs Screening Methodology

The use of the site, noted as generally high rise (up to 52-storeys) buildings comprising residential apartments with retail, leisure and commercial spaces with single and dual storey basements; is most analogous with a *commercial* end-use scenario and so assessment has been undertaken against the following GACs, in order of preference:

1. Environment Agency Soil Guideline Values,
2. CL:AIRE, AGS, EIC. Soil Generic Assessment Criteria for Human Health Risk Assessments,
3. LQM/CIEH 2015 S4ULs for Human Health Risk Assessment, and
4. DEFRA Category 4 Screening Levels.

The soil organic matter (SOM) content has an influence on the volatilisation of organic contaminants (i.e. the higher the SOM, the lower the volatilisation rate and therefore inhalation exposure risk). Soil organic matter (SOM) values for the site soils ranged significantly from 0.2% w/w to 21.4% w/w. the greatest concentrations of soil organic matter were encountered in WS02 at 0.20m, WS03 at 0.30m, WS05 at 0.80m and WS10 at 0.50m (21.4%, 14.9%, 11.2% and 17.5% w/w respectively). Soils where, or directly above where, these samples were obtained from, with the exception of WS02 recorded the presence of slag, and or wood fragments, and the high concentrations are attributed to these features. A strong diesel odour was recorded in WS03.

With consideration for a calculated geometric average, Made Ground features determine an SOM of 4.94% w/w while natural soils maintain a lower valuation of 0.56% w/w. As such, a

comparison against Tier 1 thresholds for a conservative SOM of 2.5% for Commercial end use has been adopted for Made Ground, and a SOM of 1.0% for natural soil features.

The adopted GAC's are listed in *Appendix F*.

6.1.2 Generic Assessment Criteria Screening of Soil Laboratory Results

The results of the environmental testing can be referred to in *Appendix C*.

With respect to the proposed end use of the site, no exceedances are noted within recovered soil samples.

Concentrations of SVOCs above the limit of detection of the laboratory testing methodology were identified in four soil samples. These are outlined in Table 6.1.2 below.

Table 6.1.2 – *SVOC Concentrations Identified Above the LOD of the Testing Methodology in Tested Soil Samples.*

Exploratory Hole ID	Depth (m bgl)	Stratum	Determinant	Concentration (µg/kg)
RBH06	0.40	Made Ground	Perylene	276
WS03	0.30	Made Ground	Dibenzofuran Carbazole* 2,4-Dinitrotoluene 1,4-Dichlorobenzene 1,2-Dichlorobenzene 2-Methylnaphthalene Perylene	6150 3680 1190 1400 9190 2280 4490
WS03	1.00	Made Ground	Dibenzofuran Carbazole* 2,4-Dinitrotoluene 2,4-dimethylphenol 1,4-Dichlorobenzene 1,2-Dichlorobenzene 2-Methylnaphthalene Perylene	2710 1110 1230 1320 1350 7440 3460 2760
WS02	0.30	Made Ground	Dibenzofuran Carbazole* 2-Methylanphthalene Perylene	644 683 751 1120

Selected soil samples were screened for asbestos. No suspected asbestos containing materials (ACMs) were identified in the exploratory hole logs and laboratory screening confirmed that asbestos was absent in the soil samples tested.

On 17th July 2018, asbestos boarding was identified during trial trenches undertaken as part of an archaeological investigation, running simultaneously with this intrusive investigation. A sample was not obtained for screening.

6.2 Controlled Waters GQRA

A model for assessing the potential for pollution of controlled waters and for deriving a safe concentration in ground and groundwater is the Environment Agency's publication "Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination' (Ref. 16)

In relation to the standards for controlled waters, there are currently no generic groundwater standards or surface water standards that are necessarily applicable to all sites.

However, dependant on the receptor identified as being at risk, see *Section 6.2.1*, the UK Drinking Water Standards (Ref. 17), Surface Water (Abstraction for Drinking Water and/or Water Framework Directive Water Quality Standards (WFD WQS) (Ref. 18)) can be utilised as primary screening values in a Level 1 assessment. These can also be supplemented by World Health Organisation (WHO) guidelines (Ref. 19), where WFD or DWS water quality standards (WQS) do not exist.

In addition to surface and groundwater samples a soil leaching test can be undertaken to provide a preliminary, conservative, assessment of the potential for contaminants in the soil to pollute ground or surface water. Leachate test results are screened in the same way as for groundwater above.

6.2.1 Adopted Controlled Waters Tier 1 Screening Values and Methodology

The results of laboratory analysis of groundwater have been assessed against water framework directive (WFD) WQS, due to the proximity of the River Irwell to the north of the site. The site is underlain by a Principal Aquifer, associated with the Chester Pebble Beds Formation, and so groundwater chemical testing results have also been assessed against UK Drinking Water Standards.

The adopted Level 1 Screening Values are listed in *Appendix F*.

6.2.2 Tier 1 Screening of Groundwater Laboratory Results

The results of the environmental testing can be referred to in *Appendix C*.

With respect to the proposed end use of the site, several exceedances are noted within recovered soil samples as detailed below.

Table 6.2 – *Exceedances Recorded in Groundwater Chemical Testing Results*

Determinant	Tier 1 Value (µg/l)	Min Conc. (µg/l)	Max Conc. (µg/l)	Samples > Tier 1 Value
Copper	**1[1]** *2000*	<1	**3**	**RBH02 (3 µg/l)**
Chromium	**4.7** *50*	1	**13**	**RBH02 (10 µg/l)** **BH04 (13 µg/l)** **BH02 (7 µg/l)**
Nickel	**4[1]** *20*	<1	**6**	**BH02 (6 µg/l)**

Selenium	**-** *10*	<1	*27*	*RBH02 (27 µg/l)*
Zinc	**10.9[1]** *5000*	1	**13**	**BH02 (13 µg/l)**
Anthracene	**0.1** -	<0.01	**0.74**	**RBH02 (0.74 µg/l)** **BH02 (0.69 µg/l)**
Benzo(a)pyrene	**0.00017** *0.01*	<0.01	***3.06***	***RBH02 (3.06 µg/l)*** ***BH04 (0.02 µg/l)*** ***BH02 (2.01 µg/l)***
PAHs Sum of: benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene and indeno(1,2,3-c,d)pyrene	**-** *0.1*	<0.01	*7.60*	*RBH02 (7.60 µg/l)* *BH02 (5.78 µg/l)*
Fluoranthene	**0.0063**	**0.01**	**5.94**	**WS10 (0.01 µg/l)** **RBH02 (5.94 µg/l)** **BH04 (0.03 µg/l)** **BH02 (4.71 µg/l)**

Note: **EQS (Freshwater)** screening values in bold, *EU DWS* thresholds are in italics.
Bioavailable fraction.

The chemical testing results identified exceedances, with respect to Water Quality Standards, of numerous heavy metals and PAHs, primarily within RBH02, centrally located within the site, and BH02, at the north of the site. Slightly elevated chromium concentrations were also identified in BH04 at the east of the site.

With respect to EU DWS, limited exceedances of selenium (RBH02) were recorded, in addition to PAH concentration exceedances in RBH02 and BH02, and a very minor exceedance of benzo(a)pyrene in BH04.

The site is located in Manchester city centre, which historically was heavily industrialised throughout the surrounding area. Although it is considered likely that the exceedances recorded in Table 6.2, above, are associated with downward migration of contaminants from on-site Made Ground soils, leaching into bedrock, it is likely that the contaminants are also indicative of the wider historic, industrial, land use of the city centre. It is noted that due to the construction of the double storey basement, all potential sources of contamination within Made Ground will be removed from the site.

6.3 Water Supply Pipe Assessment

It is anticipated that Made Ground soils and superficial soils are to be excavated and removed from site to facilitate the construction of a basement. As such, it is likely that PE/PVC pipes may be used however the exact requirements are to be confirmed with the relevant utility supplier.

6.4 Materials Management

6.4.1 Re-use of Site Soils

Based on the geochemical testing results presented as part of this investigation it is considered that there is no specific requirement to remove soils from site because of them presenting an unacceptable risk to human health or the environment.

The re-use of site-won soils may therefore be undertaken if the following principles are met: i) the geotechnical suitability of the material needs to be confirmed; ii) the re-use of the material needs to be covered as part of the planning approval, e.g. site levels maintained within agreed limits; iii) the volume of the material being re-used needs to be confirmed and traceable and iv) regulatory approval from the relevant authorities has been sought. These principles are outlined within the CL;AIRE Definition of Waste Code of Practice (v2) and if and where the re-use of site-won soils is proposed as part of the development works it is recommended that a Materials Management Plan is produced in line with the Definition of Waste Code of Practice to detail and document the process.

6.4.2 Material Classification

It is envisaged that significant volumes of material are to be removed from site to facilitate the construction of a dual storey basement.

Where any site soils are to be disposed of off-site guidance on the disposal of contaminated soils is provided within the following document published by the Environment Agency, the Guidance on the classification and Assessment of Waste Technical Guidance WM3 (1st Edition 2015) (Ref. 20).

Guidance states that the principal contractor (or any other sub-contractor undertaking excavations) should, in conjunction with the proposed disposal facility, use where possible the relevant environmental chemistry analyses results to classify any surplus material identified for off-site disposal. However, it should be noted that this information is for guidance only and material identified for disposal should be tested and assessed in accordance with WM3 to enable classification during the works.

An initial assessment for the waste classification of the shallow and deeper Made Ground soils encountered on site has been carried out through a comparison of the soil testing results against the Tier 1 Thresholds and using the Waste Soils Characterisation Assessment Tool, Cat-WasteSoil, developed by McArdle and Atkins. This online tool gives a rapid assessment of contaminated soils and their classification as either hazardous or non-hazardous (stable non-reactive hazardous waste) waste, it should be noted that this tool does not classify inert waste.

Persistent Organic Pollutants (POP's) were not tested for as part of the investigation, however based on the Conceptual Site Model the risk of these being present on the site is considered low.

The initial assessment revealed that of the nineteen Made Ground soils tested, seventeen soil samples have indicated to be non-hazardous with respect to Environment Agency waste classes, using the guidance given in WM3. However, two samples have indicated to be hazardous waste for off-site disposal owing to the concentrations of copper and zinc (RBH06 at 0.40m bgl) and benzo(a)anthracene, diesel, copper, lead and zinc (WS03 at 0.30m bgl). A strong diesel odour was identified in WS03 during the service clearance pit, thought to be associated with a historic diesel spill.

In addition to the samples tested, chrysotile board was identified in archaeological trenches undertaken simultaneously with this investigation. A sample of the material was not tested. It is considered likely that more asbestos will be present in locations not tested during this investigation. Additional testing should be undertaken during the excavation phase to confirm the hazardous waste classification of material prior to removal from site.

The initial assessment of the seven natural soil samples tested may be considered non-hazardous waste for off-site disposal. Where natural soils are being considered for off-site disposal as inert waste, Waste Acceptance Criteria (WAC) testing should first be undertaken with confirmation of acceptability from the receiving landfill.

As discussed, preliminary waste classification is undertaken to offer indicative advice with respect to disposal requirements. Landfill operators are not obliged to accept waste and, if they were to do so, may have specific requirements beyond those outlined above prior to acceptance. Landfill operators should be contacted to confirm the above classifications or otherwise.

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7.0 Ground Gas Assessment

The assessment of risk presented by ground gases is assessed with reference to guidance published by CIRIA (Assessing Risks Posed by Hazardous Ground Gases to Buildings, C665 (Ref.21), BSI Publication (Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings BS8485:2015 (Ref.22) and other broadly accepted references such as the Ground Gas Handbook 2009 (Ref.23).

The gas risk assessment adopts a tiered approach. In the first instance this involves a re-evaluation of the Conceptual Site Model described within the Phase 1 Preliminary Site Assessment (desk study) and thereafter validating this conceptual model with the ground gas data, the semi-quantitative risk assessment.

7.1 Ground Gas Monitoring Results

To characterise the site's ground gas regime and validate the qualitative assessment of ground gas risk 50mm standpipe installations were incorporated within the six window sample borehole locations and four rotary cored borehole locations. 19mm piezometers were within four rotary cored borehole locations. The details of the response zone of each monitoring installation are outlined in *Section 3.2*.

An initial programme of six gas monitoring visits over three months was proposed. Three gas monitoring visits have been undertaken between 26th July and 23rd August 2018, with barometric pressure recorded between 1009 mb and 1011 mb and the monitoring period included one monitoring visit following precipitation. The results log sheets are contained within *Appendix E* and summarised in *Table 7.1*.

Table 7.1 – *Summary of Ground Gas Monitoring Results*

Exploratory Hole ID	Maximum Methane Concentration (%)	Maximum Carbon Dioxide Concentration (%)	Minimum Steady Oxygen Concentration (%)	Maximum gas flow (l/hr)	
				Peak	Steady State
WS04	<0.1	5.2	12.2	-*	<0.1
WS05	<0.1	3.4	16.0	-*	<0.1
WS06	<0.1	1.8	19.0	-*	<0.1
WS08	<0.1	0.4	17.0	-*	<0.1
WS10	<0.1	1.5	18.5	-*	<0.1
BH02	<0.1	4.0	2.5	-*	<0.1
BH03	<0.1	0.9	18.1	-*	<0.1
BH04	<0.1	0.2	20.5	-*	<0.1
RBH02	<0.1	0.2	19.0	-7.0	-2.3/1.0
RBH04	<0.1	1.7	17.0	-*	-0.1
RBH05	<0.1	0.3	20.9	16.1	0.3
RBH06	<0.1	0.2	19.7	-	-

Note: WS11 and RBH03 are located within a demolition exclusion zone. These wells could not be monitored.
* Peak flow rate not recorded.

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Methane (CH_4), carbon monoxide (CO) and hydrogen sulphide (H_2S) concentrations were recorded below the monitoring instrument's limit of detection within all the monitoring wells throughout the monitoring period.

Carbon Dioxide (CO_2) was recorded in peak concentrations between 0.2% and 5.2%. The greatest concentrations were recorded in WS04, BH02 and WS05.

Maximum, peak, gas flow was recorded between <0.1 and 16.1 litres per hour (l/hr), returning to steady state flow rates of between <0.1 and 1.0 l/hr. Peak flow rates in RBH02 of -7.0 l/hr were recorded, returning to a steady state flow rates of between -2.3 and -1.4 l/hr after 5 minutes on the first monitoring visit.

The highest concentrations of carbon dioxide were consistently recorded from WS04, centrally within the site, with carbon dioxide concentrations of between 4.5% v/v to 5.2% v/v recorded.

7.2 Ground Gas Assessment

The Preliminary Site Model presented in *Section 2.8* identified possible Made Ground deposits as a potential source of Ground Gas generation, both on-site and off-site, resulting from historical development and land use.

A review of geological mapping suggests no records of organic rich drift deposits (e.g. peat) being present. A historic infilled canal is present at orientated northwest to southeast across the centre of the development site, and south to north beneath the existing Old Granada Studios building. This could act as a source of ground. Coal deposits are noted to not underlie the site.

Noxious and asphyxiate gases were attributed to include, but not limited to, carbon dioxide, carbon monoxide, methane and hydrogen sulphide. The consequence was evaluated as Moderate risk.

Made Ground soils were encountered to depths of between 0.60 m to 6.25m bgl with limited putrescible content generally. Soils within WS02 (0.20m), WS03 (0.30m), WS05 (0.80m) and WS10 (0.50m) identified soil organic matter concentrations of >10% w/w.

The ground investigation revealed a ground model generally consistent with the preliminary conceptual site model. Natural deposits were generally sand with no significant putrescible/organic content, however one localised band of 'black spongey peat' was recorded at 2.00m – 2.20m bgl in RBH03. Sandstone bedrock was encountered at depths of between 3.05m (WS04) and 6.25m (RBH02) bgl.

To facilitate the construction of the basement, significant volumes of Made Ground and superficial soils are to be removed from the site. The base level of the basement is likely to be constructed within bedrock deposits, some circa 6m below existing ground level. Consequently, ground gas results from the window sample boreholes are unlikely to be representative of the ground conditions and have

therefore been discounted from the following analysis. Table 7.2, below, summarises the results considered to be representative of ground conditions for the proposed development.

Table 7.2 – *Representative Ground Gas Monitoring Results*

Exploratory Hole ID	Maximum Methane Concentration (%)	Maximum Carbon Dioxide Concentration (%)	Minimum Steady Oxygen Concentration (%)	Maximum gas flow (l/hr)	
				Peak	Steady State
BH02	<0.1	4.0	2.5	-	<0.1
BH03	<0.1	0.9	18.1	-	<0.1
BH04	<0.1	0.2	20.5	-	<0.1
RBH02	<0.1	0.2	19.0	-7.0	-2.3/1.0
RBH04	<0.1	1.7	17.0	-	-0.1
RBH05	<0.1	0.3	20.9	16.1	0.3
RBH06	<0.1	0.2	19.7	-	-

* Peak flow rate not recorded

Consideration of the recorded soil gas flow rates, presented above, enables hazardous gas flow rates to be evaluated. Q_{hg} can be derived for both 'representative' and 'worst case' scenarios and a comparison made in support of an appropriate assessment of ground gas risk.

The ground gas monitoring data is considered to be representative, given the varying ground conditions, ambient weather conditions and barometric pressures recorded throughout the monitoring period. Therefore, steady state gas flow rates are considered the most appropriate, discounting negative peak flow rates recorded where groundwater levels may have influenced the peak flow rate.

Evaluation of the 'representative' Q_{hg} for carbon dioxide (highest steady state gas flow rate that is realistically possible in a single borehole) records a maximum Q_{hg} of 0.0040 l/hr, from RBH02.

Evaluation of the 'worst case' Q_{hg} for carbon dioxide (highest steady state gas flow rate that is realistically possible in any borehole on any occasion) records a maximum Q_{hg} of 0.0400 l/hr.

The 'representative' scenario has been adopted as the sites Gas Screening Value (GSV) and in accordance with an assessment by CIRIA C665 the GSV indicates a Characteristic Situation 1 (CS1) gas regime which does not require any gas protection measures.

The potential risks from ground gases to the excavations are to be dealt with by the Contractor, in accordance with the Confined Space Regulations, during construction. Appropriate ground gas monitoring and safety measures should be in place during the works, as the potential presence of ground gases could pose a risk in any confined spaces of deep excavations.

8.0 Revised Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) presented in the previous Phase 1 reports and discussed in *Section 3.0* of this report has been revised following the GQRA in *Section 6.0* above. The Revised Conceptual Site Model (CSM) is summarised in the table overleaf and graphically presented as *Appendix A*.

The CSM details the source-pathway-receptor linkages or potential pollutant linkages (PPL) that have been identified as relevant for the site. The GQRA details the associated level of risk relating to these potential pollutant linkages.

The CSM follows the framework outlined within CIRIA C552 (Ref. 24) which is summarised within *Appendix G*.

The 'risk rating' within the CSM refers to the risk that the source, pathway, receptor linkage or PPL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

Risks presented by Unexploded Ordnance is discussed and assessed in *Section 2.6*.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 (Ref. 25) which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements. Reference should be given to the environmental testing results discussed within *Section 8.0* and presented within *Appendix C*.

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Qualitative Risk Assessment → Generic Quantitative Risk Assessment → Detailed Quantitative Risk Assessment or; Remedial Action

- The table below represents the Second stage in the land quality risk assessment process; the Revised Conceptual Site Model following the Quantitative Risk Assessment.
- For a development site to be deemed 'suitable for use' the level of risk needs to be brought down to acceptable levels, i.e. low to very low risk. The purpose of each stage of risk assessment is ultimately to establish if there is a requirement for additional levels of assessment to be made to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.
- In the absence of specific site data, a Generic Quantitative Risk Assessment is invariably recommended.

Conceptual Site Model			Generic Qualitative Risk Assessment			Comments	Action
Identified Source	**Pathway(s)**	**Receptor(s)**	**Consequence**	**Likelihood of Occurrence**	**Risk Rating**		
Made Ground soils derived from historical development and land use as a source of contamination.	Direct contact and dermal uptake, soil and dust ingestion, dust* and migration inhalation (indoor & outdoor air)	Commercial end users	Medium	**Unlikely**	**Low**	It is anticipated that all Made Ground soils will be excavated and removed from the site to facilitate the construction of the basement. This will remove any potential source of contamination from the site, breaking the SPR linkage. Chemical testing results do not identify any exceedances with respect to the nominated screening criteria. Asbestos boarding was identified in archaeological trenches undertaken simultaneously with this investigation. The material was not quantified. It is considered likely that more asbestos may be present in other locations across the site. As discussed, Made Ground soils are to be removed from site, limiting the likelihood of exposure to site end users. Construction workers are to be provided with appropriate PPE during all construction activities, to limit the likelihood of exposure to contamination sourced within Made Ground soils.	**Construction and groundworkers to be provided with appropriate PPE.** **No further action required.**
	Direct contact and dermal uptake, soil and dust ingestion, dust* & migration inhalation (outdoor air)	Construction and maintenance workers	Mild (Standard Health & Safety precautions likely to be used by workers)	**Unlikely**	**Very Low**		
	Soil dust and vapour ingestion/inhalation produced during construction (indoor and outdoor air)	Adjacent residents	Medium	**Unlikely**	**Low**	Four soil samples (RBH06 at 0.40m, WS02 at 0.30m and WS03 at 0.30m and 1.00m) recorded the presence of SVOCs. All samples are located within 'Zone 1' at the north of the site. Contaminants are likely to have volatilised prior to exposure to members of the public.	**No further action required**
	Downward vertical migration through superficial soils	Controlled Waters Principal Aquifer (Bedrock) Chester Pebble Beds Formation (Sandstone)	Medium	**Unlikely**	**Low**	Groundwater chemical testing results indicated exceedances of selenium, and several PAHS, when compared against EU DWS. No potable groundwater abstractions are located within 250m of the site, limiting the likelihood of exposure to the relatively minor concentrations identified. It is anticipated that Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement. The removal of Made Ground soils will remove the potential source of contamination. As such, no further action to address the elevated concentrations identified in the groundwater samples tested is required.	**No further action required.**
	Vertical and horizontal migration through superficial soils and bedrock	Controlled Waters Surface Water (River Irwell approximately 60m northwest)	Medium	**Unlikely**	**Low**	The chemical testing results identified exceedances, with respect to Water Quality Standards, of numerous heavy metals and PAHs. Contaminants from Made Ground soils may have leached into the underlying aquifer, although it likely that the concentrations identified are indicative of background concentrations associated with historical industrial land use in Manchester city centre. It is anticipated that Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement. The removal of Made Ground soils will remove the potential source of contamination. As such, no further action to address the elevated concentrations identified in the groundwater samples tested is required.	**No further action required.**

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Conceptual Site Model			Qualitative Risk Assessment			Comments	Action
Source	**Pathway(s)**	**Receptor(s)**	**Consequence**	**Likelihood of Occurrence**	**Risk Rating**		
Production of ground generating gases from: • Made Ground deposits containing organic/ putrescible content; • Infilling of canal basin directly beneath the site; • Historic St. Johns Church Graveyard.	(Ground gas & vapour) migration and inhalation	Commercial end users	**Medium**	**Unlikely**	**Low**	Made Ground soils are to be excavated and removed from the site to facilitate the construction of the basement. As such, any source of ground gas generation will be removed from the site.	**No further action required.** **Should development plans change, this recommendation may be reassessed.**
		Construction and maintenance workers	**Medium**	**Unlikely**	**Low**		
Bedrock deposits as a source of ground gas generation		Commercial end users	**Medium**	**Unlikely**	**Low**	Ground gas monitoring results recorded a maximum carbon dioxide concentration of 4% v/v in BH02 on the third monitoring visit. Methane concentrations were recorded below the limit of detection of the monitoring equipment on each visit throughout the monitoring period. Steady state gas flow rates recorded from this borehole were recorded at <0.1 l.hr on each monitoring visit. A representative Qhg of 0.004 l/hr for carbon dioxide was calculated, corresponding with a Characteristic Gas Situation of CS1, where ground gas protection measures are not required.	**No further action required.**
		Construction and maintenance workers	**Medium**	**Unlikely**	**Low**		

8.1 Summary of Significant Pollutant Linkages

A **Low** to **Very Low** risk to presented to site end users and construction workers from Made Ground soils. No exceedances with respect to the nominated GACs were recorded in any soil samples tested, and all Made Ground soils are likely to be removed from the site to facilitate the construction of a single and dual storey basement. Construction workers should be provided with appropriate PPE during all earthworks and groundwork activities.

A **Low** risk is presented to site end users and construction workers from ground gas migration from Made Ground and natural sources. In accordance with an assessment by CIRIA C665, the calculated gas screening value (GSV) indicates a Characteristic Situation 1 (CS1) classification may be assigned to the site, indicating no gas protection measures are required for the proposed development.

A **Low** risk is presented to controlled waters (Groundwater). Limited exceedances of selenium and PAHs were identified in groundwater samples when compared against EU DWS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, and no potable groundwater abstractions are located within 250m of the site.

A **Low** risk is presented to controlled waters (Surface water). Exceedances of heavy metals and PAHs were identified in groundwater samples when compared against WFD EQS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, removing a potential source of contamination.

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9.0 Engineering Assessment and Recommendations

9.1 Introduction

This section will assess the relevant geotechnical issues for the proposed redevelopment as generally high rise (up to 36-storeys,140m above ground level) buildings comprising residential apartments with retail, leisure and commercial spaces with a dual storey basement. The proposed development plan is contained within *Appendix A*. The engineering assessment considers foundation design, excavations, and ground floor slabs for the site. It should be noted that detail may change in the development of designs beyond the issue of this Phase 2 Report and the Construction designer should satisfy themselves regarding the adequacy of their design and proposed approach to construction by reference to the on-going project design proposals, the site investigation information and their own examination of the site.

9.2 Summary of Ground Conditions

The ground conditions at the site generally comprised Made Ground underlain by superficial and residual soil deposits predominately comprising of Sand and Gravel underlain by Chester Pebble Beds Sandstone Formation. Groundwater monitoring recorded groundwater to be between 1.97m – 4.44m bgl with potential artesian groundwater conditions.

The geotechnical parameters recommended for use in the design based on the ground conditions encountered are summarised in *Table 9.2* below.

Table 9.2 – Geotechnical Parameters

Parameter	Granular superficial deposit / residual soil	Sandstone
Unit Weight, γ (kN/m^3) (1)	18	22
Effective Angle of Shearing Resistance, Φ' (°) (2)	34	38
Unconfined compressive strength based on laboratory testing and logging (MPa): – 8.0m bgl – 12.0m bgl – 16m bgl – 24m bgl – 40m bgl		 1 2 6 9 11
Drained Modulus of Elasticity, E' (kPa) (3)	15,000	100-150,000

(1) From published sources (BS8002) and laboratory test results.
(2) Estimated from the relationship between SPT 'N' Value and angle of shearing resistance (Peck et al, 1976) laboratory testing and published values (Hoek & Bray 1974).
(3) From published relationships and sources CIRIA R103, R143, R181 [Ref.27] and C504).

9.3 Excavation and Support

Based on observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to <1.00m bgl should stand unsupported in the short term (1-14 days). Side support for safety purposes should of course be provided to all excavations which appear unstable, and those >1.20m deep, in accordance with Health and Safety Regulations.

Suitable side slope angles excavated in Clay is likely to be in the region of 20-35 degrees when wet, increasing to 35-45 degrees when dry, based on guidance provided by CIRIA report 97 Trenching Practice (Ref.28). Within Sand and Gravel, it is likely to be in the region of 30-40 degrees when dry, decreasing to 10-30 degrees when wet.

Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. However buried obstructions associated with service runs and significant foundations are expected to be present underlying the current buildings. An allowance should be made for breaking out any concrete which may be encountered.

Monitoring recorded groundwater levels within the bedrock deposits typically above the monitoring installation response zone, to depths of between 1.97m – 4.44m bgl. Therefore, groundwater ingress is likely once rockhead is penetrated. This is likely to cause instability to excavations and may hinder construction of the basements and foundations. It is recommended that groundwater monitoring should continue to allow a greater understanding the groundwater regime at the site with consideration to installing additional monitoring points around the site.

Temporary earthworks support is envisaged to allow the proposed construction which may be in the form of sheet piled walls.

9.4 Foundation Design

The developments range in scale and height from 46m to 140m above ground (9-35 storeys respectively) with both the shortest and tallest buildings in Zone 1, two buildings some 46m and 105m above ground (10 and 31 storeys respectively) are proposed in Zone 6 with one building 114m above ground (35 storey) in Zone 7 proposed. It is understood that the proposed foundations may comprise of a combination of pads, rafts and piles.

The Made Ground and the superficial deposits are not considered to be suitable founding stratums due to the likely significant loadings for a high-rise building and it is considered that a piled foundation solution is adopted designed as end bearing in the sandstone bedrock. However, pad foundations for the low-rise buildings may be suitable founding in the superficial deposits /completely weathered sandstone.

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Assuming foundation excavations to approximately 4.5mbgl and founding strata having bearing capacity characteristics not less than those of very dense sand then square pad foundations with may be designed to a bearing resistance of approximately 400-600kN/m^2

If excavations are taken deeper to found in the partially weathered Sandstone at approximately 8.0m bgl, then spread foundations on may be designed using the method of presumed bearing resistance. The method is based on the relationships outlined in BS EN 1997-1:2004. Assessment of the Chester Pebble Beds based on field descriptions, lab test results and discontinuity spacing indicates that the sandstone beneath the upper weathered layer, provides a presumed bearing resistance of approximately 600 - 1000 kN/m^2. This assessment assumes square pad foundations bearing onto the weak sandstone for settlements not exceeding 0.5% of the total foundation width. These initial estimates should be reassessed on a plot by plot case and should be undertaken once loadings and configurations are known. If the founding horizon reveals very closely spaced discontinuities, then it would be prudent to adopt a lower presumed bearing resistance. All foundation excavations should be approved by a suitably experienced Geotechnical Engineer.

For the high-rise buildings it is considered that a piled foundation be adopted to accommodate the anticipated significant loads. The load capacity of the piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

Initial estimates in accordance with Eurocode 7 (Ref.7) indicate that a bored pile of 750mm diameter and 16m length would provide a total design resistance of 11,025 kN for combination 1 and 6228 kN for combination 2. Increasing to 14,502 kN combination 1 and 8110 kN combination 2 for a 900mm diameter bored pile of 16m length.

However, this initial estimate should be reassessed on a plot by plot case. This should be undertaken once loadings and configurations are known. It is also recommended that additional analysis be undertaken to model the pile interaction with the sandstone and to obtain a greater understanding of the pile carrying capacity and settlement. From this additional analysis it may become evident that another phase of site investigation and testing may be required to fully validate the detailed design.

Modulus of subgrade reaction values on the weathered Sandstone at 4.5m bgl have been estimated between 7.0MN/m^3 and 13.0MN/m^3 with values between 10.0MN/m^3 and 21.0MN/m^3 at in the partially weathered sandstone at 10.0m bgl, however, this should be reassessed on a plot by plot basis.

Due to the likely presence of groundwater into excavations once rockhead is penetrated a contiguous pile or secant piled foundation should be considered to reduce groundwater flow into excavations to

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enable basements to be constructed. Hydrostatic uplift should be considered as part of the detailed design following additional groundwater monitoring to develop the groundwater model at the site

9.5 Ground Floor slabs

It is recommended that all ground slabs should be suspended to account for the high structural loads and any potential hydrostatic uplift. Basement slabs should be developed to span between foundations to resist buoyancy. The potential risk of floatation should be considered in the temporary condition during construction.

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10.0 Conclusions & Recommendations

10.1 Conclusions

A revised tabulated revised Conceptual Site Model has been derived following the findings on the Generic Quantitative Risk Assessment risk assessment and is presented in *Section 8.0*.

10.1.1 Geotechnical Assessment

The proposed development range in in scale and height from 46m to 140m above ground with a dual storey basement. It is understood that the proposed foundations may comprise of a combination of pads, rafts and piles.

The Made Ground and the superficial deposits are not considered to be suitable founding stratums due to the likely significant loadings for a high-rise building and it is considered that a piled foundation solution is adopted designed as end bearing in the sandstone bedrock. However, pad foundations for the low-rise buildings may be suitable founding in the superficial deposits /completely weathered sandstone.

Square pad foundations maybe suitable for the low-rise buildings with a presumed bearing resistance of approximately 400-600kN/m^2 founding at 4.5m bgl in the weathered Sandstone increasing to approximately 600 - 1000 kN/m^2 at 8.0m bgl founding in the partially weathered sandstone.

For the high-rise buildings it is considered that a piled foundation be adopted to accommodate the significant loads. Initial estimates in accordance with Eurocode 7 (Ref.7) indicate that a bored pile of 750mm diameter and 16m length would provide a total design resistance of 11,025 kN for combination 1 and 6228 kN for combination 2. Increasing to 14,502 kN combination 1 and 8110 kN combination 2 for a 900mm diameter bored pile of 16m length.

Due to the likely presence of groundwater into excavations once rockhead is penetrated a contiguous pile or secant piled foundation should be considered to reduce groundwater flow into excavations to enable basements to be constructed.

It is recommended that all ground slabs should be suspended to account for the high structural loads and any potential hydrostatic uplift. Basement slabs should be developed to span between foundations to resist buoyancy. The potential risk of floatation should be considered in the temporary condition during construction.

Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. An allowance should be made for breaking out and removing any encountered concrete obstructions associated with existing foundations. Temporary earthworks

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support is envisaged to allow the proposed construction within the Made Ground outside the permanent basement wall, which may be in the form of sheet piled walls, subject to design by a temporary works engineer.

10.1.2 Ground and Groundwater Contamination

The environmental chemistry soil results have been compared with the Tier 1 criteria for soils with respect to human health against '*Commercial*' thresholds. No exceedances were recorded in any of the soil samples tested with respect to these thresholds. Four Made Ground soil samples at the north of the site recorded minor concentrations of SVOCs. All Made Ground soils are likely to be removed from the site to facilitate the construction of a single and dual storey basement. Construction workers should be provided with appropriate PPE during all earthworks and groundwork activities.

A **Low** risk is presented to controlled waters (Groundwater). Limited exceedances of selenium and PAHs were identified in groundwater samples when compared against EU DWS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, and no potable groundwater abstractions are located within 250m of the site.

A **Low** risk is presented to controlled waters (Surface water). Exceedances of heavy metals and PAHs were identified in groundwater samples when compared against WFD EQS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, removing a potential source of contamination.

10.1.3 Ground Gas Assessment

Three gas monitoring visits have been undertaken to date, with a maximum carbon dioxide concentration of 4.0% v/v and a maximum, steady state, flow rate of 1.0 l/hr recorded. Methane concentrations were recorded below the limit of detection of the monitoring instrument throughout the monitoring period. The risk to the end user the development site from ground gas generating sources is therefore considered to be Low. The gas regime for the site is CS1, requiring no gas protection measures.

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The BGS Radon Mapping confirms the site is situated in an area where less than 1% of homes are above the radon action level. The new development incorporates a single and dual storey basement, and so the advice of a specialist Radon assessor must be obtained.

10.1.4 Additional Considerations

The site is in Manchester City Centre, which during WWII suffered bomb damage. Records obtained to date indicate that the site may have been struck during bombing raids, and land in the vicinity of the site was impacted by them. However, several recommendations have been made for the implementation of mitigation measures during intrusive works which are detailed within *Section 2.6*.

In the unlikely event that material is revealed on the site of a nature that does not accord with the anticipated ground conditions identified in Section 5.0 the following procedure is to be complied with.

a) Cease and make safe all excavations in this location and report observations to the Site Manager.

b) The Site Manager is to notify the Engineer.

c) Under guidance of the Engineer take representative samples of the suspect materials and forward to a suitably accredited laboratory for analysis.

d) Await Engineers instructions with respect to re-commencement of the works and or removal from of suspect material to a suitably licensed disposal facility.

e) Manchester City Council and if relevant the Environment Agency are to be kept fully informed of any site such occurrences.

10.2 Recommendations

Based on the findings of the ground investigation, the following recommendations are made:

1) It is anticipated that all Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement. It is unlikely that a remediation strategy will be required for this development;

2) Further numerical analysis be undertaken to model the pile interaction with the sandstone in order to obtain a greater understanding of the pile carrying capacity and settlement; and

3) Notwithstanding, appropriate PPE should be supplied to and worn by all groundwork and construction personnel during the basement excavation, and other groundwork and construction activities, with reference to the environmental testing results presented herein and within *Appendix C*.

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11.0 References

1 Curtins Phase 1 Preliminary Site Assessment for Bonded Warehouse and Energy Centre (Report ref. B049241/JJ/6744) dated 24th May 2018.

2 Curtins Phase 1 Preliminary Site Assessment for St. John's Place, Manchester (Report ref. B049228/JJ/6743) dated 24th May 2018.

3 Curtins Phase 1 Preliminary Site Assessment for Central Village, Manchester (Report ref. B061604.010)/JJ/6923) dated 12th July 2016.

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22 British Standards Institution (2015) *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* (report no.BS8485).

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24 Environment Agency (2006) *Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination* (report no.ea/br/e/std/vr10thanni)

25 CITB (2015) Construction (Design and Management) Regulations.

Appendix A – Drawings

- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20059 Geotechnical Masterplan Without Proposed Buildings
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20055 Geotechnical Masterplan Stage 1
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20056 Geotechnical Masterplan Stage 2
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20057 Geotechnical Masterplan Stage 3
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20058 Geotechnical Masterplan Stage 4

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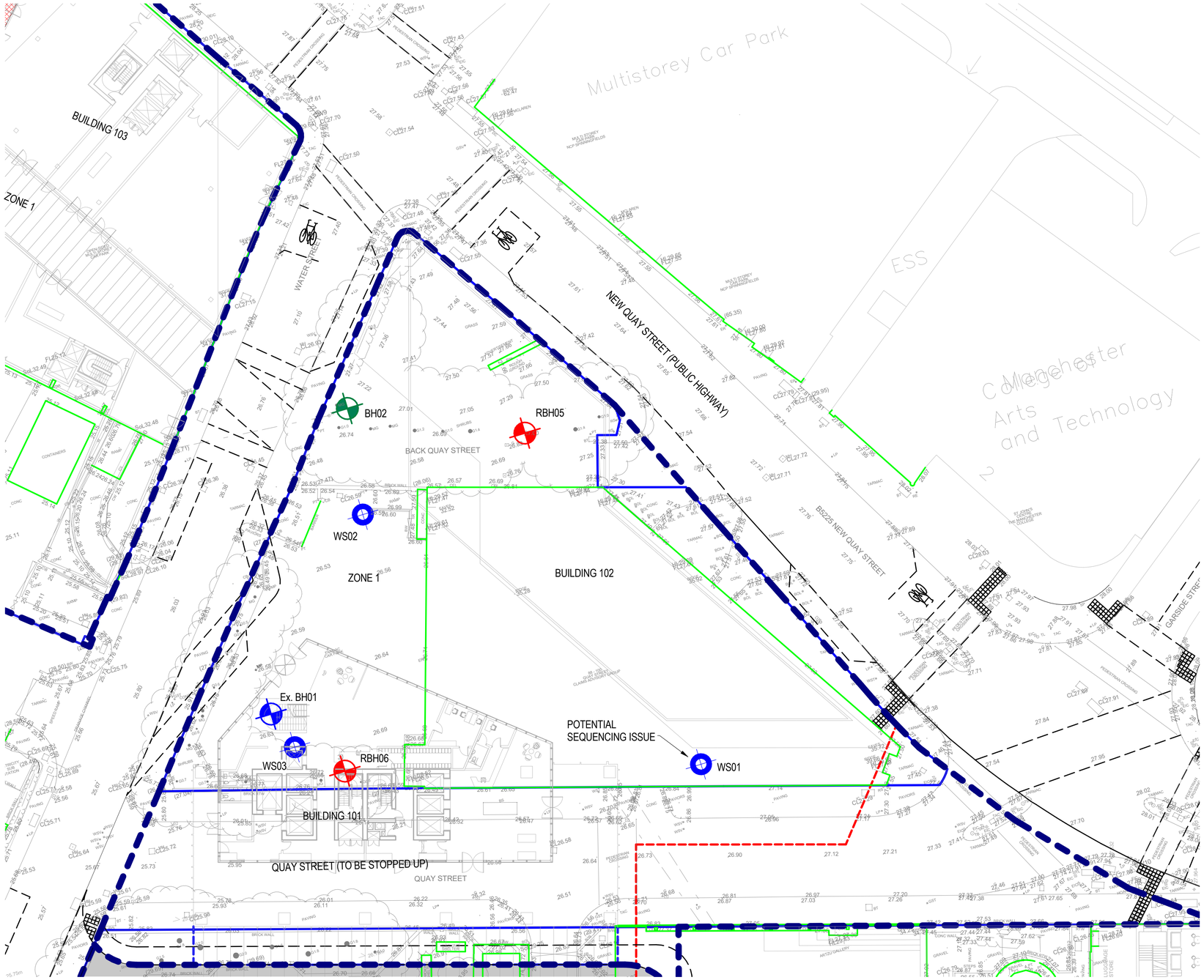

GEOTECH - STAGE 1

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KEY

- DENOTES PLOT DEFINITIONS - PLOT DESIGN TEAMS
- DENOTES OWNERSHIP BOUNDARY - SHOOSMITHS
- DENOTES UNDERSAIL OF BUILDING
- DENOTES OVERSAIL OF BUILDING
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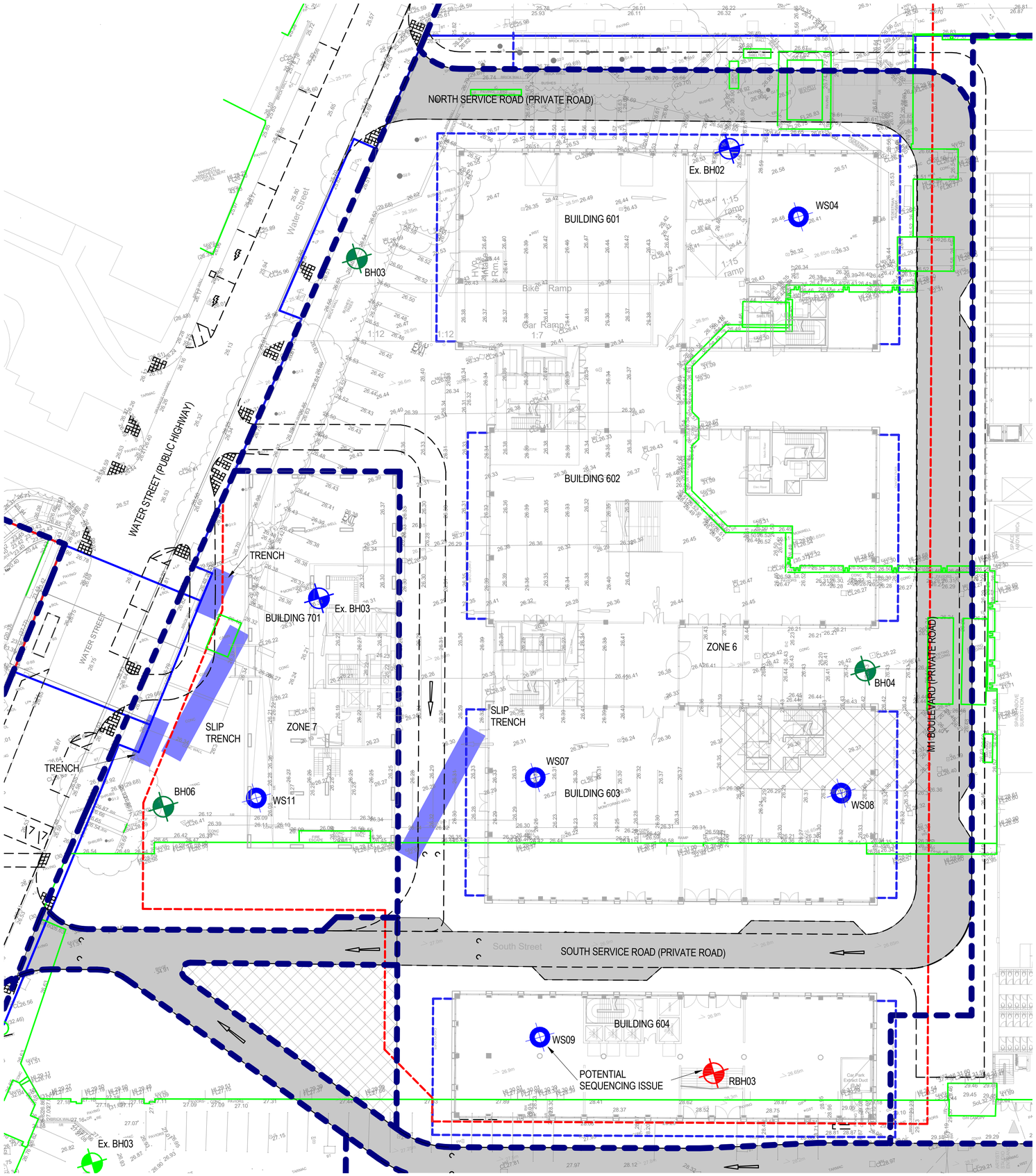

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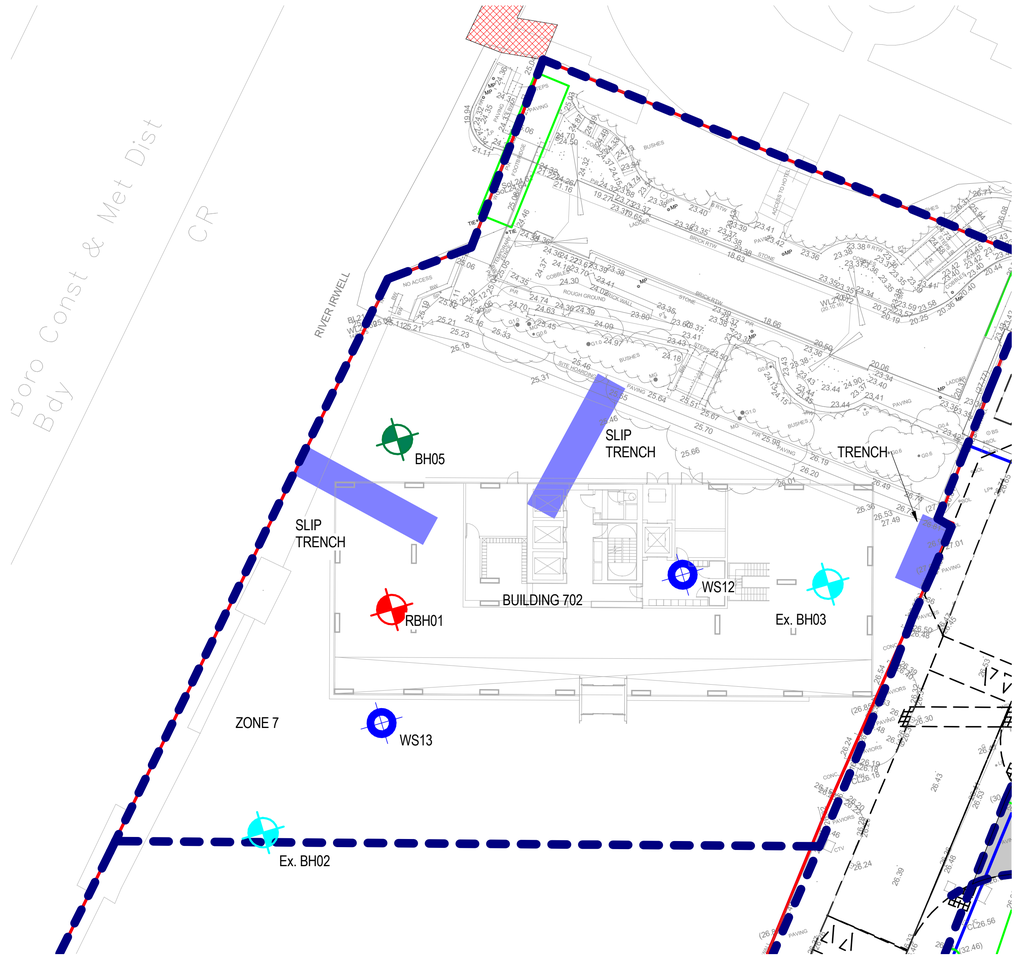

GEOTECH - STAGE 3

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4. FOR GENERAL NOTES REFER TO DRAWING.

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ZONE	ARCHITECT	CIVIL/STRUCTURAL	M&E	TRANSPORT
1	DCM	CURTINS	CWC	VECTOS
2	LEVITT BERNSTEIN	CURTINS	CWC	VECTOS
3				
4	CHAPMAN TAYLOR	RoC	CWC	VECTOS
5	ALLIED LONDON	CURTINS	CWC	VECTOS
6	CARTWRIGHT PICKARD	CURTINS	CWC	VECTOS
7	DCM	CURTINS	CWC	VECTOS
8	OMA	BURO HAPPOLD	BDP	VECTOS

Rev:	Description:	Date:	By:	Chkd:
A	PRELIMINARY ISSUE	20.02.18	AM	AI

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Status:

INFORMATION

Project:

ST JOHNS MASTERPLAN

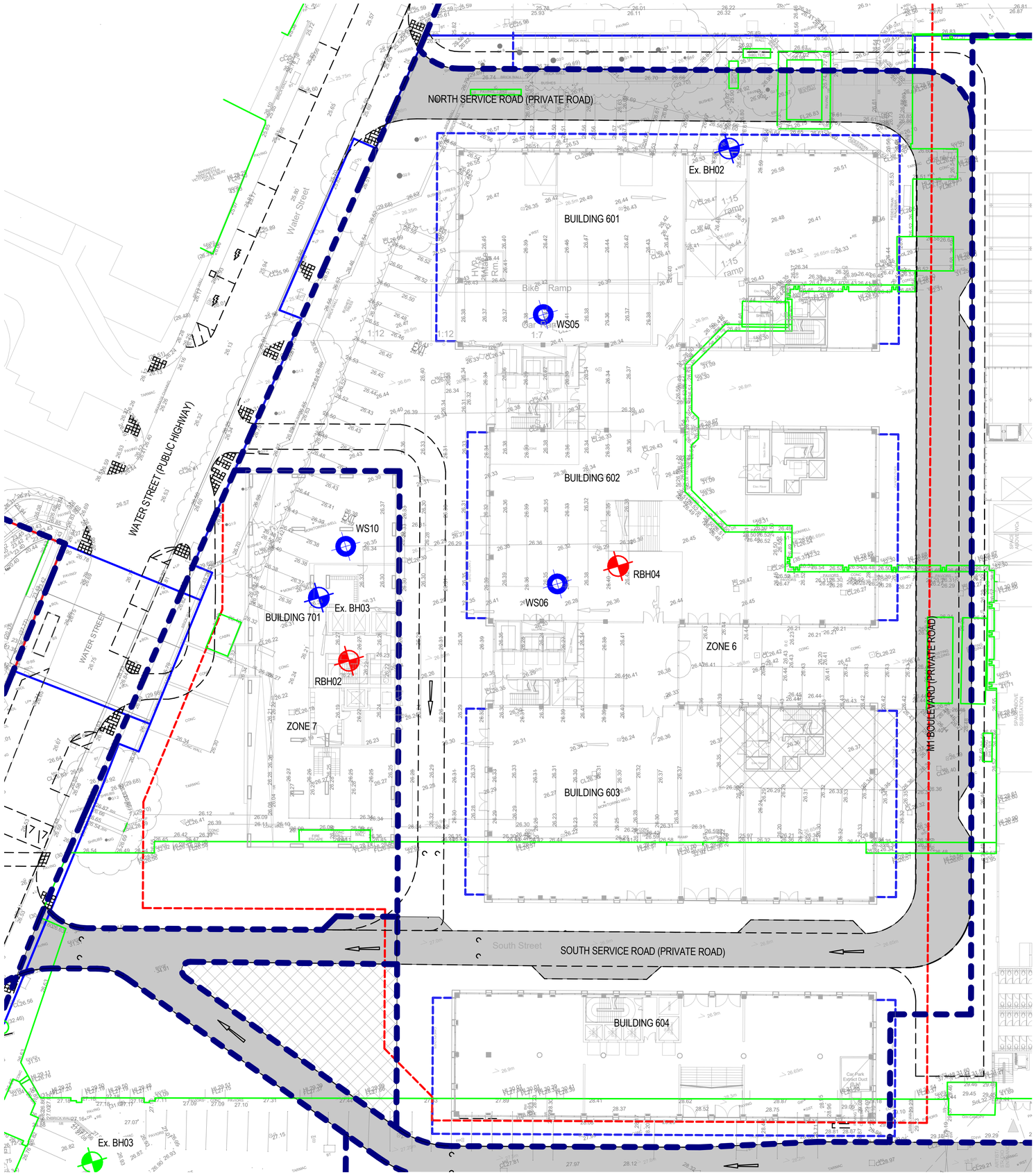
Drg Title:

GEOTECHNICAL MASTERPLAN STAGE 3

Size:	Date:	Drawn By:	Designed By:	Checked By:
A1	JAN 18	AJM	PW	AI

Scale: As indicated

Project No:	Originator:	Zone:	Level:	Type:	Discipline:	Category / Number:	Rev:
065330 -	CUR -	TMP -	XX -	DR -	S -	20057 -	A



GEOTECH - STAGE 4

1 : 250

KEY

- DENOTES PLOT DEFINITIONS - PLOT DESIGN TEAMS
- DENOTES OWNERSHIP BOUNDARY - SHOOSMITHS
- DENOTES UNDERSAIL OF BUILDING
- DENOTES OVERSAIL OF BUILDING
- DENOTES EXTENT OF EXISTING BUILDING
- DENOTES PUBLIC HIGHWAY - TM TEAM
- DENOTES PRIVATE CARRIAGEWAY - TM TEAM

DE-ADOPTION/STOPPING UP PROCESS - VECTOS/SHOOSMITHS

EASEMENT TO SHIP CANAL TBC -

OBSTRUCTIONS - TUNNEL/CANAL -

KEY

- Ex.BH** BOREHOLES TAKEN FROM THE LAND CONSULTANCY LIMITED REPORT FOR CURTINS DATED 26th MAY 2016
- Ex.BH** BOREHOLES TAKEN FROM ESG REPORT UNDERTAKEN FOR BURO HAPPOLD DATED 15th MARCH 2017
- Ex.BH** BOREHOLES TAKEN FROM CCG REPORT UNDERTAKEN FOR NORTHERN HUB ALLIANCE DATED 27th OCTOBER 2015
- RBH** PROPOSED OPEN HOLE ROTARY THROUGH SUPERFICIAL PLUS ROTARY CORED TO BASE THROUGH INTACT ROCK
- BH** PROPOSED CABLE PERCUSSIVE BOREHOLE THROUGH SUPERFICIAL PLUS ROTARY CORED TO BASE THROUGH INTACT ROCK
- TP** PROPOSED TRIAL PITS
- WS** PROPOSED WINDOW SAMPLES

- FINAL TP/BH/WS LOCATIONS TO BE AGREED
- ALLOWANCES INCLUDE WATER AND GAS MONITORING
- SAMPLING TO TRIAL PITS AND WINDOW SAMPLES INCLUDE ALLOWANCE FOR WAC TESTING
- NO ALLOWANCE HAS BEEN INCLUDED WITHIN THE PHASE 1 PRELIMINARY SCOPE FOR INVESTIGATION OR SITE ATTENDANCE ASSOCIATED WITH THE SITE WIDE ARCHAEOLOGY
- FURTHER ENGAGEMENT WITH PLANNING AUTHORITY AND CLO WILL BE REQUIRED TO DISCHARGE ANY POTENTIAL CONDITIONS ASSOCIATED WITH ANY INITIAL ENABLING WORKS. THIS ENGAGEMENT MAY ATTRACT /NECESSITATE ADDITIONAL GEO-ENVIRONMENTAL SAMPLING

GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
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ZONE	ARCHITECT	CIVIL/STRUCTURAL	M&E	TRANSPORT
1	DCM	CURTINS	CWC	VECTOS
2	LEVITT BERNSTEIN	CURTINS	CWC	VECTOS
3				
4	CHAPMAN TAYLOR	RoC	CWC	VECTOS
5	ALLIED LONDON	CURTINS	CWC	VECTOS
6	CARTWRIGHT PICKARD	CURTINS	CWC	VECTOS
7	DCM	CURTINS	CWC	VECTOS
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Rev:	Description:	Date:	By:	Chkd:
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Status: INFORMATION

Project: ST JOHNS MASTERPLAN

Drg Title: GEOTECHNICAL MASTERPLAN STAGE 4

Size:	Date:	Drawn By:	Designed By:	Checked By:
A1	JAN 18	AJM	PW	AI

Scale: As indicated

Project No:	Originator:	Zone:	Level:	Type:	Discipline:	Category / Number:	Rev:
065330 -	CUR -	TMP -	XX -	DR -	S -	20058 -	A

Appendix B – Exploratory Hole Logs

- Rotary Borehole Logs, BH02 to BH04 and RBH02 to RBH06 with Photographic Record of Rock Cores
- Window Sample Borehole Logs, WS02, WS03, WS04, WS05, WS06, WS08, WS10, and WS11

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IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **BH02**
	Dates: 13/07/2018	Client: Curtins Consulting	Sheet 1 of 3
Cable Percussion and Rotary Boring Log	Location:	Ground level: / Logged by: HD/NC / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Groundwater: Water Strike	Backfill/ Installation
0.20	ES1			(0.30)	MADE GROUND: Grass over, dark brown, gravelly, fine and medium SAND. Gravel including very angular to rounded, fine to coarse including brick, sandstone, mudstone, frequent rootlets, slate, tile with rare glass (Topsoil).			
0.25	B2			0.30				
0.50	ES3				MADE GROUND: Brownish black, gravelly fine to coarse SAND. Gravel including very angular to rounded, fine and coarse including brick, slate, mudstone, sandstone, tile, rare glass with occasional rootlets.			
1.10	D5							
1.10	ES4							
1.20		SPT(S) N=16 (2,3/4,4,4,4)						
1.20 - 1.50	B6			(2.50)				
1.20 - 1.65	D7							
1.60 - 2.60	B8							
1.80	ES9							
2.10		SPT(S) N=12 (3,3/3,3,3,3)						
2.10 - 2.55	D10							
				2.80	MADE GROUND: Greyish red, gravelly, fine to coarse SAND. Gravel including subangular to rounded, fine to coarse including tile, brick, sandstone and mudstone.			
2.90	D11			3.00				
3.00		SPT(S) 24 (3,3/24 for 160mm)			Dark yellowish brown, fine to coarse SAND and subangular to subrounded, fine to coarse GRAVEL including sandstone and mudstone.			
3.00 - 3.30	B12							
3.00 - 3.30	D13							
3.20	D14			(1.20)				
3.30 - 3.70	D15							
3.40		SPT(S) 50 (8,8/50 for 235mm)						
3.40 - 3.80	D16							
4.30		SPT(S) 20 (25 for 95mm/20 for 70mm)		4.20	Reddish brown SANDSTONE.			
4.30 - 4.40	D17			(0.40)				
4.50	D18	AZCL		4.60	Extremely weak to very weak, thickly laminated, reddish brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal, 2-4 degrees, very closely spaced, planar to undulating, open and rough.			
4.60 - 5.60	70 11 0	NI	4.70m - SPT(S) 50 (25 for 75mm/50 for 70mm) 4.70m - D19	(1.00)				
				5.60	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal, 2-4 degrees, very closely spaced, planar to undulating, open and rough.			
5.60 - 7.10	66 24 0	10		(1.40)	*Between 6.20m and 6.23m: weak reddish brown mudstone.*			
		AZCL		7.00	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal, 1-3 degrees, closely spaced, planar to undulating, open and rough.			
7.10 - 8.60	100 93 42	10		(1.70)				
				8.70	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with occasional 2-3mm thick brown mudstone laminae. Discontinuities are 1) subhorizontal, 2-6 degrees, very closely spaced, planar to undulating, open, smooth and slightly rough. 2) subvertical 70-80 degrees, medium to widely spaced, planar, open and rough.			
8.60 - 10.00	71 12 0	NI						
		AZCL						
	TCR/SCR/RQD	FI	Samples & Tests		Continued next sheet			

Chiselling: From (m)	To (m)	Time (mins)	Remarks

Borehole Diameter: Depth (m)	Dia (mm)
4.85	200

Casing Diameter: Depth (m)	Dia (mm)
4.70	200

Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)
13/07	16:00	4.60	4.60	Dry
16/07	08:00	4.60	4.60	3.50
16/07	16:30	17.20	4.60	2.10
17/07	08:00	17.50	4.60	7.20

Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	5.00	Plain	
5.00	20.00	Slotted	

Checked by:	HH	IFA CP v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **BH02**
	Dates: 13/07/2018	Client: Curtins Consulting	Sheet 2 of 3
Rotary Borehole Log	Location:	Ground level: / Logged by: HD/NC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
10.00 - 11.50	60 18 6	9 NI AZCL				Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with occasional 2-3mm thick brown mudstone laminae. Discontinuities are 1) subhorizontal, 2-6 degrees, very closely spaced, planar to undulating, open, smooth and slightly rough. 2) subvertical 70-80 degrees, medium to widely spaced, planar, open and rough. *At 10.00m: medium strong.*		11		
11.50 - 13.00	66 25 6	16 NI 10 AZCL			(5.90)			12		
13.00 - 14.50	100 74 52	9 NI 6						13 14		
14.50 - 16.00	100 86 41	NI 8			14.60 (0.40) 15.00 15.20	*Between 14.50m and 14.60m: weak, greenish brown, medium grained sandstone.* Weak, reddish brown MUDSTONE. Discontinuities are subhorizontal, 6-7 degrees, closely spaced, undulating open and smooth. Medium strong, reddish brown MUDSTONE and pale green SILTSTONE. Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional brown 3-8mm thick clay laminae. Discontinuities are subhorizontal, 1-4 degrees, very closely to closely spaced, planar tight to open and slightly rough.		15		
16.00 - 17.50	83 83 30	AZCL 13						16 17		
17.50 - 19.00	86 66 46	AZCL NI			(6.95)			18		
19.00 - 20.50	100 93 56							19 20		

Continued next sheet

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
4.60	25.00	Air mist	80

Borehole Diameter

Depth (m)	Dia (mm)
4.85	200

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
13/07	16:00	4.60	4.60	Dry
16/07	08:00	4.60	4.60	3.50
16/07	16:30	17.20	4.60	2.10
17/07	08:00	17.50	4.60	7.20

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter

Depth (m)	Dia (mm)
4.70	200

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	5.00	Plain	
5.00	20.00	Slotted	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **BH02**
	Dates: 13/07/2018	Client: Curtins Consulting	Sheet 3 of 3
Rotary Borehole Log	Location:	Ground level: / Logged by: HD/NC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
						Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional brown 3-8mm thick clay laminae. Discontinuities are subhorizontal, 1-4 degrees, very closely to closely spaced, planar tight to open and slightly rough.				
20.50 - 22.00	100 100 71							21		
					22.15			22		
22.00 - 23.50	100 97 82	5				Strong, reddish brown, fine grained SANDSTONE with rare off white and black 3-5mm sized quartzite and lignite inclusions. Discontinuities are subhorizontal, 2-5 degrees, widely spaced, planar to undulating, open and slightly rough. *At 22.20m: iron staining along fracture.* *Between 22.20m and 25.00m: occasional brown 10-20mm sized mudstone inclusions.*		23		
					(2.85)					
23.50 - 25.00	100 93 78							24		
					25.00	End of Borehole at 25.00m		25		
								26		
								27		
								28		
								29		
								30		

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter: Depth (m)	Dia (mm)

Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)
17/07	16:30	25.00	4.60	6.80

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter: Depth (m)	Dia (mm)

Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
BH02

Core Photographs
BH02

Core Photographs
BH02

Core Photographs
BH02

Core Photographs
BH02

Core Photographs
BH02

Core Photographs
BH02

IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205	Project: St John's Masterplan	Location ID: **BH03**
	Dates: 29/06/2018 - 03/07/2018	Client: Curtins Consulting	Sheet 1 of 3
Cable Percussion and Rotary Boring Log	Location:	Ground level: / Logged by: HD / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Groundwater: Water Strike	Backfill/ Installation
0.20	D2			0.10	MADE GROUND: Tarmacadam			
0.20	ES1			0.30	MADE GROUND: Grey, fine to coarse SAND and very angular to subangular, fine and medium GRAVEL including granite.			
0.50	D4				MADE GROUND: Brownish black, clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including brick, tile and sandstone.			
0.50	ES3			(0.80)				
1.20		SPT(S) N=15 (1,2/3,3,4,5)		1.10	Medium dense, yellowish brown, clayey, fine to coarse SAND and very angular to rounded, fine to coarse GRAVEL including sandstone, mudstone and limestone (possible made ground).			
1.20	D7							
1.20	ES5							
1.20 - 1.65	D8			(1.10)				
1.20 - 2.00	B6							
2.00		SPT(S) N=20 (3,3/3,4,5,8)						
2.20	D9			2.20	Medium dense, brown, clayey, fine to coarse SAND and angular to rounded, fine to coarse GRAVEL including sandstone, mudstone and limestone.			
2.70	B10							
3.00		SPT(S) 50 (5,5/50 for 295mm)		(1.60)	*Below 3.00m: very dense.*			
3.00 - 3.50	B11							
3.00 - 3.50	D12							
3.70		SPT(S) 50 (12,12/50 for 180mm)		3.80	Reddish brown SANDSTONE recovered as fine to coarse sand.			
3.70	D13							
3.70 - 4.15	D14							
4.10		SPT(S) 50 (10,15/50 for 95mm)		(0.90)				
4.10 - 4.35	D15							
		AZCL 0 NI; 4.70m - SPT(S) 50 (25 for 75mm/50 for 295mm)		4.70	Very weak to weak, reddish brown, coarse grained SANDSTONE with rare mudstone lenses (<20x20mm). Discontinuities are subhorizontal, very closely spaced, rough undulating, open to moderately wide sand and angular to subangular, fine to coarse gravel fill. Orange staining on fracture surfaces and reduced strength.			
4.70 - 6.20	84 47 0	18		(1.43)				
				6.13	Medium strong, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to closely spaced, rough planar, undulating, open to moderately wide, clean and with sand, gravel and rare clay fill. Orange staining on fracture surfaces.			
6.20 - 7.70	100 100 21							
		12		(3.47)				
7.70 - 9.20	100 92 25				*Between 8.26m and 8.33m: subhorizontal fracture with clay and gravel fill.*			
9.20 - 10.70	100 94 53			9.60	Medium strong, reddish brown, coarse grained SANDSTONE with occasional subangular, medium and coarse gravel of mixed			
	TCR/SCR/RQD	FI	Samples & Tests		Continued next sheet			

Chiselling

From (m)	To (m)	Time (mins)	Remarks
3.00	4.70	90	

Borehole Diameter

Depth (m)	Dia (mm)
25.00	107

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
03/07	08:00	4.70	4.70	2.10
29/06	16:30	4.70	4.70	Dry
04/07	08:00	25.00		1.90
03/07	16:30	25.00	4.70	1.80

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter

Depth (m)	Dia (mm)
4.70	200

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	8.80	Plain	19
8.80	10.00	Slotted	19

Checked by:	HH	IFA CP v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205	Project: St John's Masterplan	Location ID: **BH03**
	Dates: 29/06/2018 - 03/07/2018	Client: Curtins Consulting	Sheet 2 of 3
Rotary Borehole Log	Location:	Ground level: / Logged by: HD / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
					(1.90)	Medium strong, reddish brown, coarse grained SANDSTONE with occasional subangular, medium and coarse gravel of mixed lithologies. Discontinuities are subhorizontal, very closely spaced to closely, open to moderately wide, clean and with sand film fill. Reduced strength along fractures. *Between 10.70m and 10.79m: medium and coarse grained sandstone.* *Between 11.13m and 11.15m: coarse grained.*		11		
10.70 - 12.20	100 82 15				11.50	Medium strong to strong, thickly laminated, reddish brown medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, closely spaced to medium spaced, rough, undulating, open to moderately wide with subangular, fine to coarse gravel of sandstone and sand fill and orange brown staining.		12		
12.20 - 13.70	100 95 75	4			(2.20)	*Between 13.48m and 13.54m: non intact sand and gravel.*		13		
		NI 4			13.70	Medium strong, reddish brown, coarse grained SANDSTONE with rare lenses of mudstone. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating and moderately wide with grey sandy clay fill. 2) 20 degrees, very widely spaced, rough undulating, moderately wide with film of grey sandy clay. Fractures stained yellow, grey and orange.		14		
13.70 - 15.20	71 43 7	9 AZCL 11			(2.40)	*Between 15.83m and 16.00m: non intact stained yellow orange grey.*		15		
15.20 - 16.70	73 37 24	AZCL 0 NI 10			16.10	Medium strong, reddish brown, locally coarse grained SANDSTONE with rare to occasional subangular medium and coarse gravel of mixed lithologies. Discontinuities are 1) subhorizontal, very closely spaced to closely spaced, rough, undulating, open to moderately wide with sand film fill and subangular, fine to coarse gravel fill. 2) 40-55 degrees, widely spaced, rough undulating, open with film of sand.		16		
16.70 - 18.20	100 93 42	20			(1.33) 17.43	Strong, thinly laminated, reddish brown, interbedded medium and coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced to closely spaced, rough undulating, open to moderately wide with sand and gravel fill. 2) 40 degrees, widely spaced to very widely spaced, rough, undulating, open with film of grey clay fill. *Between 18.11m and 18.12m: bed of coarse sandstone and clay lenses.* *Between 18.12m and 18.60m: coarse grained sandstone with subrounded, medium and coarse gravel of mixed lithologies.* *At 18.50m: clay lense 30x 2mm.*		17		
18.20 - 19.70	100 100 61	6			(1.63) 19.06	Medium strong to strong, reddish brown, coarse grained SANDSTONE with medium and coarse subrounded gravel of mixed lithologies and lenses of mudstone. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open to moderately wide, clean and with sand film fill. 2) 15-25 degrees, very closely spaced to medium spaced, rough		18 19		
						Continued next sheet		20		

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter

Depth (m)	Dia (mm)
25.00	107

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
03/07	08:00	4.70	4.70	2.10
29/06	16:30	4.70	4.70	Dry
04/07	08:00	25.00		1.90
03/07	16:30	25.00	4.70	1.80

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter

Depth (m)	Dia (mm)
4.70	200

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	8.80	Plain	19
8.80	10.00	Slotted	19

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Dando 2000/Comacchio 205	Project: St John's Masterplan	Location ID: **BH03**
	Dates: 29/06/2018 - 03/07/2018	Client: Curtins Consulting	Sheet 3 of 3
Rotary Borehole Log	Location:	Ground level: / Logged by: HD / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
19.70 - 21.20	100 100 71					Medium strong to strong, reddish brown, coarse grained SANDSTONE with medium and coarse subrounded gravel of mixed lithologies and lenses of mudstone. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open to moderately wide, clean and with sand film fill. 2) 15-25 degrees, very closely spaced to medium spaced, rough undulating, open and clean.		21		
21.20 - 22.70	100 100 53	10			(5.44)			22		
22.70 - 24.20	100 100 73	5						23 24		
24.20 - 25.20	100 74 42	14 0			24.50 24.60 24.85 (0.35) 25.20	Extremely weak to weak, thinly laminated MUDSTONE. Discontinuities are subhorizontal smooth, undulating planar and stepped, very tight to moderately wide, clean and with clay film fill. Weak to medium strong, thinly to thickly laminated medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to closely spaced, rough, stepped and undulating, open and with film of sand. Medium strong, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to closely spaced, open with sand and silt film fill. End of Borehole at 25.20m		25		
								26 27 28 29 30		

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
BH03

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Core Photographs
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IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **BH04B**
	Dates: 02/07/2018 - 05/07/2018	Client: Curtins Consulting	Sheet 1 of 3
Cable Percussion and Rotary Boring Log	Location:	Ground level: / Logged by: NC / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing

Depth	Sample ID	Test Result
1.20		SPT(S) N=7 (1,1/1,2,2,2)
2.10		SPT(S) N=16 (3,3/3,3,3,7)
3.00		SPT(S) 50 (10,14/50 for 160mm)
3.30		SPT(S) 50 (10,11/50 for 265mm)
4.00 - 4.40	0	AZCL
4.40 - 4.90	39 0 0	NI
4.90 - 5.90	70 38 0	4.90m - SPT(S) 50 (25 for 30mm/50 for 30mm)
5.90 - 7.40	59 23 0	35
7.40 - 8.50	90 43 0	NI
8.50 - 10.00	100 57 33	31
	TCR/SCR/RQD	FI

Samples & Tests

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend
	0.25	MADE GROUND: Tarmacadam.	
	(0.35)	MADE GROUND: Light cream brown, very gravelly, fine to coarse SAND. Gravel is subangular to angular, fine to coarse including tarmacdam and concrete.	
	0.60	MADE GROUND: Dark brown, cobbly, gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including brick. Cobbles are subangular of brick.	
	(0.50)	MADE GROUND: Brown mottled orange brown, clayey, gravelly, fine and medium SAND. Gravel is subangular to subrounded, fine to coarse including brick and sandstone. *Between 11.16m and 11.39m: non intact recovered as gravel including sandstone and quartzite.*	
	1.10	dark grey, sandy GRAVEL with strong organic odour. Gravel is subrounded to rounded, fine and medium including sandstone and quartzite.	
	(2.30)	Extremely weak reddish brown weathered SANDSTONE.	
	3.40	Assumed zone of core loss.	
	3.65	Very weak, very thinly bedded, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating, open to moderately wide sand fill. 2) 35-40 degrees, closely to medium spaced, rough undulating, open, sand fill and medium and coarse gravel fill. *At 4.40m: non intact recovered as gravel.* *Between 6.40m and 6.45m: medium grained gravel and clay lenses.* *Between 7.69m and 7.74m: subrounded, medium grained gravel.*	
	(0.35)	Extremely weak to very weak, very thinly bedded reddish brown, coarse SANDSTONE. Completely weathered. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating, partly open to moderately wide clay with subangular to subrounded gravel of quartz fill. 2) 80-90 degrees widely spaced tight with clay fill <3mm. *Between 7.96m and 8.16m: non intact recovered as gravel.* *Between 8.12m and 8.14m: MUDSTONE recovered as gravel.*	
	4.00	Medium strong, thickly laminated to thinly bedded, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating open, moderately wide sand and gravel fill. 2) 80-90 degrees widely spaced, tight with clay fill <3mm.	
	(0.40)	Medium strong, thickly laminated to thinly bedded, medium and	
	4.40		
	(3.56)		
	7.96		
	8.14		
	(0.72)		
	8.86		

Continued next sheet

Groundwater: Water Strike; Backfill/ Installation

Chiselling

From (m)	To (m)	Time (mins)	Remarks
3.00	3.30	30	

Borehole Diameter

Depth (m)	Dia (mm)
25.10	107

Casing Diameter

Depth (m)	Dia (mm)
5.90	200

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
04/07	08:00	3.70	3.70	1.90
04/07	16:30	14.50	5.90	2.20
05/07	08:00	14.50	5.90	2.10

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	5.00	PLAIN	
5.00	20.00	SLOTTED	

Checked by:	HH	IFA CP v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **BH04B**
	Dates: 02/07/2018 - 05/07/2018	Client: Curtins Consulting	Sheet 2 of 3
Rotary Borehole Log	Location:	Ground level: / Logged by: NC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
10.00 - 11.50	83 53 0	NI			(2.53) 11.39	Medium strong, thickly laminated to thinly bedded, medium and coarse SANDSTONE, poorly sorted with medium and coarse gravel predominantly quartzite with striations along the walls of the subvertical fractures. Discontinuities are 1) subhorizontal to 15 degrees, very closely spaced, rough undulating, open, sand fill. 2) 80-90 degrees, medium spaced, rough striated undulating, open and discoloured grey.		11		
11.50 - 13.00	100 89 53				(2.11) 13.50	Weak, thickly laminated to thinly bedded reddish brown, medium and coarse SANDSTONE. Walls of subhorizontal fracture one weaker than the solid core. Discontinuities are subhorizontal, very closely to closely spaced, rough undulating open, moderately wide sand fill <1mm and gravel fill. *Between 12.45m and 12.50m: with localised, subangular to subrounded, fine and medium grained gravel of mixed lithology.* *Between 13.00m and 13.50m: with localised, subangular to subrounded, fine and medium grained gravel of mixed lithology.*		12 13		
13.00 - 14.50	100 77 23	10			(0.81) 14.31	Weak thinly laminated to very thinly bedded, reddish brown, coarse grained SANDSTONE interbedded with lenses of mudstone. Discontinuities are 1) subhorizontal, very closely spaced to closely spaced, rough undulating, open clay and sand fill <3mm. 2) 30 degrees, very closely spaced to closely spaced, rough undulating, open sand fill <1mm. *Between 13.50m and 14.00m: weathered clay.*		14		
14.50 - 16.00	100 89 53				(0.99) 15.30	Medium strong, thinly to thickly laminated reddish brown, medium grained SANDSTONE with lenses and very thinly bedded mudstone. Weathering stained black on surface. Discontinuities are 1) subhorizontal, very closely to closely spaced, rough undulating, open to moderately open sand and gravel fill <1mm 10mm. 2)30 degrees, closely spaced, rough, planar open stained black. *Between 14.96m and 15.20m: cross bedding.*		15		
16.00 - 17.50	100 71 53	25+			(5.20)	Weak, thinly bedded to thickly bedded, reddish brown, locally poorly sorted, coarse grained SANDSTONE. Discontinuities are 1) 15-20 degrees bedding fracture, very closely to closely spaced, rough undulating, open sand and clay fill. 2) 60 degrees closely to widely spaced, rough undulating, open grey and black staining. 3) 80-90 degrees widely spaces, rough undulating, striated, open with clay <1mm fill. *Between 15.50m and 15.60m: locally fine and medium grained.* *Between 15.75m and 15.78m: a bed of weak mudstone.* *Between 16.50m and 16.80m: frequent lenses <10mm of clay.* *Between 16.98m and 17.11m: medium grained.*		16 17		
17.50 - 19.00	100 99 85	7				*Between 18.71m and 18.72m: poorly sorted, coarse grained with medium grain gravel and lenses of mudstone 40mm by 5mm.* *Between 18.95m and 19.00m: poorly sorted, coarse grained.*		18 19		
19.00 - 20.50	100 92 61					*Between 19.40m and 19.75m: poorly sorted, coarse grained.*		20		

Continued next sheet

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter

Depth (m)	Dia (mm)
25.10	107

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
04/07	08:00	3.70	3.70	1.90
04/07	16:30	14.50	5.90	2.20
05/07	08:00	14.50	5.90	2.10

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter

Depth (m)	Dia (mm)
5.90	200

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	5.00	PLAIN	
5.00	20.00	SLOTTED	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **BH04B**
	Dates: 02/07/2018 - 05/07/2018	Client: Curtins Consulting	Sheet 3 of 3
Rotary Borehole Log	Location:	Ground level: / Logged by: NC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
					20.50 (0.85)	Weak, thinly bedded to thickly bedded, reddish brown, locally poorly sorted, coarse grained SANDSTONE. Discontinuities are 1) 15-20 degrees bedding fracture, very closely to closely spaced, rough undulating, open sand and clay fill. 2) 60 degrees closely to widely spaced, rough undulating, open grey and black staining. 3) 80-90 degrees widely spaces, rough undulating, striated, open with clay <1mm fill.			
20.50 - 22.00	100 73 50	25+			21.35 (1.50)	Medium strong, very thinly bedded to medium bedded, reddish brown, poorly sorted, coarse grained SANDSTONE with inclusions of mudstone. Striations of clay between fracture walls. Walls are weaker than core occasionally broken to gravel sized fragments. Discontinuities are 1) 15-30 degrees bedding fracture, very closely to closely spaced, smooth rough, undulating stepped, open to moderately wide, clay sand and gravel fill. 2) 80 degrees, widely spaced, smooth rough undulating striated, dry sand and gravel fill.			
22.00 - 23.50	100 65 40	3 / NI / 11			22.85 (1.30)	Strong, medium bedded MUDSTONE with frequent lenses sandstone. Lightly stained, orange black and grey along fracture surface. Discontinuities are 1) subhorizontal bedding fracture, closely spaced, rough undulating open. 2) 30 degrees closely spaced, rough undulating open, stained orange and black. 3) 65-80 degrees, very closely spaced, rough undulating stepped, open clay and gravel fill, grey and orange staining. *Between 21.80m and 22.70m: highly fractured with clay fill (possible fault zone).* *Between 22.07m and 22.20m: non intact recovered as gravel.* *Between 22.50m and 22.69m: non intact recovered as gravel.*			
23.50 - 24.25	75 75 93				24.15 (0.95)	Medium strong to strong. medium to thickly bedded, medium and coarse grain SANDSTONE. Slight black staining along fracture surface. Weathering along fracture wall. Discontinuities are 1) subhorizontal bedding fracture, very closely to closely spaced, rough undulating rough, tight to open sand fill. 2) 35 degrees, closely spaced to widely spaced, rough undulating, open to moderately wide sand and angular coarse gravel fill. 3) 75-85 degrees, closely spaced, rough undulating, tight to open to closed, stained black sand fill.			
24.25 - 25.10	100 100 100	0			25.10	Strong to very strong, thinly to medium bedded, medium and coarse grain SANDSTONE. *Between 24.35m and 24.45m: medium grain sandstone with subrounded to rounded, coarse gravel.*			
						End of Borehole at 25.10m			

21 22 23 24 25 26 27 28 29 30

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
BH04B

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IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH02**
	Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting	Sheet 1 of 5
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: / Logged by: HD/DO/HH / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing

Depth	Sample ID	Test Result
0.30	D2	
0.30	ES1	
0.50	D4	
0.50	ES3	
1.00	D6	
1.00	ES5	
1.20		SPT(S) 50 (25 for 10mm/50 for 10mm)
1.20 - 1.65	D8	
1.20 - 2.00	B7	
2.00		SPT(S) 50 (25 for 85mm/50 for 3mm)
2.00 - 2.45	D10	
2.00 - 3.00	B9	
3.00		SPT(S) 50 (25 for 40mm/50 for 10mm)
3.00 - 3.45	D11	
3.40	B12	
3.90 - 4.35	D13	
4.00		SPT(S) N=8 (2,3/2,2,2,2)
4.50 - 5.00	B14	
5.00 - 6.00	100, 88, 80	NI 5; 5.00m - SPT(S) 50 (5,10/50 for 40mm) 5.00m - D15
6.00 - 7.75	93, 93, 87	NI 6; NI 6; NI 2; NI AZCL
7.75 - 9.25	100, 100, 100	9
	TCR/SCR/RQD	FI Samples & Tests

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
	0.20	MADE GROUND: Tarmacadam.
	0.40	MADE GROUND: Greyish brown, slightly clayey, fine to coarse SAND very angular to subrounded, fine to coarse GRAVEL including brick, granite, tile, sandstone, limestone and mudstone.
	(4.60)	MADE GROUND: Red brick wall (possible canal). *Below 0.40m: brownish black.*
	5.00	MADE GROUND : Strong, red BRICK and strong light grey CONCRETE well bonded.
	(1.25)	
	6.25	Weak, reddish brown, fine grained SANDSTONE. Discontinuities are 0-20 degrees, closely spaced, planar and undulating rough, unstained. *Between 6.25m and 6.65m: 1no discontinuity, 45 degrees planar, rough, no infill. Colour changing to grey up to 5mm.* *Between 7.15m and 7.30m: with inclusions of angular to subangular, fine and medium gravel of siltstone.*
	(1.20)	
	7.45	Extremely weak, reddish brown MUDSTONE.
	7.55	Extremely weak, reddish brown, fine grained SANDSTONE recovered as gravelly, fine SAND. Gravel is angular to subangular, coarse including sandstone.
	7.65	Assumed zoneof core loss.
	7.75	Medium strong, reddish brown, fine and medium grained SANDSTONE. *At 7.88M: 1no of possibly DI fracture, 0 degrees, planar, rough, unstained no infill.*
	7.95	Weak, reddish brown, medium grained SANDSTONE. Discontinuities are 1) 0-10 degrees, predominantly very closely and rarely closely, planar smooth and occasionally rough unstained, no infill.
	(1.20)	
	9.15	Medium strong, reddish brown, fine grained SANDSTONE. Discontinuities are 1) 0-10 degrees, closely spaced, planar, smooth, unstained, clay infill up to 1mm. 2) 45-60 degrees, medium spaced, planar smooth. Colour changing to grey.
	(1.65)	

Legend: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Groundwater: Water Strike / Backfill/ Installation

Continued next sheet

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.
Rotary open hole from 5.00m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	6.30	PLAIN	
6.30	20.00	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH02**
	Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting	Sheet 2 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: HD/DO/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
9.25 - 10.75	100 100 100					Medium strong, reddish brown, fine grained SANDSTONE. Discontinuities are 1) 0-10 degrees, closely spaced, planar, smooth, unstained, clay infill up to 1mm. 2) 45-60 degrees, medium spaced, planar smooth. Colour changing to grey.				
10.75 - 12.25	100 100 100	6			10.80 (0.88)	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 15-30 degrees, medium spaced, planar smooth with less then 2mm clay infill unstained.		11		
					11.68 (0.77)	Medium strong, reddish brown, fine grained SANDSTONE, locally weak. Discontinuities are 0-15 degrees, closely spaced, planar smooth with up to 1mm clay infill unstained.		12		
12.25 - 13.75	100 100 100	9			12.45 (0.30) 12.75	Medium strong locally weak, red brown, medium grained SANDSTONE. Discontinuities are 0-15 degrees, closely spaced, undulating smooth, unstained, no infill.				
		3			(3.05)	Medium strong, reddish brown, fine and medium grained SANDSTONE, locally weak. Discontinuities are 0-15 degrees, predominantly medium and locally closely spaced, smooth and rough unstained, no infill.		13 14 15		
13.75 - 15.25	100 100 100									
15.25 - 16.75	50 48 48	NI 6			15.80 16.00 (0.75)	Weak, reddish brown, medium and coarse grained SANDSTONE. *At 15.90m: 1 no discontinuity 0 degrees, undulating smooth, unstained, no infill.* Assumed zone of core loss.	key incorrect key incorrect key incorrect key incorrect key	16		
		AZCL								
16.75 - 17.75	100 100 100	4			16.75 (2.75)	Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional inclusion of subrounded fine gravel of quartzite. Discontinuities are 0-15 degrees, closely spaced, planar smooth, unstained, no infill.		17 18 19		
17.75 - 19.25	100 100 100									
					19.50	Weak, reddish brown, medium and locally coarse grained SANDSTONE with inclusion of angular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, very		20		

Continued next sheet

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter

Depth (m)	Dia (mm)
40.00	107

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
29/06	16:30	19.25	6.20	2.90
02/07	08:00	19.25	6.20	1.60
02/07	16:00	40.00	6.20	1.50

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter

Depth (m)	Dia (mm)
6.20	200

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH02**
	Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting	Sheet 3 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: HD/DO/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
19.25 - 20.75	100 100 100	9			(1.60)	Weak, reddish brown, medium and locally coarse grained SANDSTONE with inclusion of angular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, very closely spaced, planar smooth and rough unstained no infill.		21		
20.75 - 22.25	100 100 73				21.10 (1.15)	Weak, reddish brown, fine, locally medium grained SANDSTONE with inclusion of subangular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, very closely spaced, planar smooth and rough unstained no infill.		22		
22.25 - 23.75	100 100 97	3 / 20			22.25	Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional inclusion of angular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, closely to medium spaced, planar smooth with occasional clay infill up to 1mm unstained.		23		
23.75 - 25.25	100 100 97	4						24 25		
25.25 - 26.75	100 100 80				(6.20)	*Between 25.75 and 26.05m: 1no discontinuities approx 60-70 degrees, undulating smooth, with silt infill >2mm.*		26		
26.75 - 28.25	100 100 97	3				*Between 27.75 and 27.95m: 1no discontinuities approx 60-70 degrees, undulating smooth, unstained no infill.*		27 28		
28.25 - 29.75	100 100 73	16 / 5			28.45 (0.85)	Weak, reddish brown, medium grained SANDSTONE with occasional inclusion of angular to subrounded, fine gravel of siltstone. Discontinuities are 0-15 degrees, closely spaced, planar smooth and rough unstained no infill.		29		
					29.30	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-15 degrees, closely spaced, planar smooth with clay infill upto 1mm, unstained.		30		

Continued next sheet

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH02**
	Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting	Sheet 4 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: HD/DO/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
29.75 - 31.25	100 100 87	5				Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-15 degrees, closely spaced, planar smooth with clay infill upto 1mm, unstained.				
		3			(3.10)	*Between 31.25m and 31.35m: assumed zone of ocre loss.*		31		
31.25 - 32.75	80 73 40	AZCL								
		17				*At 31.75m: gravel infill*				
		3				*Between 31.80m and 32.25m: medium spaced discontinuities.*		32		
		8 10			32.40	Weak, red brown, coarse grained SANDSTONE with rare mudstone inclusions (2mm in diameter). Discontinuities are subhorizontal very closely spaced, planar smooth.				
32.75 - 34.25	100 100 71							33		
		5				*Between 33.25m and 33.85m: medium spaced, undulating smooth discontinuities.*				
		9				*Below 34.25m: medium strong.*		34		
34.25 - 35.75	100 100 85	6								
		16						35		
		7				*Between 35.40m and 35.70m: medium spaced discontinuities.*				
35.75 - 37.25	100 100 70				(7.30)	*Between 35.95m and 36.00m: grey discolouration.*		36		
		NI				*Between 36.25m and 36.35m: non intact recovered as coarse gravel.*				
		4				*Between 36.30m and 36.90m: medium spaced discontinuities.*		37		
						Between 37.15m and 37.25m: grey discolouration.				
37.25 - 38.75	100 88 57	7				*Between 37.80m and 37.90m: a subvertical, widely spaced, undulating smooth and open fracture.* *At 37.90m: grey discolouration.*		38		
		20				*Below 38.25m: fine to medium grained* *At 38.30m: grey discolouration.*				
		7								
38.75 - 40.00	87 73 64	NI				*At 38.75m: mudstone gravel.* *Between 38.75m to 38.95m: non intact recovered as coarse gravel.*				
		14						39		
		AZCL				*Between 39.02m and 39.25m: assumed zone of core loss.*				
		9				*Below 39.30m: weak, medium to coarse grained.*				
					39.70 39.80	Very weak, brown MUDSTONE.				
		NI			40.00	Weak, red brown, coarse grained SANDSTONE with rare		40		

Continued next sheet

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %	Borehole Diameter: Depth (m)	Dia (mm)	Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)	Remarks:
											SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter: Depth (m)	Dia (mm)	Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH02**
	Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting	Sheet 5 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: HD/DO/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
						Weak, red brown, coarse grained SANDSTONE with rare mudstone inclusions (2mm in diameter). Discontinuities are subhorizontal very closely spaced, planar smooth. *Between 39.90m and 40.00m: non intact recovered as coarse gravel.* End of Borehole at 40.00m		41		
								42		
								43		
								44		
								45		
								46		
								47		
								48		
								49		
								50		

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
RBH02

Core Photographs
RBH02

Core Photographs
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Core Photographs
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IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: RBH03
	Dates: 03/04/2018 - 06/04/2018	Client: Curtins Consulting	Sheet 1 of 5
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: RS/HH / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Groundwater: Water Strike	Backfill/ Installation
0.20	D1			0.17	MADE GROUND: Concrete.			
0.25 - 0.60	B2			0.25	MADE GROUND: Light pinkish grey, slightly sandy, subrounded to angular, fine to coarse GRAVEL including limestone.			
0.40	ES3			(1.75)	MADE GROUND: Loose, brown, gravelly, slightly clayey, fine to coarse SAND with medium cobble content and low boulder content. Gravel is angular to subrounded of brick, sandstone and rare granite. Boulders are subangular to subrounded including sandstone and granite.			
1.20		SPT(S) N=8 (2,2/2,2,2,2)						
1.20 - 1.65	D4			2.00	Black, spongy PEAT.			
2.20		SPT(S) N=27 (4,5/7,6,7,7)		2.20	Medium dense, light, brown, gravelly SAND.			
2.20 - 2.65	D5			(1.00)				
3.20		SPT(S) N=30 (4,5/5,5,7,13)		3.20	Dense, SAND and GRAVEL (driller's description).			
3.20 - 3.65	D6			(1.00)				
4.20 - 5.40	0 0 0	NR		4.20	Reddish brown SAND, possibly weathered sandstone (driller's description).			
				(0.66)				
5.40 - 6.30	0 0 0			4.86	No recovery assumed red SANDSTONE. Driller notes pushing a boulder down			
6.30 - 7.30	0 0 0			(3.44)				
7.30 - 8.30	0 0 0			8.30	Weak, red brown, medium and coarse SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, undulating rough, open. *Between 8.30 and 8.48m: angular and coarse gravel. At 8.58m: mudstone infill. At 8.62m: siltstone inclusion at 2cm in diameter. Between 8.91m and 9.13m: extremely closely spaced, undulating, smooth. Between 9.07m and 9.13m: mudstone infill. Between 9.23m and 9.30m: subhorizontal.*			
8.30 - 8.80	100 80 36	NI 7		(1.20)				
8.80 - 10.30	100 100 31	25+ 9		9.50	Weak, very weak, red brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open.			
	TCR/SCR/RQD	FI	Samples & Tests		Continued next sheet			

Dynamic Sample Recovery				
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	14.50	PLAIN	
14.50	16.50	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: RBH03
	Dates: 03/04/2018 - 06/04/2018	Client: Curtins Consulting	Sheet 2 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: RS/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
						Weak, very weak, red brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open.				
10.30 - 11.80	100 100 69	6				*Below 10.50m: subhorizontal.*		11		
		25+				*At 11.20m: mudstone inclusion 2cm in diamter.* *Extremely closely spaced, undulating smooth, clay infill.*				
11.80 - 13.30	100 100 45	6			(5.40)	*Between 11.80m and 12.80m: medium and coarse grained sandstone.* *At 12.52m: quartzite inclusions.*		12		
		25+				*At 13.10m: sand infill.* *At 13.30m: subvertical widely spaced.*		13		
13.30 - 14.80	100 100 84	4						14		
		25+								
14.80 - 16.30	100 100 78	7			14.90	Weak, red micaeceous, fine grained SANDSTONE. Discontinuities are horizontal, very closely spaced, planar, smooth, open and clean.		15		
		25+			15.14	Weak, very weak, red brown, fine and medium grained SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open. *At 15.20m: yellow band (subvertical)>* *Between 15.37m and 15.40m: mudstone infill.*				
		4						16		
		25+								
16.30 - 17.80	100 100 66	5						17		
		25+			(5.06)	*Between 17.30m and 17.80m: mudstone inclusions 3cm in diameter.*				
17.80 - 19.30	100 100 61	6				*Below 17.80m: medium and coarse grained with occasional quartzite clasts.* *At 19.10m: sand infill.*		18		
								19		
						Continued next sheet		20		

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
5.40	4.20	Air mist	
6.30	5.40	Air mist	
6.80	6.30	Air mist	
7.30	6.80	Air mist	
7.80	7.30	Air mist	
8.30	7.80	Air mist	

Borehole Diameter

Depth (m)	Dia (mm)
40.30	92

Casing Diameter

Depth (m)	Dia (mm)
5.40	200

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
03/04	16:30	4.20		3.50
04/04	08:00	4.20		3.20
04/04	16:30	5.40	4.20	3.20
05/04	08:00	5.40		

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	14.50	PLAIN	
14.50	16.50	SLOTTED	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: RBH03
	Dates: 03/04/2018 - 06/04/2018	Client: Curtins Consulting	Sheet 3 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: RS/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
19.30 - 20.80	100 90 66				20.20	Weak, very weak, red brown, fine and medium grained SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open. Very weak red, medium and coarse grained SANDSTONE. Discontinuities are: subhorizontal, closely spaced, undulating, smooth clean.				
20.80 - 22.30	100 100 81	3				*At 21.10m: sand infill.* *Between 21.10m and 21.30m: subvertical, widely spaced.* *At 21.20m: iron stained, very weak.* *Below 21.30m: closely spaced.* *At 21.50m: mudstone inclusion.* *At 22.10m/: gravel infill.* *Below 22.30m: rare inclusions <2cm.*		21 22		
22.30 - 23.80	100 100 75	5						23		
23.80 - 25.30	86 80 51	AZCL 5 NI			(10.88)	*Between 24.80m and 24.83m: mudstone.* *Between 24.80m and 25.00m: non intact recovered as gravel.*		24 25		
25.30 - 26.80	100 100 45	6				*Below 25.30m: extremely weak/very weak.* *Between 25.60m and 25.95m: vertical discontinuity.* *Below 26.30m: very weak to weak.*		26		
26.80 - 28.30	93 100 69	3				*Between 27.30m and 27.40m: vertical discontinuity.* *At 27.57m: quartzite inclusion.* *Between 27.64m and 29.69m: sand infill.* *At 28.10m: clay (mudstone) infill.*		27 28		
28.30 - 29.80	100 100 77					*Between 29.15m and 29.30m: very coarse grained with frequent inclusions of mudstone and quartzite.*		29		
						Continued next sheet		30		

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
8.80	8.30	Air mist	
10.30	8.80	Air mist	
11.80	10.30	Air mist	
13.30	11.80	Air mist	
14.80	13.30	Air mist	
16.30	14.80	Air mist	

Checked by: HH
Log status: DRAFT
IFA RC v01.01

Borehole Diameter

Depth (m)	Dia (mm)

Casing Diameter

Depth (m)	Dia (mm)

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
05/04	16:30	32.80	5.40	
06/04	08:00	32.80	5.40	3.97
06/04	16:00	40.30	5.40	

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: RBH03
	Dates: 03/04/2018 - 06/04/2018	Client: Curtins Consulting	Sheet 4 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: RS/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
29.80 - 31.30	100 100 80	8			30.90 (0.80)	Very weak red, medium and coarse grained SANDSTONE. Discontinuities are: subhorizontal, closely spaced, undulating, smooth clean. *Between 29.90m and 29.94m: 5cm mudstone inclusion.*				
31.30 - 32.80	100 100 56	2 12			31.70 (2.20)	Weak, red medium grained SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open. *Between 31.05m and 32.70m: closely spaced, subhorizontal.*		31		
32.80 - 34.30	100 100 78	4			33.90 (6.40)	Very weak, red medium and coarse grained SANDSTONE with rare mudstone inclusions. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open.		32 33		
34.30 - 35.30	100 100 80					Very weak to weak, red, medium grained SANDSTONE with frequent mudstone banding. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open. *Between 33.90m and 34.90m: ?????* *Between 34.30m and 33.83m: sand infill.*		34 35		
35.30 - 37.30	100 100 60					*Between 37.30m and 38.30m: medium spaced.*		36 37		
37.30 - 38.80	100 100 85	1 3				*At 38.40m: mudstone infill.* *At 38.60m: mudstone inclusions.*		38 39		
38.80 - 40.30	100 100 95							40		

Continued next sheet

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %
17.80	16.30	Air mist	
19.30	17.80	Air mist	
20.80	19.30	Air mist	
22.30	20.80	Air mist	
23.80	22.30	Air mist	
25.30	23.80	Air mist	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Borehole Diameter: Depth (m) | Dia (mm)

Casing Diameter: Depth (m) | Dia (mm)

Boring Progress: Date | Time | Depth (m) | Cased (m) | Water (m)

Water Strikes: Strike (m) | Cased (m) | Sealed (m) | Time (mins) | Rose to (m) | Remarks

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Monitoring Installations: Top (m) | Base (m) | Pipe Type | Dia (mm)

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: RBH03
	Dates: 03/04/2018 - 06/04/2018	Client: Curtins Consulting	Sheet 5 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: RS/HH / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
		2			40.30	Very weak to weak, red, medium grained SANDSTONE with frequent mudstone banding. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open.				
						End of Borehole at 40.30m				

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48
49
50

Flush Details			
Top (m)	Base (m)	Flush Type	Flush Return %
26.80	25.30	Air mist	
28.30	26.80	Air mist	
29.80	28.30	Air mist	
31.30	29.80	Air mist	
32.80	31.30	Air mist	
34.30	32.80	Air mist	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Borehole Diameter	
Depth (m)	Dia (mm)

Casing Diameter	
Depth (m)	Dia (mm)

Boring Progress				
Date	Time	Depth (m)	Cased (m)	Water (m)

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)

Core Photographs
RBH03

Core Photographs
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IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH04**
	Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting	Sheet 1 of 5
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: / Logged by: NC/MD / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Groundwater: Water Strike	Backfill/ Installation
0.18 - 0.28	B1			0.18	MADE GROUND: Grey tarmacadam.			
0.20	D3			0.28	MADE GROUND: Grey brown, gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including brick and concrete.			
0.20	ES2			0.48				
0.28 - 0.48	B4				MADE GROUND: Reddish brown, gravelly, fine and medium SAND. Gravel is subrounded to rounded, coarse of sandstone.			
0.40	D6			(0.72)				
0.40	ES5				Brown mottled orange brown, very clayey, fine SAND (driller's description).			
0.48 - 1.20	B7			1.20			1	
1.00	D9				Loose, brown, clayey, gravelly, fine and medium SAND.			
1.00	ES8							
1.20		SPT(S) N=8 (1,1/2,2,2,2)						
1.20 - 1.65	D10							
2.00		SPT(S) N=21 (5,6/5,5,6,5)			*Below 2.00m: medium dense.* *Between 2.00m and 8.00m: rare red brown mudstone and grey sandstone.*		2	
2.00 - 2.45	D11							
				(4.30)				
3.00		SPT(S) N=41 (6,5/14,14,6,7)			*Below 3.00m: dense.*		3	
3.00 - 3.45	B12							
4.00 - 5.00	13 0 0	AZCL			*Between 4.00m and 4.87m: assumed zone of core loss.*		4	
		NA			*Between 4.87m and 5.00m: single cobble of limestone.* *Between 5.00m and 5.50m: assumed zone of core loss.*		5	
5.00 - 6.00	50 17 0	AZCL						
		NA		5.50	Recovered as medium and coarse, rounded GRAVEL including granite, sandstone and basalt.			
		15		5.70 5.80	Firm, red brown, slightly sandy, very gravelly CLAY. Gravel is subrounded to rounded including granite and sandstone.		6	
6.00 - 7.50	40 0 0	AZCL		(0.80)	Extremely weak, very thinly bedded, red brown, fine and medium grained SANDSTONE. Discontinuities are horizontal, very closely spaced, planar rough and clean. *Between 6.00m and 7.50m: non intact.*			
		NI		6.60 (0.90)	Extremely weak, reddish brown SANDSTONE recovered as red brown, gravelly SAND. Gravel is angular, fine to coarse including sandstone.		7	
		AZCL		7.50	Assumed zone of core loss.			
7.50 - 9.00	86 56 18	14		7.70 (1.50)	Extremely weak, thinly bedded, red brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal 5-10 degrees, closely spaced, planar rough clean.		8	
		NI			*Between 8.90m to 9.00m: non-intact recovered as coarse gravel.* *Between 9.00m and 9.20m: assumed zone of core loss.*		9	
		AZCL		9.20	Extremely weak, thinly bedded, red brown, fine and medium grained SANDSTONE. Locally recovered as red brown, gravelly sand. *Between 9.20m and 10.50m: recovered as non intact with occasional solid core sections.*			
9.00 - 10.50	86 38 27	NI		(1.30)				
	TCR/SCR/RQD	FI	Samples & Tests		Continued next sheet		10	

Dynamic Sample Recovery				
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	9.20	PLAIN	19
9.20	10.20	SLOTTED	19

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH04**
	Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting	Sheet 2 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/MD / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing

Depth	TCR/SCR/RQD	FI	Samples & Test Result
10.50 - 12.00	83 0 0	AZCL NI 10 NI 12 NI 27 NI	
12.00 - 13.50	93 0 0	AZCL 30 NI 11 NI	
13.50 - 15.00	100 91 52	11	
15.00 - 16.50	100 94 47	16 6 NI 4	
16.50 - 18.00	100 80 53	15 4 19	
18.00 - 19.50	100 87 57	NI 7 NI 5	
		9	

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend
		Extremely weak, thinly bedded, red brown, fine and medium grained SANDSTONE. Locally recovered as red brown, gravelly sand.	
	10.50	Assumed zone of core loss. *Between 10.73m and 10.83m: non intact recovered as slightly gravelly sand.*	
	10.75 (1.63)	Extremely weak, reddish brown, fine and medium grained, slightly weathered SANDSTONE. Discontinuities are 1) 0-30 degrees, very closely to closely spaced, planar and occasionally undulating, rough and clean. 2) medium spaced, planar, rough, occasionally weathered with light brown infill <5mm of clayey, fine and medium sand. *Between 11.60m and 11.65m: non intact recovered as gravel and cobbles.*	
	12.38 (5.12)	Very weak, reddish brown, medium grained, slightly weathered SANDSTONE. Discontinuities are 1) 0-25 degrees, very close to closely spaced, planar, rough and clean. 2) 45-60 degrees, medium to widely spaced, planar, rough and clean. *At 15.62m: Discontinuity is 10 degrees, stepped, rough light, yellowish brown, infilled <5mm with fine to coarse sand.* *Between 15.62m and 15.77m: 1 no 75 degrees, discontinuity, planar, rough and smooth, stained yellowish brown and infilled <3mm with soft reddish brown clay.* *At 15.63m: band of <20mm of extremely weak reddish brown mudstone.* *Between 16.21m and 16.27m: sandy gravel.* *Below 16.50m: indistinctly very thinly bedded.*	
	17.50 (0.50)	Very weak to weak, reddish brown mottled light yellowish brown indistinctly, very thinly bedded, partially weathered, fine and medium grained SANDSTONE. Discontinuities are 1) 10-30 degrees, extremely closely to closely spaced, planar and undulating, rough, clean. 2) 45-80 degrees, very closely to closely spaced, planar and undulating, filled <5mm with light yellowish brown, fine sand, rough.	
	18.00	Weak, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 0-15 degrees, very closely to closely spaced, planar, rough, clean. *between 18.00m and 18.27m: occasional light yellowish brown mottling.* *Between 18.00m and 18.11m: non intact recovered as gravel.* *Between 18.27m and 18.37m: 1no 55 degrees discontinuity, planar, rough, clean.* *Between 18.40m and 18.46m: non intact recovered as gravel.*	

Continued next sheet

Groundwater

Water Strike	Backfill/ Installation

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter

Depth (m)	Dia (mm)
40.00	107

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
26/06	16:30	6.00	5.00	
27/06	08:00	6.00	6.00	1.80
27/06	16:30	33.00	6.00	1.50
28/06	08:00	33.00	6.00	1.50

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter

Depth (m)	Dia (mm)
6.00	200

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	9.20	PLAIN	19
9.20	10.20	SLOTTED	19

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH04**
	Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting	Sheet 3 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/MD / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
19.50 - 21.00	100 84 54	NI 3 NI 5				Weak, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 0-15 degrees, very closely to closely spaced, planar, rough, clean. *Between 20.37m and 20.43m: non intact recovered as gravel.* *Between 20.37m and 20.45m: frequent clasts and inclusions of subrounded <40mm mudstone and siltstone.* *Between 20.64m and 20.84m: frequent clasts of subangular to subrounded <30mm quartzite.* *Between 20.72m and 20.78m: non intact recovered as sandy gravel, unweathered.* *Between 21.00m and 21.05m: assumed zone of core loss.* *Between 21.05m and 21.20m: non intact recovered as gravel.* *Between 21.27m and 21.32m: 1no 0-45 degrees discontinuity infilled <50mm with soft, reddish brown very sandy clay, sand is fine to coarse, surface is rough.* *Between 21.42m and 21.48m: non intact recovered as gravel.*		21		
21.00 - 22.50	97 43 40	AZCL NI 23 NI 8 4						22		
22.50 - 24.00	100 71 35	7 23			(7.35)	*Between 23.59m and 23.89m: 6no discontinuities, 40-60 degrees, very closely spaced, planar and undulating, tough, clean.* *Between 23.89m and 24.24m: non intact recovered as gravel.* *Between 24.00m and 24.40m: stained yellowsih brown.*		23		
24.00 - 25.50	100 55 21	NI 10 NI 8						24 25		
25.50 - 27.00	100 83 43	26 3 13			25.35 (3.15)	*Between 25.28m and 25.38m: non intact 40+.* Very weak, reddish brown, medium and coarse grained SANDSTONE with rare clasts <20mm 0off subangular limestone. Discontinuities are 0-20 degrees, very closely to medium spaced, undulating, rough, clean. *Between 25.50m and 26.31m: discontinuities, 30-40 degrees, closely to medium spaced, undulating, rough, occasionally stained blackish brown.*		26		
27.00 - 28.50	100 85 65	NI 6				*Between 27.00m and 27.17m: non intact recovered as gravel.*		27 28		
28.50 - 30.00	100 90 47	19			28.50	Very weak, reddish brown, medium and coarse grained SANDSTONE with rare mudstone inclusions <70mm of extremely weak reddish brown mudstone. Discontinuities are 0-10 degrees, very closely spaced, planar and occasionally undulating, rough, clean.		29 30		

Continued next sheet

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
						28/06	16:30	40.00	6.00	1.80	SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH04**
	Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting	Sheet 4 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/MD / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
30.00 - 31.50	100 100 58	7			(4.50)	Very weak, reddish brown, medium and coarse grained SANDSTONE with rare mudstone inclusions <70mm of extremely weak reddish brown mudstone. Discontinuities are 0-10 degrees, very closely spaced, planar and occasionally undulating, rough, clean.		31		
31.50 - 33.00	100 67 38	16				*Between 32.00m and 32.65m: extremely weak, stained orangish brown with 3no discontinuities, 10-90 degrees, very closely spaced, planar and undulating, rough and smooth infilled <10mm with soft sandy clay.*		32		
		4			33.00					
33.00 - 34.50	100 33 11	NI				Extremely weak to very weak, reddish brown, occasionally mottled orangish brown, medium and coarse grained SANDSTONE. Discontinuities are 1) 0-20 degrees, very closely to closely spaced, undulating and planar, rough, clean. 2) 50-90 degrees, closely spaced, planar, occasionally infilled <10mm with light brown and blackish brown. *Between 33.00m and 33.50m: 2no discontinuities, 80 degrees, planar, rough, infilled <15mm with soft clay.* *Between 33.00m and 33.78m: non intact recovered as clayey gravel.*		33		
		8						34		
34.50 - 36.00	100 59 9	27				*Between 34.69m and 34.73m: non intact recovered as gravel.*				
		NI								
		23						35		
		NI				*Between 35.15m and 35.17m: non intact recovered as gravel.*				
		9						36		
36.00 - 37.50	100 64 9	NI			(6.70)	*Between 36.33m and 36.50m: non intact recovered as gravel.*				
		10						37		
37.50 - 39.00	83 0 0	AZCL								
		NI						38		
						Between 38.50m and 38.75m: non intact 40+.				
		NI				*Between 38.75m and 39.00m: non intact recovered as gravel.*				
								39		
39.00 - 40.50	67 13 0	AZCL								
		15			39.70					
						Extremely weak, poorly cemented, medium and coarse grained SANDSTONE recovered as non intact, sandy gravel. Probable		40		

Continued next sheet

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter: Depth (m)	Dia (mm)

Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter: Depth (m)	Dia (mm)

Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **RBH04**
	Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting	Sheet 5 of 5
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/MD / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
		NI			(0.80) 40.50	Extremely weak, poorly cemented, medium and coarse grained SANDSTONE recovered as non intact, sandy gravel. Probable fault gouge, weakly cemented. *At 39.70m: subvertical, widely spaced and smooth (probable fault plane).* *Between 39.70m and 40.50m: non intact recovered as sandy gravel.*		41		
						End of Borehole at 40.00m		42		
								43		
								44		
								45		
								46		
								47		
								48		
								49		
								50		

Flush Details			
Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter	
Depth (m)	Dia (mm)

Boring Progress				
Date	Time	Depth (m)	Cased (m)	Water (m)

Remarks:

SPT Hammer: N/R, Energy Ratio: N/R

Casing Diameter	
Depth (m)	Dia (mm)

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
RBH04

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IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **RBH05**
	Dates: 12/07/2018	Client: Curtins Consulting	Sheet 1 of 4
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: / Logged by: NC/RS / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Groundwater: Water Strike	Backfill/ Installation
0.10 - 0.60	B1				Grass over Black TOPSOIL.			
0.20	D2			0.20	MADE GROUND: brown slightly gravelly fine to coarse SAND. Gravel is subangular to subrounded, fine to medium including sandstone, brick and metal wire fragments.			
0.40	ES3			(0.30)				
0.50	D5			0.50				
0.50	ES4			0.60	MADE GROUND: Greyish brown gravely fine to coarse SAND. Gravel is subangular to subrounded, fine to medium including brick.			
0.70 - 1.20	B6				Medium dense, light brown slightly gravely fine to coarse SAND. Gravel is subagnaualr to subrounded, fine and medium including sandstone and coal.			
0.80	ES7							
1.00	D8						1	
1.20		SPT(S) N=17 (1,4/5,4,4,4)						
1.20	D9							
1.50 - 2.00	B10							
2.00		SPT(S) N=25 (7,6/5,6,7,7)					2	
2.00	D11							
2.50 - 3.00	B12							
				(4.90)				
3.00		SPT(S) N=40 (8,9/9,10,11,10)			*Below 3.00m: dense.*		3	
3.00	D13							
4.00		SPT(S) 50 (10,12/50 for 235mm)			*Below 4.00m: very dense.*		4	
4.00	B14							
4.00	D15							
5.00 - 5.50	0 / 0 / 0	NR; 5.00m - SPT(S) N=50 (6,7/8,9,15,18)					5	
		NI		5.50	Medium strong, reddish brown, fine grained SANDSTONE with occasional off white 5-10mm sized quartzite inclusions. Discontinuities are 2-50 degrees, very closely to closely spaced, subhorizontal, open and rough.			
5.50 - 6.00	100 / 68 / 0	14						
		NI						
		AZCL					6	
6.00 - 7.50	86 / 80 / 35	12						
							7	
				(3.50)				
7.50 - 9.00	40 / 37 / 0	AZCL					8	
				9.00	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with rare grey 10mm sized quartzite inclusions. Discontinuities are 3-50 degrees, very closely to closely spaced, subhorizontal, planar to undulating, open and rough.		9	
9.00 - 10.50	100 / 100 / 0	19		(1.36)				
	TCR/SCR/RQD	FI	Samples & Tests		Continued next sheet		10	

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: JT.01 Energy Ratio: 64%

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	5.00	Plain	
5.00	20.00	Slotted	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **RBH05**
	Dates: 12/07/2018	Client: Curtins Consulting	Sheet 2 of 4
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/RS / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing

Depth	TCR/SCR/RQD	FI	Samples & Test Result
10.50 - 12.00	66 42 22	NR NI 10	
12.00 - 13.50	83 66 42	NI 10	
13.50 - 15.00	66 61 48	AZCL NI	
15.00 - 16.50	100 90 34	9	
16.50 - 18.00	100 100 48		
18.00 - 19.50	100 92 55	6 NI 16 6	
		NI	

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend
	10.36	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with rare grey 10mm sized quartzite inclusions. Discontinuities are 3-50 degrees, very closely to closely spaced, subhorizontal, planar to undulating, open and rough.	
	(0.64) 11.00	Medium strong, reddish brown, medium and coarse grained SANDSTONE with occasional off white and grey 4-8mm sized quartzite inclusions. Discontinuities are 1-30 degrees, closely spaced, subhorizontal, planar, open and rough.	
	(3.00)	Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional brown and grey 3-6mm sized quartzite and mudstone inclusions. Discontinuities are 2-6 degrees, closely spaced, subhorizontal, planar to undulating, open and rough.	
	14.00	Strong, reddish brown, fine and medium grained SANDSTONE with occasional off white and grey 3-10mm sized quartzite inclusions. Discontinuities are very 1-8 degrees, closely to closely spaced, subhorizontal, planar to undulating, open and rough.	
	(4.00)		
	18.00	Weak, reddish brown, thinly to medium bedded, medium and coarse grained SANDSTONE with very rare thin bands and pockets of extremely weak, reddish brown mudstone and rare clasts of subrounded quartzite. Discontinuities are 0-15 degrees, very closely spaced, undulating rough and clean. *Between 19.73m and 19.81m: band of extremely weak reddish brown mudstone.*	

Continued next sheet

Groundwater: Water Strike / Backfill/ Installation

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
5.00	6.00	Air mist	50
6.00	13.50	Air mist	0
13.50	19.50	Air mist	25
19.50	40.00	Air mist	20

Borehole Diameter

Depth (m)	Dia (mm)
40.00	102

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
12/07	16:30	19.50	8.00	8.40
13/07	08:00	19.50	8.00	4.90
13/07	16:30	40.00	8.00	7.40

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter

Depth (m)	Dia (mm)
8.00	146

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	5.00	Plain	
5.00	20.00	Slotted	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **RBH05**
	Dates: 12/07/2018	Client: Curtins Consulting	Sheet 3 of 4
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/RS / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
19.50 - 21.00	100 84 41	6 NI 10				Weak, reddish brown, thinly to medium bedded, medium and coarse grained SANDSTONE with very rare thin bands and pockets of extremely weak, reddish brown mudstone and rare clasts of subrounded quartzite. Discontinuities are 0-15 degrees, very closely spaced, undulating rough and clean.		21		
21.00 - 22.50	100 87 18	15 8						22		
22.50 - 24.00	100 81 37	24 NI 7 24 7			(8.00)			23 24		
24.00 - 25.50	100 97 66	33 5 40 6						25		
25.50 - 27.00	100 97 65	NI			26.00	*Between 25.90m and 26.00m: band of extremely weak reddish brown mudstone.* Medium strong, reddish brown, thinly to thickly bedded, fine and medium grained SANDSTONE with occasional reduction spots and rare pockets and bands of extremely to very weak, reddish brown mudstone. Discontinuities are 0-15 degrees, very closely to medium spaced, planar and undulating rough and clean.		26		
27.00 - 28.50	100 97 87	4			(6.18)			27 28		
28.50 - 30.00	100 93 69	NI 4				*Between 28.85m and 28.90m: stained light brown. Between 28.90m and 29.00m: extremely weak to very weak, reddish brown, highly fractured mudstone.*		29		
						Continued next sheet		30		

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: **RBH05**
	Dates: 12/07/2018	Client: Curtins Consulting	Sheet 4 of 4
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/RS / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details					Groundwater	
Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
30.00 - 31.50	100 90 57	NI 27				Medium strong, reddish brown, thinly to thickly bedded, fine and medium grained SANDSTONE with occasional reduction spots and rare pockets and bands of extremely to very weak, reddish brown mudstone. Discontinuities are 0-15 degrees, very closely to medium spaced, planar and undulating rough and clean.		31		
31.50 - 33.00	100 94 67	10 NI 5			32.18	Medium strong, thinly to thickly bedded, fine to coarse grained SANDSTONE with rare reduction spots <5mm. Discontinuities are 0-10 degrees, very closely to widely spaced, planar, rough and clean.		32		
33.00 - 34.50	100 100 86	1 6			(3.89)			33 34		
34.50 - 36.00	100 97 88	NI 3						35		
36.00 - 37.00	93 76 56	AZCL NI 5			36.07	Weak, reddish brown, indistinctly medium bedded, medium and coarse grained SANDSTONE with occasional pockets <40mm of extremely weak to very weak reddish brown mudstone. Discontinuities are 0-20 degrees, very closely to medium spaced, planar, rough and clean.		36		
37.00 - 38.50	77 40 21	AZCL NI 13			(2.43)			37 38		
38.50 - 40.00	97 93 72	AZCL NI 3			38.50 (1.50)	Weak, reddish brown, indistinctly medium bedded, medium and coarse grained SANDSTONE with rare reduction spots <5mm. Discontinuities are 0-10 degrees, medium spaced, undulating, rough and clean.		39		
					40.00	End of Borehole at 40.00m		40		

Flush Details				Borehole Diameter		Boring Progress					Remarks:
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter		Water Strikes						Monitoring Installations			
Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
RBH05

Core Photographs
RBH05

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Core Photographs
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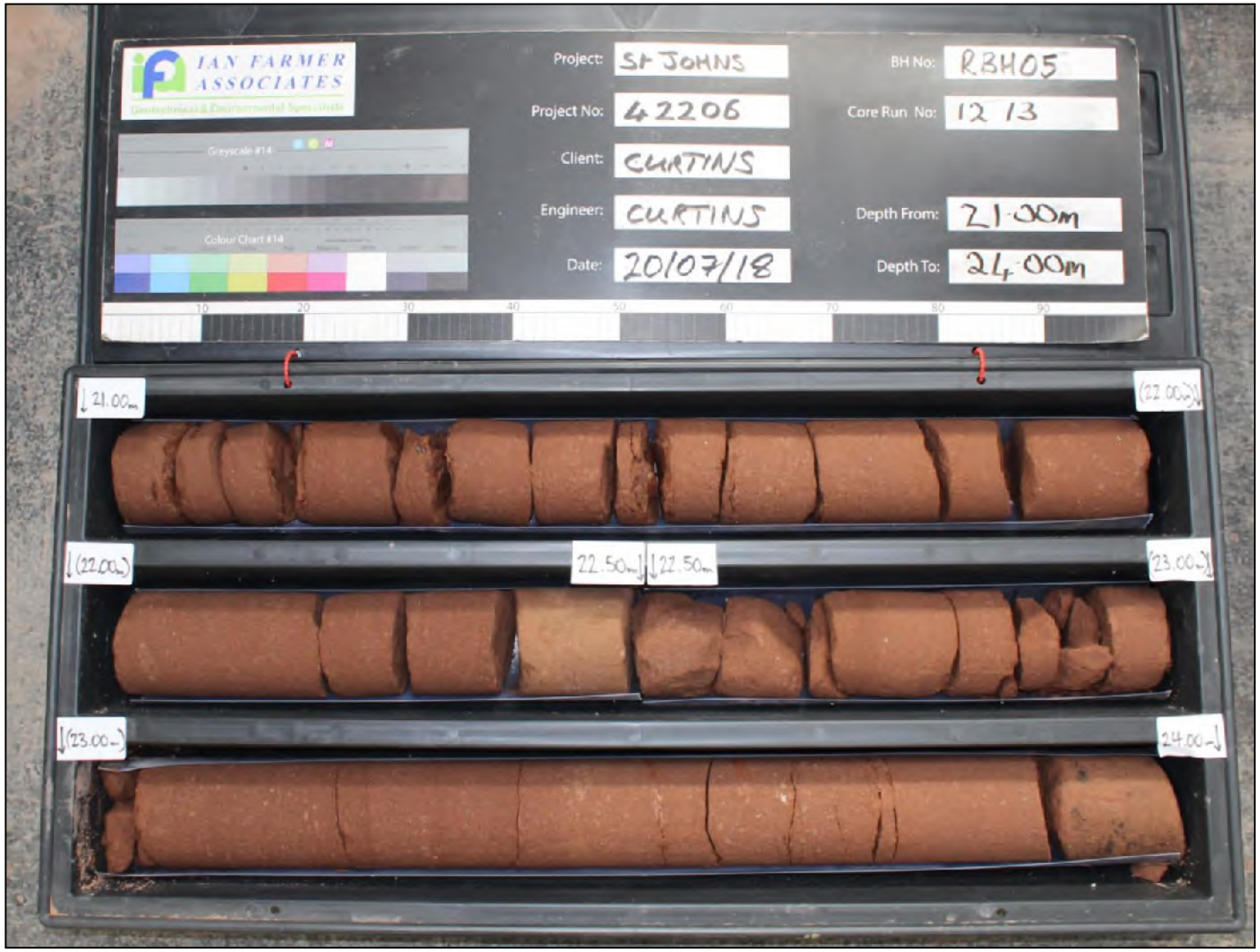
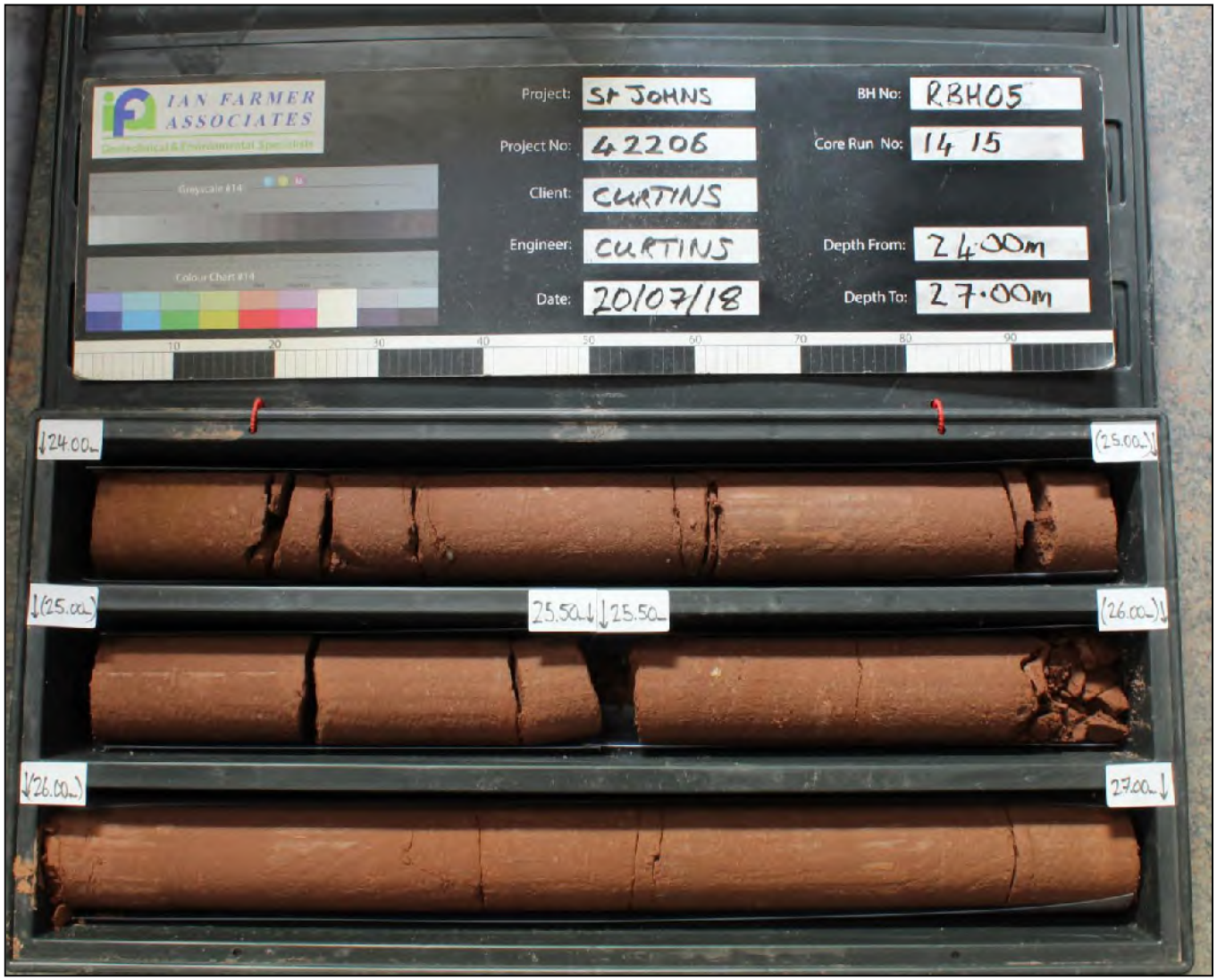
RBH05

Core Photographs
RBH05



Core Photographs
RBH05



Core Photographs
RBH05

Core Photographs
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Core Photographs
RBH05

Core Photographs
RBH05

IAN FARMER ASSOCIATES	Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: **RBH06**
	Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 1 of 6
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: / Logged by: NC/NC/LVC / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Groundwater: Water Strike	Backfill/ Installation
				0.18	MADE GROUND: Light grey concrete.			
0.35 - 0.55	B1			0.38	MADE GROUND: Yellow and orange subangular COBBLES of brick and sandstone.			
0.55 - 1.00	B2			0.55	MADE GROUND: Yellow and dark brown, clayey, gravelly, fine to coarse SAND with low cobble content. Gravel is subangular, fine to coarse including brick. Cobbles are subangular including brick and sandstone.			
1.20 - 2.00	B3			(2.45)	MADE GROUND: Firm, orange brown and grey, sandy, gravelly CLAY. Gravel is angular to subangular, fine to coarse including concrete, sandstone and brick.			
2.00		SPT(S) N=17 (1,2/3,5,4,5)						
2.00 - 2.45	D5							
2.00 - 3.00	B4							
3.00		SPT(S) N=18 (1,3/5,4,5,4)		3.00	Medium dense, orange brown, gravelly, fine and medium SAND. Gravel is subrounded to rounded, fine and medium including sandstone.			
3.00 - 3.45	D7							
3.00 - 4.00	B6			(1.65)				
4.00		SPT(S) 50 (6,7/50 for 225mm)			*Below 4.00m: very dense.*			
4.00 - 4.45	D9							
4.00 - 5.00	B8							
4.50 - 5.00	70 / 50 / 0	AZCL / NI / 15 / NI		4.65	Extremely weak to weak, very thinly bedded, reddish brown, coarse grained SANDSTONE with subangular, medium gravel including mudstone, quartzite and with lenses of mudstone <60x30mm. Discontinuities are subhorizontal, closely spaced, rough planar.			
5.00 - 6.00	73 / 49 / 0	AZCL / 9 / NI / 11		(1.07)	*Between 5.39m and 5.40m: mudstone.* *Between 5.44m and 5.66m: mudstone.* *Between 5.58m and 5.60m: mudstone.*			
6.00 - 7.00	100 / 65 / 0	NI / 25 / NI / 17		5.72	Weak to medium strong, thickly laminated, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely spaced, rough stepped, undulating, open with clay and sand fill.			
				(1.68)	*Between 7.14m and 7.16m: soft clay.*			
7.00 - 8.50	97 / 65 / 0	AZCL / NI / 0 / NI / 17 / NI / 7 / NI		7.40	Extremely weak to weak, very thinly bedded, reddish brown, coarse grained SANDSTONE with subangular, medium gravel of mixed lithologies. Locally recovered as sand and gravel. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide with sand and gravel fill <160mm.			
				(1.05)				
				8.45				
				8.53	Medium strong, very thinly bedded, mica rich reddish brown medium grained SANDSTONE.			
8.50 - 10.00	73 / 55 / 0	AZCL / 12		(0.47)	Extremely weak, very thinly bedded, reddish brown, coarse grained SANDSTONE with subangular, medium gravel of mixed lithologies. Locally recovered as sand.			
				9.00	Medium strong, very thinly bedded, coarse grained SANDSTONE with subangular, fine and medium gravel of mixed lithologies. Discontinuities are subhorizontal, very closely to closely spaced, rough undulating planar, open with sand film.			
				(1.46)				
	TCR/SCR/RQD	FI	Samples & Tests		Continued next sheet			

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks
1.20	2.00		100	
2.00	3.00		100	
3.00	4.00		100	
4.00	4.50		100	

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: JT.01 Energy Ratio: 64%

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
10.20	10.50	Slotted	19
0.00	10.20	Plain	19

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: **RBH06**
	Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 2 of 6
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/NC/LVC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
10.00 - 11.50	100 35 7	18 NI 6 NI 10			10.46 (0.74) 11.20	Medium strong, very thinly bedded, coarse grained SANDSTONE with subangular, fine and medium gravel of mixed lithologies. Discontinuities are subhorizontal, very closely to closely spaced, rough undulating planar, open with sand film. Extremely weak to weak, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely spaced, rough undulating open, moderately wide with sand and gravel fill <200mm. *Between 11.00m and 11.20m: sand and gravel.*		11		
11.50 - 13.00	83 53 28	NI 8 AZCL			(3.01)	Weak to strong, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, rough undulating, open to wide with clay sand fill <5mm and gravel fill 120mm.		12 13		
13.00 - 14.50	95 88 55	6 20			14.21 14.31			14		
14.50 - 16.00	97 53 37	6 NI AZCL 3			(0.97) 15.28 15.55	Extremely weak, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating open, moderately wide with sand film fill. 2) 80 degrees, very widely spaced, rough undulating, moderately wide with sand film fill. Weak to thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 10-15 degrees, closely spaced, rough undulating, with sand fill and stained orange yellow. Extremely weak, reddish brown, coarse grained SANDSTONE. Recovered as coarse sand.		15		
16.00 - 17.50	100 100 40	11			(4.95)	Weak to medium strong, very closely to closely bedded, reddish brown, coarse grained SANDSTONE, locally with subrounded fine to coarse gravel of mixed lithologies. *Between 15.77m and 15.78m: with coarse subhorizontal gravel.* *Between 16.77m and 16.78m: with coarse subrounded gravel.*		16 17		
17.50 - 19.00	100 100 18					*Between 18.72m and 18.88m: with coarse subhorizontal gravel.* *Between 18.81m and 18.86m: lenses of clay <10mm x 40mm.*		18		
19.00 - 20.50	100 97 63	0 14				*Between 19.05m and 19.06m: medium gravel.*		19 20		

Continued next sheet

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
8.50	4.50	Air mist	80
10.00	8.50	Air mist	70
50.50	10.00	Air mist	10
55.00	50.50	Air mist	0

Borehole Diameter

Depth (m)	Dia (mm)
55.00	102

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
06/07	09:00	1.20		Dry
09/07	08:00	1.20		Dry
09/07	16:30	14.50	7.50	4.80
10/07	08:00	14.50	7.50	2.80

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter

Depth (m)	Dia (mm)
7.50	146

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
10.20	10.50	Slotted	19
0.00	10.20	Plain	19

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: **RBH06**
	Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 3 of 6
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/NC/LVC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
					20.50 (0.50)	Weak to medium strong, very closely to closely bedded, reddish brown, coarse grained SANDSTONE, locally with subrounded fine to coarse gravel of mixed lithologies. *Between 19.89m and 19.90m: lenses of mudstone.* *Between 20.13m and 20.18m: lenses of mudstone (40mm x 2mm).* *Between 20.25m and 20.26m: with medium gravel.* *Between 20.44m and 20.52m: glauconitic patch.*				
20.50 - 22.00	100 93 55	6			21.00	Extremely weak to very weak, thinly laminated reddish brown, fine grained MUDSTONE. Locally glauconitic . Discontinuities are subhorizontal, closely spaced, smooth, undulating, open and wide with clay and mudstone gravel fill. *Between 20.53m and 20.55m: glauconitic lenses.*		21		
22.00 - 23.50	100 100 69				(2.88)	Medium strong, thinly laminated to closely bedded, reddish brown, coarse grained SANDSTONE with mudstone interlaminated and lenses of mudstone <20mm x5mm. Discontinuities are subhorizontal, closely spaced, rough, undulating, open wide with sand and coarse gravel fill. *Between 22.04m and 22.05m: lense of glauconite.*		22 23		
		4				*Between 23.34m and 23.88m: lenses of mudstone 40mm x 2mm and with subangular, fine and medium gravel.*				
23.50 - 25.00	100 91 64	2 NI NI 0 NI			23.88	Medium strong, very thinly bedded to thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, closely spaced, rough, undulating, open moderately wide with sand film fill and subangular coarse gravel fill. 2) 20 degrees, very closely to closely spaced, rough stepped undulating moderately wide to wide, with sand film fill and subangular coarse gravel fill.		24		
25.00 - 26.50	100 97 72				(4.48)			25 26		
26.50 - 28.00	100 98 68	6				*Between 27.83m and 27.84m: lense of mudstone 20mm x 5mm.*		27 28		
28.00 - 29.50	100 98 67				28.36 (1.64)	Medium strong, very thinly laminated, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, closely spaced, rough undulating, open to wide with sand film fill. 2) 20 degrees, closely spaced, rough undulating, open with sand film fill.		29		
		AZCL			30.00	Continued next sheet		30		

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter: Depth (m)	Dia (mm)

Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)
10/07	16:30	49.00	7.50	4.20
11/07	08:00	49.00	7.50	5.80
11/07	16:30	55.00	7.50	5.10

Remarks:

SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter: Depth (m)	Dia (mm)

Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: **RBH06**
	Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 4 of 6
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/NC/LVC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
29.50 - 31.00	93 90 52	6			(1.84)	Medium strong, thickly laminated, reddish brown, medium grained SANDSTONE. Discontinuities are 1) subhorizontal, closely spaced, rough undulating, open, with sand film fill. 2) 40 degrees widely spaced, rough stepped, wide and clean. *Between 30.95m and 31.00m: coarse grained sandstone.* *Between 31.29m and 31.33m: mudstone.*		31		
31.00 - 32.50	100 89 51	NI 0 NI 0 40+ 0 NI NI			31.84	Weak to medium strong, thinly laminated to very thinly bedded, reddish brown, coarse grained SANDSTONE with rare beds of mudstone. Discontinuities are 1) subhorizontal, very closely to closely spaced, rough undulating, open to moderately wide with, subangular, fine to coarse gravel and clay fill. 2)15-25 degrees, closely spaced, rough undulating tight to moderately wide with sand film fill.		32		
32.50 - 34.00	100 100 75	6			(3.96)			33		
34.00 - 35.50	100 96 91					*Between 35.21m and 35.23m: lense of mudstone.*		34 35		
35.50 - 37.00	91 90 74	AZCL 5 0 9			35.80 (0.39) 36.19	Medium strong, reddish brown, medium grained SANDSTONE. Glauconitic. *Between 35.85m and 35.86m: lense of glauconite,*		36		
37.00 - 38.50	100 94 73	2 13			(3.81)	Medium strong to strong, thinly laminated to thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely to medium spaced, rough undulating, open moderately wide with angular fine to coarse gravel of mudstone and sandstone and sand fill. 2) 25 degrees medium spaced, rough, undulating, open and clean. 3) 85 degrees, widely spaced, rough undulating, open with sand film fill. *Between 36.94m and 36.95m: incipent fracture.* *Between 37.31m and 37.34m: mudstone.* *Between 38.34m and 38.37m: with fine and medium grained gravel and lense of mudstone <30 x 10mm).*		37 38		
38.50 - 40.00	100 92 85	2 6 2				*Between 39.04m and 39.12m: beds and lenses of mudstone.*		39		
					40.00	Continued next sheet		40		

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %	Borehole Diameter: Depth (m)	Dia (mm)	Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)	Remarks:
											SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter: Depth (m)	Dia (mm)	Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: **RBH06**
	Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 5 of 6
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/NC/LVC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
40.00 - 41.50	100 100 93	12			(2.00)	Medium strong to strong, thinly bedded to medium bedded, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open, clean and reduced strength <3mm.		41		
		0			42.00			42		
41.50 - 43.00	100 98 93	8			(1.00)	Medium strong, thickly laminated to thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open moderately wide, clean and with sand and angular, fine to coarse gravel fill.				
		0			43.00			43		
		36			(0.84)	Strong, thinly to thickly laminated, reddish brown, medium grained SANDSTONE. Discontinuities are subhorizontal, widely spaced, rough undulating, open and clean.				
43.00 - 44.50	100 100 100	1			43.84			44		
		5			(1.51)	Medium strong to strong, thickly laminated to closely bedded, reddish brown, coarse grained SANDSTONE with subangular, fine and medium gravel. Discontinuities are subhorizontal, closely spaced, rough undulating, open clean and with clay fill. *Between 44.77m and 44.78m: mudstone weathered to clay in discontinuity.*		45		
44.50 - 46.00	100 97 83				45.35					
					45.56	Strong, thinly laminated, reddish brown, fine grained SILTSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open to moderately wide with clay fill <6mm. *Between 45.52m and 45.53m: mica present.* *Between 45.54m and 45.55m: clay fill.*				
					(0.67)			46		
					46.23	Strong, thinly to thickly laminated, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely spaced, rough undulating, open moderately wide and clean.				
46.00 - 47.50	100 99 69	7			(1.23)	Strong, thinly to thickly laminated, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide, clean and with to subangular, fine and medium gravel fill. 2) 30-45 degrees, very closely spaced, rough, undulating, clean and with spot of glauconite <10mm.		47		
					47.46					
47.50 - 49.00	100 100 77	0				Medium strong to strong, very thinly bedded to medium bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely to medium spaced, rough undulating, open moderately wide clean and with sand film fill. 2) 50 degrees, very widely spaced, rough undulating, moderately wide and with clay sand and fine gravel fill. *Between 47.86m and 48.00m: with subangular, fine to coarse gravel of mixed lithologies.*		48		
		10						49		
49.00 - 50.50	100 100 87	0				*Between 49.07m and 49.18m: with subangular, fine to coarse gravel of mixed lithologies.*				
						Continued next sheet		50		

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %	Borehole Diameter: Depth (m)	Dia (mm)	Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)	Remarks:
											SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter: Depth (m)	Dia (mm)	Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: **RBH06**
	Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 6 of 6
Rotary Borehole Log	Location:	Ground level: / Logged by: NC/NC/LVC / Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing: Depth	TCR/SCR/RQD	FI	Samples & Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Groundwater: Water Strike	Backfill/ Installation
		6				Medium strong to strong, very thinly bedded to medium bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely to medium spaced, rough undulating, open moderately wide clean and with sand film fill. 2) 50 degrees, very widely spaced, rough undulating, moderately wide and with clay sand and fine gravel fill.				
50.50 - 52.00	100 100 36	19						51		
		0			(5.14)					
		12						52		
52.00 - 53.50	100 97 88	1			52.60	*Between 52.48m and 52.60m: with sandstone with subangular, fine to coarse gravel of mixed lithologies.*				
					(0.48)	Strong, very thinly bedded, reddish brown, medium grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide and clean.		53		
		9			53.08	*Between 52.77m and 52.79m: subrounded, coarse gravel of mudstone.* *Between 52.88m and 52.89m: subangular gravel.*				
53.50 - 55.00	100 100 81				(0.92)	Strong, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide, clean and with clay, sand and subangular, fine to coarse gravel fill.				
					54.00	*Between 53.17m and 53.45m: sandstone with coarse gravel.*		54		
		0			(0.75)	Strong, thinly laminated, reddish brown, medium grained SANDSTONE. Discontinuities are subhorizontal, closely to medium spaced, rough undulating, open moderately wide and clean.				
		9			54.75					
					55.00	Strong, thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open and clean.		55		
						End of Borehole at 55.00m				
								56		
								57		
								58		
								59		
								60		

Flush Details: Top (m)	Base (m)	Flush Type	Flush Return %

Borehole Diameter: Depth (m)	Dia (mm)

Boring Progress: Date	Time	Depth (m)	Cased (m)	Water (m)

Remarks:

SPT Hammer: JT.01 Energy Ratio: 64%

Casing Diameter: Depth (m)	Dia (mm)

Water Strikes: Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations: Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Core Photographs
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Core Photographs
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IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **WS02**
	Dates: 09/07/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: NC / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details					Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
0.30	ES1			0.05 (0.15)	MADE GROUND: Dark grey Tarmacadam.				
					MADE GROUND: Light grey concrete.				
				(0.65)	MADE GROUND: Orange brown, sandy, gravelly, angular COBBLE. Gravel is subangular, fine to coarse including brick and concrete.				
				0.80	End of Borehole at 0.80m				
							1		
							2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							10		

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 0.8m. Borehole terminated at 0.80m due to dense material unable to progress further.

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: **WS03**
	Dates: 09/07/2018	Client: Curtins Consulting	Sheet 1 of 1

Dynamic Sample Borehole Log	Location:	Ground level:	Logged by: NC	Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details					Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
0.10 - 0.90	B1			0.10	MADE GROUND: Light grey Tarmacadam.				
0.30 - 0.80	ES2			(0.80)	MADE GROUND: Orange brown, gravelly, fine to coarse SAND with low cobble content. Gravel is subangular to angular, fine to coarse including slag, concrete and brick. Cobbles are subangular including brick.				
0.80	ES3								
0.90 - 1.20	B4			0.90 (0.30) 1.20	MADE GROUND: Very soft, greenish grey, gravelly, sandy CLAY with low cobble content. Gravel is subangular including brick and slag. Cobbles are subangular including brick.		1		
					End of Borehole at 1.20m		2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							10		

Dynamic Sample Recovery				
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: **WS04**
	Dates: 24/06/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: HD / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
				0.10	MADE GROUND: Tarmacadam.			
0.30	D2			0.20	MADE GROUND: Grey, gravelly, fine to coarse SAND. Gravel is angular to subangular, fine to coarse including limestone.			
0.30	ES1				MADE GROUND: Loose, brown, clayey, gravelly, fine to coarse SAND. Gravel is very angular to rounded, fine to coarse including mudstone, brick, slate, tile sandstone and mudstone.			
0.60	D4							
0.60	ES3			(1.10)				
0.70 - 1.20	B5							
1.20		SPT(S) N=5 (1,1/1,1,1,2)						
1.20	ES6			1.30				
1.20 - 1.60	B7			(0.40)	MADE GROUND: Firm, brown, slightly gravelly CLAY. Gravel is very angular to rounded, fine to coarse including sandstone, brick, limestone, mudstone and tile.			
1.20 - 1.65	D8			1.70				
				(0.30)	Orangey brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone, mudstone, limestone and quartzite.			
2.00		SPT(S) N=21 (5,5/4,3,6,8)		2.00				
2.00	D10			2.10	Firm, dark brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine and medium including sandstone and limestone.			
2.00	ES9							
2.00 - 2.45	D11			(0.95)	Medium dense, orangy brown, gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone, limestone, mudstone and quartzite.			
2.70	D12							
3.00		SPT(S) 50 (8,9/50 for 240mm)		3.05				
				(0.34)	Brownish red, fine to coarse grained SANDSTONE.			
3.00 - 3.39	D13			3.39				
					End of Borehole at 3.39m			

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks
1.20	2.00		100	
2.00	3.00		80	
3.00	4.00		20	

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	3.00	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: **WS05**
	Dates: 24/06/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: HD / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
				0.20	MADE GROUND: Tarmacadam.			
0.40	D2			0.35	MADE GROUND: Grey, sandy, very angular to subangular, fine to coarse GRAVEL including granite and sandstone (Type 1).			
0.40	ES1			(0.35)	MADE GROUND: Brownish black, slightly clayey, slightly gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including tile, brick, slag, asphalt, sandstone, mudstone and limestone.			
0.70 - 1.20	B3			0.70				
0.80	D5							
0.80	ES4							
1.20		SPT(S) N=10 (2,2/2,3,2,3)		(1.00)	MADE GROUND: Firm, orangy brown mottled black, gravelly, slightly sandy CLAY with some cobbles. Gravel is very angular to subangular, fine to coarse including brick.			
1.20	D7							
1.20	ES6							
1.20 - 1.65	D8			1.70	Loose, light brown, fine to coarse SAND.			
1.90	D10							
1.90	ES9							
2.00		SPT(S) N=8 (1,1/2,1,2,3)		(1.00)				
2.00 - 2.45	D12							
2.00 - 2.50	B11							
2.80	D13			2.70	Dense, orangy brown, gravelly, fine to coarse SAND. Gravel is subangular to rounded including quartzite and sandstone.			
3.00		SPT(S) 50 (7,12/50 for 150mm)		(0.60)				
3.00 - 3.30	D14			3.30	End of Borehole at 3.30m			

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks
1.20	2.00		100	
2.00	3.00		80	
3.00	4.00		10	

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	3.00	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: **WS06**
	Dates: 23/06/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: RS / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
					MADE GROUND: CONCRETE.			
0.30	ES1			0.25				
0.50 - 1.00	B2			(0.55)	MADE GROUND: Dark reddish brown/black, gravelly fine to coarse SAND. Gravel is subangular to angular, fine to coarse including concrete, brick and sandstone.			
0.60	D3							
0.80	ES4			0.80	MADE GROUND: Soft, black, sandy CLAY.			
1.00 - 1.50	B5			(0.50)				
1.20		SPT(S) N=7 (1,1/1,2,2,2)		1.30				
1.20	D6				Firm, light brown, sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium including sandstone.			
1.30	ES7							
1.70	D8			(0.70)				
2.00		SPT(S) N=13 (2,3/3,3,3,4)		2.00				
2.00	D9				Medium dense, reddish brown, gravelly, fine to coarse SAND. Gravel is subangular to subrounded fine to coarse including sandstone and coal.			
2.20	ES10							
2.50 - 3.00	B11							
2.70	D12			(1.41)				
3.00		SPT(S) 53 (2,2/53 for 260mm)			*Below 3m: dense.*			
3.00 - 3.41	D13							
				3.41	End of Borehole at 3.41m			

1 2 3 4 5 6 7 8 9 10

Dynamic Sample Recovery				
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	3.00	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: **WS08**
	Dates: 23/06/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: RS / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
				0.20	MADE GROUND: CONCRETE.			
0.25	ES1			(0.40)	MADE GROUND: Brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to angular, fine to coarse including brick, concrete and roadstone.			
0.50 - 1.00	B2			0.60	MADE GROUND: Soft, dark brown, sandy, slightly gravelly CLAY. Gravel is subangular to angular, fine and medium including brick, sandstone and concrete.			
0.60	ES3							
0.70	D4			(0.60)				
1.20		SPT(S) N=6 (1,1/1,1,2,2)		1.20	Firm, light brown mottled grey and brown, sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine including rounded, sandstone and limestone.			
1.20	D6			(0.30)				
1.20	ES5			1.50	Medium dense, light brown reddish brown, slightly gravelly SAND. Gravel is subangular to subrounded, fine to coarse including sandstone and coal.			
1.50	D8				*Between 2.00m and 2.20m: light green, abundant coal.*			
1.50 - 2.00	B7				*Between 2.20m and 2.80m: reddish brown.*			
2.00		SPT(S) N=11 (2,2/2,2,3,4)						
2.00	D9							
2.10	D10							
2.20	ES11			(1.88)				
2.50 - 3.00	B12							
3.00		SPT(S) 50 (5,5/50 for 235mm)			*Below 3.00m: very dense.*			
3.00 - 3.38	D13			3.38	End of Borehole at 3.38m			

Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

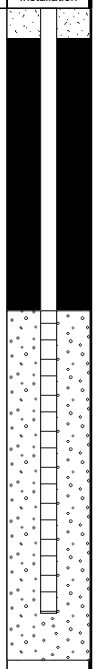
Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	3.00	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: **WS10**
	Dates: 24/06/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: HD / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing: Depth	Sample ID	Test Result	Strata Details: Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend
0.15	D2			0.15	MADE GROUND: Tarmacadam.	
0.15	ES1			0.40	MADE GROUND: Brownish black, slightly clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including brick, tile, porcelain, mudstone, sandstone, slag, limestone and wood fragments.	
0.50	D4			(0.60)		
0.50	ES3			1.00	MADE GROUND: Brownish black, slightly clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine and medium including brick, tile, porcelain, mudstone, sandstone, slag, limestone and wood fragments.	
1.20		SPT(S) N=0 (1,0/0,0,0,0)		(0.60)	MADE GROUND: Very soft, orangy brown mottled black, gravelly, slightly sandy CLAY. Gravel is angular to rounded, fine to coarse including mudstone, brick, sandstone and limestone (reworked).	
1.20	D6			1.60	Medium dense, orangy brown, slightly clayey, gravelly, fine to coarse SAND. Gravel is angular to rounded, fine to coarse including sandstone, mudstone and limestone.	
1.20	ES5					
1.20 - 1.65	D7					
2.00		SPT(S) N=21 (4,3/4,5,6,6)				
2.00	D9					
2.00	ES8			(1.70)		
3.00		SPT(S) N=37 (5,5/9,8,7,13)			*Below 3.00m: dense.*	
3.50	D10			3.30	Orangey brown, gravelly, slightly clayey, fine to coarse SAND with lenses of brownish grey, fine to coarse SAND. Gravel is angular to rounded, fine to coarse including sandstone, mudstone and limestone.	
4.00		SPT(S) 50 (6,9/50 for 160mm)		(0.60)		
4.00	D11			3.90	Very dense, brownish red, fine to coarse SAND.	
4.00 - 4.31	D12			(0.41)		
				4.31	End of Borehole at 4.31m	

Groundwater: Water Strike / Backfill/ Installation



Dynamic Sample Recovery

Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks
1.20	2.00		100	
2.00	3.00		100	
3.00	4.00		100	

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	4.00	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

IAN FARMER ASSOCIATES	Plant used:	Project: St John's Masterplan	Location ID: **WS11**
	Dates: 23/06/2018	Client: Curtins Consulting	Sheet 1 of 1
Dynamic Sample Borehole Log	Location:	Ground level: / Logged by: RS / Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details					Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend		Water Strike	Backfill/ Installation
				0.20	MADE GROUND: CONCRETE.				
0.20 - 0.70	B1			0.40 (0.30)	MADE GROUND: Light brown, sandy, fine and medium grained GRAVEL. Gravel is subangular to angular, fine and medium including limestone (Type 1).				
0.25	D3			0.70 (0.80)	MADE GROUND: Dark brown, clayey, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including brick, concrete and plastic.				
0.25	ES2				MADE GROUND: Firm, brown, sandy CLAY.				
0.40	ES4								
0.50 - 1.00	B5								
0.70	ES6								
0.75	D7						1		
1.20		SPT(S) N=14 (1,1/2,2,2,8)							
1.20	D8								
				1.50 (2.80)	Very dense, dark reddish brown, gravelly, fine to coarse SAND. Gravel is subangular to angular, fine to coarse including sandstone.				
1.70	D9								
2.00		SPT(S) N=20 (4,5/4,4,5,7)					2		
2.00	D11								
2.00 - 2.50	B10								
2.70	D12								
3.00		SPT() N=14 (6,6/4,4,3,3)					3		
3.00	D14								
3.00 - 3.50	B13								
3.70	D15								
4.00		SPT(S) 50 (8,10/50 for 150mm)			*Below 4.00m: very dense.*		4		
4.00 - 4.30	D16			4.30	End of Borehole at 4.30m				
							5		
							6		
							7		
							8		
							9		
							10		

Dynamic Sample Recovery				
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

SPT Hammer: N/R, Energy Ratio: N/R

Water Strikes					
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Monitoring Installations			
Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	1.50	PLAIN	
1.50	3.50	SLOTTED	

Checked by:	HH	IFA DS v01.01
Log status:	DRAFT	

Appendix C – Chemical Laboratory Testing Results

- Environmental Chemistry Analysis Results (Soil)
  - Envirolab Certificate Number: 18-02606-1
  - Envirolab Certificate Number: 18-05180-1
  - Envirolab Certificate Number: 18-05337-1
  - Envirolab Certificate Number: 18-05734-1
  - Envirolab Certificate Number: 18-05735-1

- Environmental Chemistry Analysis Results (Groundwater)
  - Envirolab Certificate Number: 18-06429-1

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envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/02606
Issue Number: 1 **Date:** 18 April, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 44368
Date Samples Received: 06/04/18
Date Instructions Received: 10/04/18
Date Analysis Completed: 18/04/18

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Danielle Brierley
Client Manager

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
% Stones >10mm$_{A}$	16.6								% w/w	A-T-044
pH$_{D}^{M\#}$	7.75								pH	A-T-031s
Sulphate (water sol 2:1)$_{D}^{M\#}$	1.23								g/l	A-T-026s
Cyanide (total)$_{A}^{M\#}$	2								mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_{A}$	<0.2								mg/kg	A-T-050s
Sulphide$_{A}$	<5								mg/kg	A-T-S2-s
Sulphur (elemental)$_{D}^{M\#}$	15								mg/kg	A-T-029s
Organic matter$_{D}^{M\#}$	9.7								% w/w	A-T-032 OM
Arsenic$_{D}^{M\#}$	23								mg/kg	A-T-024s
Boron (water soluble)$_{D}^{M\#}$	1.4								mg/kg	A-T-027s
Cadmium$_{D}^{M\#}$	1.1								mg/kg	A-T-024s
Copper$_{D}^{M\#}$	128								mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	30								mg/kg	A-T-024s
Chromium (hexavalent)$_{D}$	<1								mg/kg	A-T-040s
Lead$_{D}^{M\#}$	970								mg/kg	A-T-024s
Mercury$_{D}$	0.91								mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	41								mg/kg	A-T-024s
Selenium$_{D}^{M\#}$	<1								mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	188								mg/kg	A-T-024s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	**18/02606/1**								**Units**	**Method ref**
Client Sample No	**2**									
Client Sample ID	**RBH03**									
Depth to Top	**0.40**									
Depth To Bottom										
Date Sampled	**03-Apr-18**									
Sample Type	**Soil - ES**									
Sample Matrix Code	**4AB**									
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_{A}^{\#}$	**NAD**									**A-T-045**
Asbestos ACM - Suitable for Water Absorption Test?	**N/A**									

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	0.07								mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	0.05								mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	0.21								mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	0.61								mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	0.47								mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	0.59								mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	0.35								mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	0.19								mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	0.73								mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	0.08								mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	1.52								mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	0.06								mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	0.38								mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	0.04								mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	0.73								mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	1.48								mg/kg	A-T-019s
PAH (total 16)$_{A}^{M\#}$	7.55								mg/kg	A-T-019s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
VOC										
Dichlorodifluoromethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Chloromethane$_{A}^{\#}$	<10								µg/kg	A-T-006s
Vinyl Chloride$_{A}^{\#}$	<1								µg/kg	A-T-006s
Bromomethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Chloroethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Trichlorofluoromethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1-Dichloroethene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Carbon Disulphide$_{A}^{\#}$	<1								µg/kg	A-T-006s
Dichloromethane$_{A}$	<5								µg/kg	A-T-006s
trans 1,2-Dichloroethene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1-Dichloroethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
cis 1,2-Dichloroethene$_{A}^{\#}$	<1								µg/kg	A-T-006s
2,2-Dichloropropane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Bromochloromethane$_{A}^{\#}$	<5								µg/kg	A-T-006s
Chloroform$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1,1-Trichloroethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1-Dichloropropene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Carbon Tetrachloride$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,2-Dichloroethane$_{A}^{\#}$	<2								µg/kg	A-T-006s
Benzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Trichloroethene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,2-Dichloropropane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Dibromomethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Bromodichloromethane$_{A}^{\#}$	<10								µg/kg	A-T-006s
cis 1,3-Dichloropropene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Toluene$_{A}^{\#}$	<1								µg/kg	A-T-006s
trans 1,3-Dichloropropene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1,2-Trichloroethane$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,3-Dichloropropane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Tetrachloroethene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Dibromochloromethane$_{A}^{\#}$	<3								µg/kg	A-T-006s
1,2-Dibromoethane$_{A}^{\#}$	<1								µg/kg	A-T-006s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
Chlorobenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1,1,2-Tetrachloroethane$_{A}$	<1								µg/kg	A-T-006s
Ethylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
m & p Xylene$_{A}^{\#}$	<1								µg/kg	A-T-006s
o-Xylene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Styrene$_{A}^{\#}$	<1								µg/kg	A-T-006s
Bromoform$_{A}^{\#}$	<1								µg/kg	A-T-006s
Isopropylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,1,2,2-Tetrachloroethane$_{A}$	<1								µg/kg	A-T-006s
1,2,3-Trichloropropane$_{A}^{\#}$	<1								µg/kg	A-T-006s
Bromobenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
n-Propylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
2-Chlorotoluene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,3,5-Trimethylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
4-Chlorotoluene$_{A}^{\#}$	<1								µg/kg	A-T-006s
tert-Butylbenzene$_{A}^{\#}$	<2								µg/kg	A-T-006s
1,2,4-Trimethylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
sec-Butylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
4-Isopropyltoluene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,3-Dichlorobenzene$_{A}$	<1								µg/kg	A-T-006s
1,4-Dichlorobenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
n-Butylbenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,2-Dichlorobenzene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,2-Dibromo-3-chloropropane$_{A}$	<2								µg/kg	A-T-006s
1,2,4-Trichlorobenzene$_{A}$	<3								µg/kg	A-T-006s
Hexachlorobutadiene$_{A}^{\#}$	<1								µg/kg	A-T-006s
1,2,3-Trichlorobenzene$_{A}$	<3								µg/kg	A-T-006s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01								mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01								mg/kg	A-T-022s
Ali >C8-C10$_A^{\#}$	<0.01								mg/kg	A-T-022s
Ali >C10-C12$_A^{\#}$	2.2								mg/kg	A-T-023s
Ali >C12-C16$_A^{\#}$	11.7								mg/kg	A-T-023s
Ali >C16-C21$_A^{\#}$	14.9								mg/kg	A-T-023s
Ali >C21-C35$_A^{\#}$	192								mg/kg	A-T-023s
Total Aliphatics$_A$	221								mg/kg	A-T-023s
Aro >C5-C7$_A^{\#}$	<0.01								mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01								mg/kg	A-T-022s
Aro >C8-C9$_A^{\#}$	<0.01								mg/kg	A-T-022s
Aro >C9-C10$_A^{\#}$	<0.01								mg/kg	A-T-022s
Aro >C10-C12$_A^{\#}$	0.9								mg/kg	A-T-023s
Aro >C12-C16$_A^{\#}$	6.1								mg/kg	A-T-023s
Aro >C16-C21$_A^{\#}$	19.0								mg/kg	A-T-023s
Aro >C21-C35$_A^{\#}$	182								mg/kg	A-T-023s
Total Aromatics$_A$	208								mg/kg	A-T-023s
TPH (Ali & Aro)$_A$	430								mg/kg	A-T-023s
BTEX - Benzene$_A^{\#}$	<0.01								mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01								mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01								mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01								mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01								mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01								mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

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Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05180
Issue Number: 1 **Date:** 09 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin/Michelle Louise Hirst-Watson
Project Name: St Johns
Project Ref: 42206
Order No: 44837
Date Samples Received: 25/06/18
Date Instructions Received: 29/06/18
Date Analysis Completed: 09/07/18

Prepared by:

Kate Keningale
Sales Executive

Approved by:

Danielle Bescoby
Quality Manager

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Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
% Stones >10mm$_{A}$	<0.1	22.8	<0.1	21.7	21.9	33.8	7.5	25.4	% w/w	A-T-044
pH$_{D}^{M\#}$	7.05	7.58	7.40	7.64	7.57	7.31	7.00	7.27	pH	A-T-031s
Sulphate (water sol 2:1)$_{D}^{M\#}$	0.05	0.02	0.20	0.04	0.16	0.04	0.10	0.02	g/l	A-T-026s
Cyanide (total)$_{A}^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_{A}$	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	mg/kg	A-T-050s
Organic matter$_{D}^{M\#}$	3.8	1.5	3.8	0.5	4.3	0.2	17.5	1.5	% w/w	A-T-032 OM
Arsenic$_{D}^{M\#}$	11	2	9	3	12	3	19	1	mg/kg	A-T-024s
Boron (water soluble)$_{D}^{M\#}$	1.7	<1.0	1.4	<1.0	1.6	<1.0	<1.0	<1.0	mg/kg	A-T-027s
Cadmium$_{D}^{M\#}$	0.6	<0.5	0.6	0.5	0.9	<0.5	1.6	<0.5	mg/kg	A-T-024s
Copper$_{D}^{M\#}$	25	5	47	3	27	4	125	6	mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	21	6	19	9	10	7	21	8	mg/kg	A-T-024s
Chromium (hexavalent)$_{D}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-040s
Lead$_{D}^{M\#}$	80	8	254	5	751	6	921	8	mg/kg	A-T-024s
Mercury$_{D}$	0.26	<0.17	0.48	<0.17	0.20	<0.17	1.66	<0.17	mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	16	9	16	12	16	8	38	10	mg/kg	A-T-024s
Selenium$_{D}^{M\#}$	<1	<1	<1	<1	<1	<1	2	<1	mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	47	18	125	31	35	18	119	27	mg/kg	A-T-024s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD		A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

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Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.02	mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.11	0.11	mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	<0.04	<0.04	0.06	<0.04	<0.04	<0.04	0.59	0.61	mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	<0.04	<0.04	0.06	<0.04	<0.04	<0.04	0.59	0.45	mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	<0.05	<0.05	0.08	<0.05	0.06	<0.05	0.72	0.54	mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.38	0.18	mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.25	0.19	mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	<0.06	<0.06	0.08	<0.06	<0.06	<0.06	0.68	0.62	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.10	0.06	mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	<0.08	<0.08	0.13	<0.08	<0.08	<0.08	0.96	1.22	mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.02	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	<0.03	<0.03	0.04	<0.03	<0.03	<0.03	0.40	0.23	mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	<0.03	<0.03	0.08	<0.03	<0.03	<0.03	0.40	0.30	mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	<0.07	<0.07	0.11	<0.07	<0.07	<0.07	1.02	1.18	mg/kg	A-T-019s
Total PAH-16MS$_{A}^{M\#}$	<0.08	<0.08	0.64	<0.08	<0.08	<0.08	6.30	5.73	mg/kg	A-T-019s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	<1	2	<1	<1	<1	<1	2	<1	mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	<1	2	<1	<1	<1	<1	2	2	mg/kg	A-T-055s
Ali >C21-C35$_{A}^{M\#}$	7	2	<1	<1	5	<1	4	2	mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}^{\#}$	7	4	<1	<1	6	<1	9	5	mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	<1	<1	<1	<1	<1	<1	2	<1	mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	<1	<1	<1	<1	<1	<1	2	<1	mg/kg	A-T-055s
Aro >C12-C16$_{A}^{M\#}$	3	2	<1	<1	3	<1	7	2	mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	3	<1	<1	<1	15	<1	19	8	mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	11	2	3	<1	55	<1	59	21	mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}^{\#}$	16	4	3	<1	73	<1	89	31	mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}^{\#}$	23	9	3	<1	79	<1	98	36	mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
% Stones >10mm$_{A}$	19.7	<0.1	8.5	<0.1					% w/w	A-T-044
pH$_{D}^{M\#}$	7.34	7.31	7.51	4.46					pH	A-T-031s
Sulphate (water sol 2:1)$_{D}^{M\#}$	1.24	0.07	0.17	0.20					g/l	A-T-026s
Cyanide (total)$_{A}^{M\#}$	<1	<1	<1	<1					mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_{A}$	<0.2	<0.2	<0.2	<0.2					mg/kg	A-T-050s
Organic matter$_{D}^{M\#}$	11.2	0.3	2.5	0.3					% w/w	A-T-032 OM
Arsenic$_{D}^{M\#}$	35	<1	7	15					mg/kg	A-T-024s
Boron (water soluble)$_{D}^{M\#}$	1.2	<1.0	1.4	<1.0					mg/kg	A-T-027s
Cadmium$_{D}^{M\#}$	1.0	<0.5	0.6	1.5					mg/kg	A-T-024s
Copper$_{D}^{M\#}$	163	5	22	<1					mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	18	5	10	5					mg/kg	A-T-024s
Chromium (hexavalent)$_{D}$	<1	<1	<1	<1					mg/kg	A-T-040s
Lead$_{D}^{M\#}$	511	6	49	6					mg/kg	A-T-024s
Mercury$_{D}$	2.63	<0.17	<0.17	<0.17					mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	38	5	16	15					mg/kg	A-T-024s
Selenium$_{D}^{M\#}$	2	<1	<1	<1					mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	128	15	46	18					mg/kg	A-T-024s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	NAD	NAD	NAD						A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A						

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
PAH-16MS										
Acenaphthene$_A^{M\#}$	0.05	<0.01	<0.01	<0.01					mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	0.05	<0.01	<0.01	<0.01					mg/kg	A-T-019s
Anthracene$_A^{M\#}$	0.17	<0.02	0.03	<0.02					mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.50	<0.04	0.11	<0.04					mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.49	<0.04	0.11	<0.04					mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.63	<0.05	0.14	<0.05					mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	0.36	<0.05	0.07	<0.05					mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	0.20	<0.07	<0.07	<0.07					mg/kg	A-T-019s
Chrysene$_A^{M\#}$	0.58	<0.06	0.13	<0.06					mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	0.08	<0.04	<0.04	<0.04					mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	1.01	<0.08	0.22	<0.08					mg/kg	A-T-019s
Fluorene$_A^{M\#}$	0.07	<0.01	<0.01	<0.01					mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	0.34	<0.03	0.08	<0.03					mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03	<0.03	<0.03	<0.03					mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.68	<0.03	0.07	<0.03					mg/kg	A-T-019s
Pyrene$_A^{M\#}$	0.96	<0.07	0.21	<0.07					mg/kg	A-T-019s
Total PAH-16MS$_A^{M\#}$	6.17	<0.08	1.17	<0.08					mg/kg	A-T-019s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	<1	<1					mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	<1	<1	<1					mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	<1	<1	<1	<1					mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	2	<1	<1	<1					mg/kg	A-T-055s
Ali >C21-C35$_{A}^{M\#}$	8	<1	1	<1					mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}^{\#}$	11	<1	1	<1					mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	<1	<1	<1	<1					mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	<1	<1	<1	<1					mg/kg	A-T-055s
Aro >C12-C16$_{A}^{M\#}$	5	<1	2	<1					mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	9	<1	3	<1					mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	36	1	10	1					mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}^{\#}$	53	1	15	1					mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}^{\#}$	64	1	16	1					mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40℃).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25℃ / 11550µS/cm @ 20℃ fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05337
Issue Number: 1 **Date:** 17 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 44842
Date Samples Received: 29/06/18
Date Instructions Received: 05/07/18
Date Analysis Completed: 17/07/18

Prepared by:

MMarshall

Melanie Marshall
Laboratory Coordinator

Approved by:

Richard Wong
Client Manager

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING 1247

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
% Stones >10mm$_{A}$	27.3	<0.1	6.9						% w/w	A-T-044
pH$_{D}^{M\#}$	9.99	10.01	7.99						pH	A-T-031s
Sulphate (water sol 2:1)$_{D}^{M\#}$	0.06	0.06	0.03						g/l	A-T-026s
Cyanide (total)$_{A}^{M\#}$	<1	<1	<1						mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_{A}$	<0.2	<0.2	<0.2						mg/kg	A-T-050s
Organic matter$_{D}^{M\#}$	4.7	4.3	1.3						% w/w	A-T-032 OM
Arsenic$_{D}^{M\#}$	4	4	3						mg/kg	A-T-024s
Boron (water soluble)$_{D}^{M\#}$	<1.0	<1.0	<1.0						mg/kg	A-T-027s
Cadmium$_{D}^{M\#}$	0.6	1.4	<0.5						mg/kg	A-T-024s
Copper$_{D}^{M\#}$	19	32	12						mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	17	17	9						mg/kg	A-T-024s
Chromium (hexavalent)$_{D}$	<1	<1	<1						mg/kg	A-T-040s
Lead$_{D}^{M\#}$	104	581	61						mg/kg	A-T-024s
Mercury$_{D}$	0.91	0.99	<0.17						mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	15	18	12						mg/kg	A-T-024s
Selenium$_{D}^{M\#}$	<1	<1	<1						mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	46	107	27						mg/kg	A-T-024s

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_{A}^{\#}$	NAD	NAD	NAD							A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A							

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	<0.01	0.39	<0.01						mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	<0.01	0.12	<0.01						mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	<0.02	1.17	<0.02						mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	<0.04	4.52	<0.04						mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	<0.04	4.07	<0.04						mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	<0.05	4.47	<0.05						mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	<0.05	2.55	<0.05						mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	<0.07	1.76	<0.07						mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	<0.06	5.13	<0.06						mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	<0.04	0.57	<0.04						mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	<0.08	9.69	<0.08						mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	<0.01	0.31	<0.01						mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	<0.03	2.96	<0.03						mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	<0.03	<0.30	<0.03						mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	<0.03	4.18	<0.03						mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	<0.07	8.68	<0.07						mg/kg	A-T-019s
Total PAH-16MS$_{A}^{M\#}$	<0.08	50.6	<0.08						mg/kg	A-T-019s

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	<1						mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	<1	<1						mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	<1	3	<1						mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	<1	4	<1						mg/kg	A-T-055s
Ali >C21-C35$_{A}^{M\#}$	2	94	1						mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}^{\#}$	2	100	1						mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	<1	2	<1						mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	<1	4	<1						mg/kg	A-T-055s
Aro >C12-C16$_{A}^{M\#}$	2	16	2						mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	<1	118	1						mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	3	1070	4						mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}^{\#}$	4	1210	6						mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}^{\#}$	6	1310	8						mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s

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A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

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Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05734
Issue Number: 1 **Date:** 26 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 44884
Date Samples Received: 09/07/18
Date Instructions Received: 18/07/18
Date Analysis Completed: 26/07/18

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Georgia King
Admin & Client Services Supervisor

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
% Stones >10mm$_{A}$	<0.1	3.6	<0.1	18.7	<0.1				% w/w	A-T-044
pH$_{D}^{M\#}$	7.71	7.87	8.36	7.56	8.49				pH	A-T-031s
Sulphate (water sol 2:1)$_{D}^{M\#}$	0.22	0.04	0.50	0.02	0.07				g/l	A-T-026s
Cyanide (total)$_{A}^{M\#}$	<1	<1	<1	<1	<1				mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_{A}$	<0.2	<0.2	<0.2	<0.2	<0.2				mg/kg	A-T-050s
Organic matter$_{D}^{M\#}$	5.2	2.5	14.9	4.2	21.4				% w/w	A-T-032 OM
Arsenic$_{D}^{M\#}$	17	8	29	10	31				mg/kg	A-T-024s
Boron (water soluble)$_{D}^{M\#}$	<1.0	1.4	<1.0	<1.0	<1.0				mg/kg	A-T-027s
Cadmium$_{D}^{M\#}$	1.5	0.8	12.7	1.2	0.9				mg/kg	A-T-024s
Copper$_{D}^{M\#}$	4820	26	530	74	294				mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	17	14	61	18	20				mg/kg	A-T-024s
Chromium (hexavalent)$_{D}$	<1	<1	<1	<1	<1				mg/kg	A-T-040s
Lead$_{D}^{M\#}$	698	228	2010	281	444				mg/kg	A-T-024s
Mercury$_{D}$	<0.17	<0.17	1.67	0.55	1.93				mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	32	14	72	15	31				mg/kg	A-T-024s
Selenium$_{D}^{M\#}$	<1	<1	1	<1	<1				mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	8230	131	1880	130	150				mg/kg	A-T-024s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_{A}^{\#}$	NAD	NAD	NAD	NAD	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A					

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	0.05	<0.01	9.43	5.54	0.21				mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	<0.01	<0.01	0.17	0.04	0.13				mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	0.10	<0.02	10.9	3.65	0.52				mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	0.46	<0.04	23.6	6.94	1.50				mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	0.45	<0.04	17.8	5.63	1.62				mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	0.53	<0.05	23.1	6.44	1.85				mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	0.30	<0.05	8.17	3.19	1.07				mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	0.21	<0.07	8.45	2.24	0.63				mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	0.53	<0.06	25.9	7.42	1.71				mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	0.08	<0.04	2.54	0.94	0.29				mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	1.01	<0.08	55.5	20	2.94				mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	0.02	<0.01	7.65	4.37	0.29				mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	0.32	<0.03	9.86	3.40	1.05				mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	<0.03	<0.03	0.93	4.35	0.30				mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	0.46	<0.03	43	21.1	2.16				mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	0.93	<0.07	49.4	19.5	3.05				mg/kg	A-T-019s
Total PAH-16MS$_{A}^{M\#}$	5.45	<0.08	296	115	19.3				mg/kg	A-T-019s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
SVOC excluding PAH-16										
Hexachlorobenzene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Diethyl phthalate$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Dimethyl phthalate$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Dibenzofuran$_A$	<100	<100	6150	2710	644				µg/kg	A-T-052s
Carbazole$_A$	<100	<100	3680	1110	683				µg/kg	A-T-052s
Butylbenzyl phthalate$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Bis(2-ethylhexyl)phthalate$_A$	<500	<500	<5000	<5000	<500				µg/kg	A-T-052s
Bis(2-chloroethoxy)methane$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Bis(2-chloroethyl)ether$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
4-Nitrophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
4-Methylphenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
4-Chloro-3-methylphenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Nitrophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Methylphenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
1,2,4-Trichlorobenzene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Chlorophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,6-Dinitrotoluene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,4-Dinitrotoluene$_A$	<100	<100	1190	1230	<100				µg/kg	A-T-052s
2,4-Dimethylphenol$_A$	<100	<100	<1000	1320	<100				µg/kg	A-T-052s
2,4-Dichlorophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,4,6-Trichlorophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,4,5-Trichlorophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
1,4-Dichlorobenzene$_A$	<100	<100	1400	1350	<100				µg/kg	A-T-052s
1,3-Dichlorobenzene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
1,2-Dichlorobenzene$_A$	<100	<100	9190	7440	<100				µg/kg	A-T-052s
2-Chloronaphthalene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Methylnaphthalene$_A$	<100	<100	2280	3460	751				µg/kg	A-T-052s
Bis(2-chloroisopropyl)ether$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Phenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Pentachlorophenol$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
n-Nitroso-n-dipropylamine$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
n-Dioctylphthalate$_A$	<500	<500	<5000	<5000	<500				µg/kg	A-T-052s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
n-Dibutylphthalate$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Nitrobenzene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Isophorone$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Hexachloroethane$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Hexachlorocyclopentadiene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Hexachlorobutadiene$_A$	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Perylene$_A$	276	<100	4490	2760	1120				µg/kg	A-T-052s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	0.06	0.09	<0.01				mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	159	409	2				mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	<1	566	1350	4				mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	35	<1	591	1370	10				mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	101	<1	665	1390	9				mg/kg	A-T-055s
Ali >C21-C35$_{A}^{M\#}$	31	<1	156	207	28				mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}^{\#}$	167	<1	2140	4710	54				mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	<1	<1	148	377	4				mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	<1	<1	403	962	5				mg/kg	A-T-055s
Aro >C12-C16$_{A}^{M\#}$	6	<1	1100	897	20				mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	26	<1	4080	718	38				mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	58	6	6040	700	145				mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}^{\#}$	90	6	11800	3650	211				mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}^{\#}$	257	6	14000	8360	265				mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	0.04	<0.01				mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05735
Issue Number: 1 **Date:** 26 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns Manchester
Project Ref: 42206
Order No: 44888
Date Samples Received: 13/07/18
Date Instructions Received: 18/07/18
Date Analysis Completed: 26/07/18

Prepared by:

Richard Wong
Client Manager

Approved by:

Danielle Brierley
Client Manager

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Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
% Stones >10mm$_{A}$	16.0	4.1	12.2	20.3	<0.1				% w/w	A-T-044
pH$_{D}^{M\#}$	8.05	7.90	7.67	8.05	7.91				pH	A-T-031s
Sulphate (water sol 2:1)$_{D}^{M\#}$	<0.01	<0.01	<0.01	<0.01	0.04				g/l	A-T-026s
Cyanide (total)$_{A}^{M\#}$	<1	<1	<1	<1	<1				mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_{A}$	<0.2	<0.2	<0.2	<0.2	<0.2				mg/kg	A-T-050s
Organic matter$_{D}^{M\#}$	7.0	1.2	4.0	3.3	0.9				% w/w	A-T-032 OM
Arsenic$_{D}^{M\#}$	12	4	10	14	<1				mg/kg	A-T-024s
Boron (water soluble)$_{D}^{M\#}$	<1.0	<1.0	<1.0	<1.0	<1.0				mg/kg	A-T-027s
Cadmium$_{D}^{M\#}$	1.0	<0.5	0.6	0.6	<0.5				mg/kg	A-T-024s
Copper$_{D}^{M\#}$	88	17	32	44	4				mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	18	8	13	14	9				mg/kg	A-T-024s
Chromium (hexavalent)$_{D}$	<1	<1	<1	<1	<1				mg/kg	A-T-040s
Lead$_{D}^{M\#}$	307	43	106	144	19				mg/kg	A-T-024s
Mercury$_{D}$	0.90	<0.17	0.51	9.99	<0.17				mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	16	12	11	13	4				mg/kg	A-T-024s
Selenium$_{D}^{M\#}$	<1	<1	2	<1	<1				mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	202	42	105	101	19				mg/kg	A-T-024s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	NAD	NAD	NAD	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A					

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	1.02	6.10	0.74	0.26	<0.01				mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	0.25	<1.00	0.03	0.07	<0.01				mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	1.97	8.78	0.94	0.54	<0.02				mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	5.33	14.1	1.61	1.51	<0.04				mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	5.22	10	1.43	1.52	<0.04				mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	6.21	12.4	1.73	1.76	<0.05				mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	2.85	<5.00	0.83	1.00	<0.05				mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	2.07	<7.00	0.58	0.57	<0.07				mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	5.59	17.9	1.81	1.66	<0.06				mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	0.77	<4.00	0.22	0.26	<0.04				mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	12.3	33.1	4.31	3.14	<0.08				mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	1.10	6.04	0.52	0.25	<0.01				mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	2.98	5.37	0.86	1.01	<0.03				mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	0.78	4.50	0.11	0.11	<0.03				mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	8.67	51.7	4.22	2.24	<0.03				mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	12.1	33.8	3.68	3.00	<0.07				mg/kg	A-T-019s
Total PAH-16MS$_{A}^{M\#}$	69.2	204	23.6	18.9	<0.08				mg/kg	A-T-019s

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Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
SVOC excluding PAH-16										
Hexachlorobenzene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Diethyl phthalate$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Dimethyl phthalate$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Dibenzofuran$_A$	459	1930	<100	661	<100				µg/kg	A-T-052s
Carbazole$_A$	617	1350	107	716	<100				µg/kg	A-T-052s
Butylbenzyl phthalate$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Bis(2-ethylhexyl)phthalate$_A$	<500	<500	<500	<500	<500				µg/kg	A-T-052s
Bis(2-chloroethoxy)methane$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Bis(2-chloroethyl)ether$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
4-Nitrophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
4-Methylphenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
4-Chloro-3-methylphenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Nitrophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Methylphenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,2,4-Trichlorobenzene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Chlorophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,6-Dinitrotoluene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4-Dinitrotoluene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4-Dimethylphenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4-Dichlorophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4,6-Trichlorophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4,5-Trichlorophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,4-Dichlorobenzene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,3-Dichlorobenzene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,2-Dichlorobenzene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Chloronaphthalene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Methylnaphthalene$_A$	254	1770	<100	517	<100				µg/kg	A-T-052s
Bis(2-chloroisopropyl)ether$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Phenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Pentachlorophenol$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
n-Nitroso-n-dipropylamine$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
n-Dioctylphthalate$_A$	<500	<500	<500	<500	<500				µg/kg	A-T-052s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
n-Dibutylphthalate$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Nitrobenzene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Isophorone$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Hexachloroethane$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Hexachlorocyclopentadiene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Hexachlorobutadiene$_A$	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Perylene$_A$	1430	1680	387	1010	<100				µg/kg	A-T-052s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	<1	<1	<1				mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	2	<1	<1	<1				mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	4	6	<1	2	<1				mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	5	6	2	4	<1				mg/kg	A-T-055s
Ali >C21-C35$_{A}^{M\#}$	27	5	16	19	1				mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}^{\#}$	38	20	20	27	1				mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	2	1	<1	3	<1				mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	4	14	3	4	<1				mg/kg	A-T-055s
Aro >C12-C16$_{A}^{M\#}$	20	104	8	11	2				mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	105	338	24	40	<1				mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	373	736	100	218	5				mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}^{\#}$	502	1190	137	275	6				mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}^{\#}$	541	1210	157	302	8				mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40℃).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25℃ / 11550µS/cm @ 20℃ fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/06429
Issue Number: 1 **Date:** 21 August, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 45039
Date Samples Received: 10/08/18
Date Instructions Received: 13/08/18
Date Analysis Completed: 21/08/18

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Danielle Brierley
Client Manager

UKAS TESTING 1247

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
pH (w)$_{A}^{\#}$	6.96	8.54	8.42	7.00					pH	A-T-031w
Hardness Total$_{A}^{\#}$	536	119	232	495					mg/l Ca CO3	A-T-049w
Sulphate (w)$_{A}^{\#}$	254	187	114	195					mg/l	A-T-026w
Cyanide (total) (w)$_{A}^{\#}$	0.007	0.014	<0.005	<0.005					mg/l	A-T-042wTCN
Phenols - Total by HPLC (w)$_{A}$	<0.01	<0.01	<0.01	<0.01					mg/l	A-T-050w
Sulphide (w)$_{A}$	<0.1	<0.1	<0.1	<0.1					mg/l	A-T-S2-w
Arsenic (dissolved)$_{A}^{\#}$	<1	8	1	<1					µg/l	A-T-025w
Boron (dissolved)$_{A}^{\#}$	158	64	155	99					µg/l	A-T-025w
Cadmium (dissolved)$_{A}^{\#}$	<0.2	<0.2	<0.2	<0.2					µg/l	A-T-025w
Copper (dissolved)$_{A}^{\#}$	<1	3	<1	<1					µg/l	A-T-025w
Chromium (dissolved)$_{A}^{\#}$	1	10	13	7					µg/l	A-T-025w
Lead (dissolved)$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-025w
Mercury (dissolved)$_{A}^{\#}$	<0.1	<0.1	<0.1	<0.1					µg/l	A-T-025w
Nickel (dissolved)$_{A}^{\#}$	<1	4	2	6					µg/l	A-T-025w
Selenium (dissolved)$_{A}^{\#}$	<1	27	2	<1					µg/l	A-T-025w
Zinc (dissolved)$_{A}^{\#}$	8	3	1	13					µg/l	A-T-025w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
PAH 16MS (w)										
Acenaphthene (w)$_{A}^{\#}$	<0.01	0.23	<0.01	0.45					µg/l	A-T-019w
Acenaphthylene (w)$_{A}^{\#}$	<0.01	0.05	<0.01	0.13					µg/l	A-T-019w
Anthracene (w)$_{A}^{\#}$	<0.01	0.74	<0.01	0.69					µg/l	A-T-019w
Benzo(a)anthracene (w)$_{A}^{\#}$	<0.01	2.47	0.02	2.03					µg/l	A-T-019w
Benzo(a)pyrene (w)$_{A}^{\#}$	<0.01	3.06	0.02	2.01					µg/l	A-T-019w
Benzo(b)fluoranthene (w)$_{A}^{\#}$	<0.01	2.96	0.02	2.01					µg/l	A-T-019w
Benzo(ghi)perylene (w)$_{A}^{\#}$	<0.01	1.51	<0.01	0.80					µg/l	A-T-019w
Benzo(k)fluoranthene (w)$_{A}^{\#}$	<0.01	1.08	<0.01	0.66					µg/l	A-T-019w
Chrysene (w)$_{A}^{\#}$	<0.01	2.63	0.02	2.28					µg/l	A-T-019w
Dibenzo(ah)anthracene (w)$_{A}^{\#}$	<0.01	0.32	<0.01	0.22					µg/l	A-T-019w
Fluoranthene (w)$_{A}^{\#}$	0.01	5.94	0.03	4.71					µg/l	A-T-019w
Fluorene (w)$_{A}^{\#}$	<0.01	0.17	<0.01	0.46					µg/l	A-T-019w
Indeno(123-cd)pyrene (w)$_{A}^{\#}$	<0.01	2.05	0.01	0.96					µg/l	A-T-019w
Naphthalene (w)$_{A}^{\#}$	<0.01	0.01	<0.01	0.18					µg/l	A-T-019w
Phenanthrene (w)$_{A}^{\#}$	0.01	2.29	0.01	3.79					µg/l	A-T-019w
Pyrene (w)$_{A}^{\#}$	0.01	5.39	0.03	4.97					µg/l	A-T-019w
Total PAH 16MS (w)$_{A}^{\#}$	0.03	30.9	0.16	26.4					µg/l	A-T-019w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
SVOC (excluding PAH-16) (w)										
2,4,5-Trichlorophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2,4,6-Trichlorophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2,4-Dichlorophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2,4-Dimethylphenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2,4-Dinitrotoluene$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2,6-Dinitrotoluene$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2-Chloronaphthalene$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2-Chlorophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2-Methylnaphthalene$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2-Methylphenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
2-Nitrophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
4-Bromophenyl phenyl ether$_A$	<1	<1	<1	<1					µg/l	A-T-052w
4-Chloro-3-methylphenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-chloroisopropyl)ether$_A$	<1	<1	<1	<1					µg/l	A-T-052w
4-Methylphenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
4-Nitrophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-chloroethyl)ether$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-chloroethoxy)methane$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-ethylhexyl)phthalate$_A$	<10	<10	<10	<10					µg/l	A-T-052w
Butylbenzyl phthalate$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Carbazole$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Dibenzofuran$_A$	<1	<1	<1	<1					µg/l	A-T-052w
n-Dibutylphthalate$_A$	<1	<1	<1	<1					µg/l	A-T-052w
n-Dioctylphthalate$_A$	<10	<10	<10	<10					µg/l	A-T-052w
n-Nitroso-n-dipropylamine$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Diethyl phthalate$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Dimethyl phthalate$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Hexachlorobenzene$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Pentachlorophenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Phenol$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Hexachloroethane$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Nitrobenzene$_A$	<1	<1	<1	<1					µg/l	A-T-052w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
Isophorone$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Hexachlorocyclopentadiene$_A$	<1	<1	<1	<1					µg/l	A-T-052w
Perylene$_A$	<1	<1	<1	<1					µg/l	A-T-052w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
VOC (w)										
Dichlorodifluoromethane$_{A}$	<1	<1	<1	<1					µg/l	A-T-006w
Chloromethane$_{A}$	<10	<10	<10	<10					µg/l	A-T-006w
Vinyl Chloride$_{A}^{\#}$	<1	2	<1	<1					µg/l	A-T-006w
Bromomethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Chloroethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Trichlorofluoromethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
trans 1,2-Dichloroethene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Dichloromethane$_{A}$	<5	<5	<5	<5					µg/l	A-T-006w
Carbon Disulphide$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,1-Dichloroethene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,1-Dichloroethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
cis 1,2-Dichloroethene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Bromochloromethane$_{A}^{\#}$	<5	<5	<5	<5					µg/l	A-T-006w
Chloroform$_{A}^{\#}$	<1	5	1	2					µg/l	A-T-006w
2,2-Dichloropropane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dichloroethane$_{A}^{\#}$	<2	<2	<2	<2					µg/l	A-T-006w
1,1,1-Trichloroethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,1-Dichloropropene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Benzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Carbon Tetrachloride$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Dibromomethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dichloropropane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Bromodichloromethane$_{A}^{\#}$	<10	<10	<10	<10					µg/l	A-T-006w
Trichloroethene$_{A}^{\#}$	1	<1	<1	<1					µg/l	A-T-006w
cis 1,3-Dichloropropene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
trans 1,3-Dichloropropene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,1,2-Trichloroethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Toluene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,3-Dichloropropane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Dibromochloromethane$_{A}^{\#}$	<3	<3	<3	<3					µg/l	A-T-006w
1,2-Dibromoethane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Tetrachloroethene$_{A}$	<1	<1	<1	<1					µg/l	A-T-006w

Envirolab Job Number: 18/06429 **Client Project Name: St Johns**

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
1,1,1,2-Tetrachloroethane$_{A}$	<1	<1	<1	<1					µg/l	A-T-006w
Chlorobenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Ethylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
m & p Xylene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Bromoform$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Styrene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,1,2,2-Tetrachloroethane$_{A}$	<1	<1	<1	<1					µg/l	A-T-006w
o-Xylene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,2,3-Trichloropropane$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Isopropylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
Bromobenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
2-Chlorotoluene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
n-propylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
4-Chlorotoluene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,2,4-Trimethylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
4-Isopropyltoluene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,3,5-Trimethylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dichlorobenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,4-Dichlorobenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
sec-Butylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
tert-Butylbenzene$_{A}^{\#}$	<2	<2	<2	<2					µg/l	A-T-006w
1,3-Dichlorobenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
n-butylbenzene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dibromo-3-chloropropane$_{A}^{\#}$	<2	<2	<2	<2					µg/l	A-T-006w
1,2,4-Trichlorobenzene$_{A}^{\#}$	<3	<3	<3	<3					µg/l	A-T-006w
1,2,3-Trichlorobenzene$_{A}^{\#}$	<3	<3	<3	<3					µg/l	A-T-006w
Hexachlorobutadiene$_{A}^{\#}$	<1	<1	<1	<1					µg/l	A-T-006w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
TPH CWG (w)										
Ali >C5-C6 (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C6-C8 (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C8-C10 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C10-C12 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C12-C16 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C16-C21 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C21-C35 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Total Aliphatics >C5-C35 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C5-C7 (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C7-C8 (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C8-C10 (w)$_A$	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C10-C12 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C12-C16 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C16-C21 (w)$_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C21-C35 (w)$_A^{\#}$	<10	<10	<10	<10					µg/l	A-T-055w
Total Aromatics >C5-C35 (w)$_A$	<10	<10	<10	<10					µg/l	A-T-055w
TPH (Ali & Aro >C5-C35) (w)$_A$	<10	<10	<10	<10					µg/l	A-T-055w
BTEX - Benzene (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - Toluene (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - Ethyl Benzene (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - m & p Xylene (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - o Xylene (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
MTBE (w)$_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Appendix D – Geotechnical Laboratory Testing Results

- Geotechnical Analysis Results
  - Ian Farmer Associates, Test Report 42206
  - Ian Farmer Associates, Test Report 42206A
  - Ian Farmer Associates, Test Report 42206B
  - Ian Farmer Associates, Test Report 42206 Brazilian Test
  - Ian Farmer Associates, Test Report 42206 Hoek Triaxial Test
  - Ian Farmer Associates, Test Report 42206 Hoek Shear Box Test
  - Ian Farmer Associates, Test Report 42206 Sound Velocity Test

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F.A.O.

Test Report - 42206 / 3

Site:	St John's Masterplan
Job Number:	42206
Originating Client:	Curtins Consulting
Originating Reference:	42206
Date Sampled:	25/07/2018
Date Scheduled:	01/08/2018
Date Testing Started:	08/08/2018
Date Testing Finished:	21/08/2018
Remarks:	

Authorised By:

Tim Robinson
Quality Technician

Date: 22/08/2018

Constructionline

Ian Farmer Associates (1998) Limited. Registered in England and Wales, No. 3661447.
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AGS

IAN FARMER ASSOCIATES

Laboratory Test Report | 42206 / 3

Site: St John's Masterplan | **Job Number:** 42206

Client: Curtins Consulting | **Page:** 2

ROCK INDEX TESTS - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content[1] %	Caliper[2]		Buoyancy[3]		Natural Bulk density Mg/m^3	Remarks
					Dry density Mg/m^3	Porosity %	Dry density Mg/m^3	Porosity %		
RBH02	13.20	C20	Red/Brown SANDSTONE	13.3			1.98	26.7	2.24	
RBH02	17.12	C44	Red/Brown SANDSTONE	11.0			2.04	24.7	2.27	
RBH02	26.32	C46	Red/Brown SANDSTONE	11.9			1.97	26.7	2.20	
RBH02	33.25	C34	Red/Brown SANDSTONE	13.6			1.96	27.6	2.23	
RBH02	39.25	C39	Red/Brown SANDSTONE	13.4			1.94	28.0	2.20	
RBH03	13.40	C11	Red/Brown SANDSTONE	9.7			2.09	21.2	2.29	
RBH03	19.12	C16	Red/Brown SANDSTONE	10.9			2.06	22.5	2.29	
RBH03	29.20	C24	Red/Brown SANDSTONE	11.1			1.87	30.6	2.08	
RBH03	35.01	C29	Red/Brown SANDSTONE	10.1			2.10	23.5	2.31	
RBH04	9.70	C15	Red/Brown SANDSTONE	12.6			1.98	26.3	2.23	
RBH04	12.70	C18	Red/Brown SANDSTONE	5.3			1.92	28.0	2.02	
RBH04	17.34	C23	Red/Brown SANDSTONE	5.9			2.22	17.0	2.35	
RBH04	24.25	C30	Red/Brown SANDSTONE	9.6			1.95	28.3	2.13	
RBH04	29.10	C35	Red/Brown SANDSTONE	9.5			2.06	23.6	2.25	
RBH04	36.10	C40	Red/Brown SANDSTONE	10.6			1.97	26.0	2.18	

Notes
1. ISRM p87 test 1, water content at 105 ± 3 °C, specimen as received at the laboratory
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper
3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

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Laboratory Test Report 42206 / 3

Site: St John's Masterplan **Job Number:** 42206

Client: Curtins Consulting **Page:** 3

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
RBH02	10.20	C17	Red/Brown SANDSTONE	101.7	124.2	*1.2	1.94	12.7	as received	0.3444	AC	0.9	
RBH02	13.20	C20	Red/Brown SANDSTONE	100.9	156.3	*1.5	2.22	11.8	as received	0.3501	AC	0.9	
RBH02	14.34	C22	Red/Brown SANDSTONE	101.6	242.0	*2.4	2.24	9.5	as received	0.3454	AC	5.9	
RBH02	18.32	C27	Red/Brown SANDSTONE	100.4	207.6	*2.1	2.17	13.2	as received	0.3534	AC	5.8	
RBH02	22.56	C44	Red/Brown SANDSTONE	101.4	223.2	*2.2	2.21	12.7	as received	0.3469	AC	10.6	
RBH02	26.32	C46	Red/Brown SANDSTONE	100.6	116.1	*1.2	2.25	11.9	as received	0.3523	AC	3.9	
RBH02	30.91	C32	Red/Brown SANDSTONE	101.8	243.6	*2.4	2.22	11.3	as received	0.3440	AC	12.0	
RBH02	33.25	C34	Red/Brown SANDSTONE	100.7	208.0	*2.1	2.30	8.3	as received	0.3513	AC	13.1	
RBH02	35.40	C36	Red/Brown SANDSTONE	101.0	201.3	*2	2.25	11.0	as received	0.3496	AC	8.8	
RBH02	39.25	C39	Red/Brown SANDSTONE	99.3	169.7	*1.7	2.21	11.1	as received	0.3616	S	4.6	
RBH03	10.50	C8	Red/Brown SANDSTONE	101.1	96.7	*1	2.19	11.0	as received	0.3487	AC	8.3	
RBH03	12.40	C10	Red/Brown SANDSTONE	100.9	79.1	*0.8	2.18	12.1	as received	0.3503	AC	4.9	
RBH03	14.30	C12	Red/Brown SANDSTONE	100.9	99.8	*1	2.19	9.5	as received	0.3502	AC	6.3	
RBH03	16.52	C	Red/Brown SANDSTONE	101.2	226.5	*2.2	0.22	9.7	as received	0.3484	AC	10.8	
RBH03	17.06	C37	Red/Brown SANDSTONE	99.8	143.7	*1.4	2.24	11.3	as received	0.3582	AC	7.1	
RBH03	19.12	C16	Red/Brown SANDSTONE	101.3	127.8	*1.3	2.15	4.5	as received	0.3475	AC	13.3	
RBH03	22.00	C18	Red/Brown SANDSTONE	101.0	125.1	*1.2	2.20	10.5	as received	0.3498	AC	7.9	
RBH03	26.90	C21	Red/Brown SANDSTONE	101.5	226.4	*2.2	2.19	12.2	as received	0.3459	S	6.4	
RBH03	30.42	C25	Red/Brown SANDSTONE	101.5	300.8	3	2.35	10.2	as received	0.3463	AC	11.7	
RBH03	33.90	C28	Red/Brown SANDSTONE	102.1	294.6	2.9	2.30	9.5	as received	0.3419	AC	18.6	
RBH04	14.56	C20	Red/Brown SANDSTONE	100.0	186.7	*1.9	2.23	11.9	as received	0.3562	AC	1.3	
RBH04	15.90	C22	Red/Brown SANDSTONE	101.3	186.0	*1.8	2.22	11.9	as received	0.3476	S	1.8	
RBH04	18.78	C25	Red/Brown SANDSTONE	101.4	217.6	*2.1	2.21	11.4	as received	0.3465	AC	10.7	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

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Laboratory Test Report 42206 / 3

Site: St John's Masterplan **Job Number:** 42206

Client: Curtins Consulting **Page:** 4

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
RBH04	22.03	C28	Red/Brown SANDSTONE	99.7	223.6	*2.2	2.25	11.0	as received	0.3590	AC	6.4	
RBH04	25.74	C32	Red/Brown SANDSTONE	101.7	207.9	*2	2.16	11.8	as received	0.3448	AC	11.6	
RBH04	30.07	C36	Red/Brown SANDSTONE	101.6	175.2	*1.7	2.28	9.7	as received	0.3453	AC	15.6	
RBH04	32.60	C38	Red/Brown SANDSTONE	101.6	158.1	*1.6	2.24	15.4	as received	0.3452	AC	8.0	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

IAN FARMER ASSOCIATES	Laboratory Test Report	42206 / 3

Site: St John's Masterplan **Job Number:** 42206

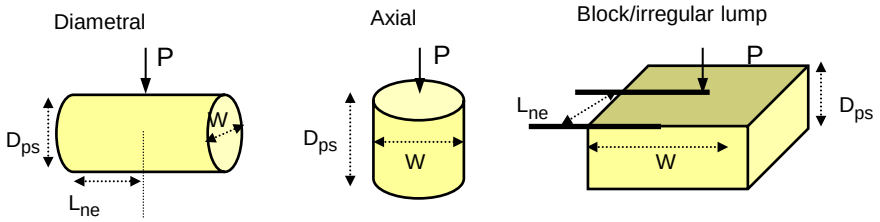
Client: Curtins Consulting **Page:** 5

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH02	8.95	C16	Red/Brown SANDSTONE As received	D	PL	YES	70.0	98.8	98.8	95.8	0.1	98.8	0.01	0.02	
RBH02	8.95	C16	Red/Brown SANDSTONE As received	A	PD	YES		98.7	69.5	63.5	0.5	93.5	0.06	0.08	
RBH02	11	C18	Red/Brown SANDSTONE As received	D	PL	YES	52.7	101.6	101.6	99.6	0.1	101.6	0.01	0.02	
RBH02	11	C18	Red/Brown SANDSTONE As received	A	PD	YES		101.3	50.9	47.9	0.1	81.0	0.01	0.01	
RBH02	12.07	C19	Red/Brown SANDSTONE As received	D	PL	YES	67.4	101.5	101.5	102.5	0.1	101.5	0.01	0.02	
RBH02	12.07	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.2	69.7	67.7	0.1	94.8	0.01	0.01	
RBH02	14	C21	Red/Brown SANDSTONE As received	D	PL	YES	83.3	102.0	102.0	99.0	0.4	102.0	0.04	0.06	
RBH02	14	C21	Red/Brown SANDSTONE As received	A	PD	YES		101.1	81.0	79.0	0.1	102.1	0.01	0.01	
RBH02	15.5	C23	Red/Brown SANDSTONE As received	D	PL	YES	68.3	101.7	101.7	99.7	0.5	101.7	0.05	0.07	
RBH02	15.5	C23	Red/Brown SANDSTONE As received	A	PD	YES		101.7	65.8	62.8	0.4	92.3	0.05	0.06	
RBH02	15.97	C24	Red/Brown SANDSTONE As received	A	PD	YES		96.8	89.1	80.1	0.1	104.8	0.01	0.01	
RBH02	17.12	C44	Red/Brown SANDSTONE Saturated	A	PD	YES		99.6	85.2	81.2	0.2	104.0	0.02	0.03	
RBH02	18	C26	Red/Brown SANDSTONE As received	D	PL	YES	78.2	100.2	100.2	98.2	0.8	100.2	0.08	0.11	
RBH02	18	C26	Red/Brown SANDSTONE As received	A	PD	YES		100.9	107.4	96.4	1.4	117.4	0.10	0.15	
RBH02	20	C28	Red/Brown SANDSTONE As received	A	PD	YES		100.0	71.8	65.8	0.3	95.6	0.03	0.04	
RBH02	20.94	C29	Red/Brown SANDSTONE As received	A	PD	YES		99.5	56.8	53.8	0.3	84.8	0.04	0.05	
RBH02	23.92	C45	Red/Brown SANDSTONE As received	D	PL	YES	55.3	101.4	101.4	98.4	1.1	101.4	0.11	0.15	
RBH02	23.92	C45	Red/Brown SANDSTONE As received	A	PD	YES		101.3	57.2	48.2	1.6	85.9	0.22	0.28	
RBH02	27.99	C30	Red/Brown SANDSTONE As received	D	PL	YES	44.5	100.9	100.9	97.9	0.1	100.9	0.01	0.02	
RBH02	27.99	C30	Red/Brown SANDSTONE As received	A	PD	YES		101.0	48.6	47.6	0.1	79.1	0.02	0.02	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206 / 3

Site: St John's Masterplan **Job Number:** 42206

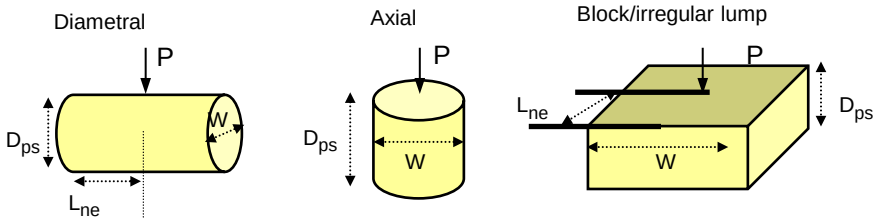
Client: Curtins Consulting **Page:** 6

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH02	29.35	C31	Red/Brown SANDSTONE As received	D	PL	YES	97.8	100.9	100.9	98.9	1.1	100.9	0.11	0.15	
RBH02	29.35	C31	Red/Brown SANDSTONE As received	A	PD	YES		100.7	102.5	96.5	1.1	114.7	0.09	0.12	
RBH02	31.82	C33	Red/Brown SANDSTONE As received	D	PL	YES	67.9	100.3	100.3	98.3	1.2	100.3	0.12	0.17	
RBH02	31.82	C33	Red/Brown SANDSTONE As received	A	PD	YES		101.2	73.1	70.1	1.0	97.0	0.10	0.14	
RBH02	34.02	C35	Red/Brown SANDSTONE As received	A	PD	YES		100.7	64.0	59.0	1.0	90.6	0.12	0.15	
RBH02	36.31	C37	Red/Brown SANDSTONE As received	D	PL	YES	59.7	99.7	99.7	98.7	0.7	99.7	0.07	0.10	
RBH02	36.31	C37	Red/Brown SANDSTONE As received	A	PD	YES		100.3	59.5	42.5	0.9	87.2	0.12	0.16	
RBH02	38.04	C38	Red/Brown SANDSTONE As received	D	PL	YES	69.5	100.0	100.0	97.0	1.1	100.0	0.11	0.14	
RBH02	38.04	C38	Red/Brown SANDSTONE As received	A	PD	YES		100.6	111.6	97.6	3.0	119.5	0.21	0.31	
RBH03	9.6	C7	Red/Brown SANDSTONE As received	D	PL	YES	52.7	101.3	101.3	98.3	0.6	101.3	0.05	0.07	
RBH03	9.6	C7	Red/Brown SANDSTONE As received	A	PD	YES		101.4	56.8	50.8	0.9	85.6	0.13	0.16	
RBH03	11.3	C9	Red/Brown SANDSTONE As received	D	PL	YES	63.3	101.5	101.5	98.5	0.6	101.5	0.06	0.08	
RBH03	11.3	C9	Red/Brown SANDSTONE As received	A	PD	YES		101.2	73.7	68.7	1.4	97.4	0.14	0.19	
RBH03	13.4	C11	Red/Brown SANDSTONE As received	A	PD	YES		101.1	92.2	66.2	1.1	108.9	0.09	0.13	
RBH03	15.4	C13	Red/Brown SANDSTONE As received	D	PL	YES	96.5	101.2	101.2	99.2	0.5	101.2	0.05	0.07	
RBH03	15.4	C13	Red/Brown SANDSTONE As received	A	PD	YES		101.2	109.6	98.6	1.6	118.8	0.11	0.16	
RBH03	18	C15	Red/Brown SANDSTONE As received	D	PL	YES	96.8	100.8	100.8	97.8	0.5	100.8	0.04	0.06	
RBH03	18	C15	Red/Brown SANDSTONE As received	A	PD	YES		100.7	86.1	77.1	1.2	105.1	0.11	0.15	
RBH03	20	C17	Red/Brown SANDSTONE As received	D	PL	YES	107.4	101.3	101.3	98.3	0.5	101.3	0.05	0.06	
RBH03	20	C17	Red/Brown SANDSTONE As received	A	PD	YES		101.2	115.4	104.4	1.5	121.9	0.10	0.15	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206 / 3

Site: St John's Masterplan **Job Number:** 42206

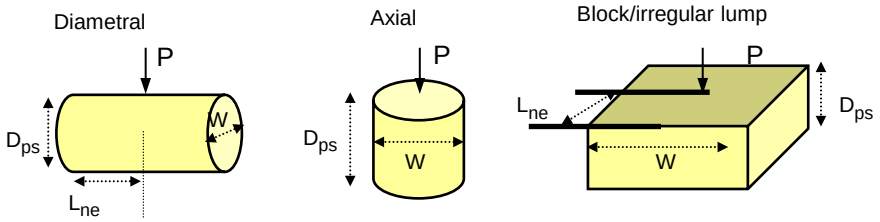
Client: Curtins Consulting **Page:** 7

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH03	24.3	C19	Red/Brown SANDSTONE As received	D	PL	YES	76.2	101.2	101.2	99.2	0.5	101.2	0.05	0.07	
RBH03	24.3	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.2	80.6	59.6	0.7	101.9	0.07	0.10	
RBH03	26.1	C20	Red/Brown SANDSTONE As received	D	PL	YES	80.1	101.5	101.5	99.5	0.6	101.5	0.06	0.08	
RBH03	26.1	C20	Red/Brown SANDSTONE As received	A	PD	YES		101.1	83.5	78.5	1.3	103.7	0.12	0.17	
RBH03	28.04	C22	Red/Brown SANDSTONE As received	D	PL	YES	88.2	101.8	101.8	98.8	0.9	101.8	0.09	0.12	
RBH03	28.04	C22	Red/Brown SANDSTONE As received	A	PD	YES		101.7	89.4	81.4	1.9	107.6	0.17	0.23	
RBH03	28.94	C23	Red/Brown SADNSTONE As received	D	PL	YES	24.9	101.3	101.3	99.3	0.3	101.3	0.03	0.05	
RBH03	28.94	C23	Red/Brown SADNSTONE As received	A	PD	YES		101.2	85.8	77.8	1.3	105.2	0.11	0.16	
RBH03	29.2	C24	Red/Brown SADNSTONE As received	D	PL	YES	78.7	101.8	101.8	99.8	1.7	101.8	0.17	0.23	
RBH03	29.2	C24	Red/Brown SADNSTONE As received	A	PD	YES		101.8	73.9	67.9	2.7	97.8	0.28	0.38	
RBH03	31.3	C26	Red/Brown SADNSTONE As received	D	PL	YES	68.1	100.3	100.3	92.3	1.8	100.3	0.18	0.24	
RBH03	31.3	C26	Red/Brown SADNSTONE As received	A	PD	YES		101.4	101.7	85.7	2.2	114.5	0.17	0.24	
RBH03	32.5	C27	Red/Brown SADNSTONE As received	A	PD	YES		99.9	82.6	76.6	2.5	102.5	0.24	0.33	
RBH03	35.01	C29	Red/Brown SADNSTONE As received	D	PL	YES	64.7	101.5	101.5	98.5	0.8	101.5	0.08	0.10	
RBH03	35.01	C29	Red/Brown SADNSTONE As received	A	PD	YES		101.1	66.0	59.0	2.4	92.1	0.29	0.38	
RBH03	36.3	C30	Red/Brown SANDSTONE As received	A	PD	YES		101.0	111.1	102.1	0.7	119.5	0.05	0.07	
RBH03	37.95	C31	Red/Brown SANDSTONE As received	A	PD	YES		100.5	87.7	78.7	2.7	106.0	0.24	0.34	
RBH03	39.35	C32	Red/Brown SANDSTONE As received	D	PL	YES	82.0	101.1	101.1	99.1	1.5	101.1	0.15	0.20	
RBH03	39.35	C32	Red/Brown SANDSTONE As received	A	PD	YES		101.6	98.0	83.0	3.4	112.6	0.26	0.38	
RBH03	39.7	C33	Red/Brown SANDSTONE As received	A	PD	YES		100.7	100.7	94.7	3.7	113.6	0.29	0.42	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206 / 3

Site: St John's Masterplan **Job Number:** 42206

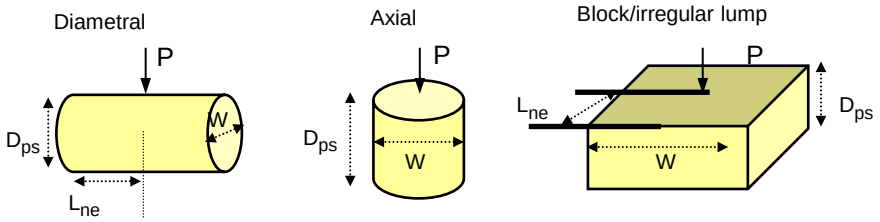
Client: Curtins Consulting **Page:** 8

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH04	9.27	C14	Red/Brown SANDSTONE As received	D	PL	YES	63.0	99.0	99.0	95.0	0.1	99.0	0.01	0.02	
RBH04	9.27	C14	Red/Brown SANDSTONE As received	A	PD	YES		99.4	77.5	68.5	0.3	99.1	0.03	0.03	
RBH04	9.7	C15	Red/Brown SANDSTONE As received	D	PL	YES	54.7	100.5	100.5	98.5	0.2	100.5	0.02	0.02	
RBH04	9.7	C15	Red/Brown SANDSTONE As received	A	PD	YES		100.0	57.0	52.0	0.2	85.2	0.02	0.03	
RBH04	11.05	C16	Red/Brown SANDSTONE As received	A	PD	YES		97.9	90.2	83.2	0.5	106.0	0.04	0.06	
RBH04	12.35	C17	Red/Brown SADNSTONE As received	D	PL	YES	74.2	97.9	97.9	94.9	0.3	97.9	0.03	0.04	
RBH04	12.35	C17	Red/Brown SADNSTONE As received	A	PD	YES		98.0	69.3	59.3	0.6	93.0	0.07	0.09	
RBH04	12.7	C18	Red/Brown SANDSTONE As received	A	PD	YES		99.1	79.1	62.1	1.2	99.9	0.12	0.16	
RBH04	13.85	C19	Red/Brown SADNSTONE As received	D	PL	YES	65.5	101.0	101.0	99.0	0.2	101.0	0.02	0.03	
RBH04	13.85	C19	Red/Brown SADNSTONE As received	A	PD	YES		101.4	92.6	85.6	0.3	109.3	0.03	0.04	
RBH04	15.1	C21	Red/Brown SADNSTONE As received	D	PL	YES	56.8	100.7	100.7	98.7	0.1	100.7	0.01	0.01	
RBH04	15.1	C21	Red/Brown SADNSTONE As received	A	PD	YES		101.2	66.6	55.6	0.3	92.7	0.04	0.05	
RBH04	17.34	C23	Red/Brown SADNSTONE As received	D	PL	YES	100.0	101.5	101.5	97.5	1.2	101.5	0.12	0.16	
RBH04	17.34	C23	Red/Brown SADNSTONE As received	A	PD	YES		101.6	67.4	57.4	2.7	93.4	0.31	0.41	
RBH04	18.1	C24	Red/Brown SADNSTONE As received	D	PL	YES	85.7	100.6	100.6	97.6	0.4	100.6	0.04	0.06	
RBH04	18.1	C24	Red/Brown SADNSTONE As received	A	PD	YES		99.9	84.3	81.3	0.6	103.6	0.06	0.08	
RBH04	19.92	C26	Red/Brown SANDSTONE As received	D	PL	YES	76.6	100.6	100.6	98.6	0.5	100.6	0.05	0.07	
RBH04	19.92	C26	Red/Brown SANDSTONE As received	A	PD	YES		100.9	76.5	71.5	1.8	99.1	0.18	0.25	
RBH04	21.31	C27	Red/Brown SANDSTONE As received	A	PD	YES		99.4	93.6	81.6	1.2	108.8	0.10	0.14	
RBH04	22.93	C29	Red/Brown SANDSTONE As received	D	PL	YES	56.9	100.4	100.4	98.4	0.3	100.4	0.03	0.04	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206 / 3

Site: St John's Masterplan **Job Number:** 42206

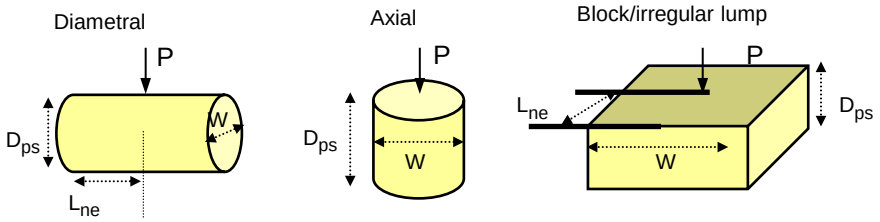
Client: Curtins Consulting **Page:** 9

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH04	22.93	C29	Red/Brown SANDSTONE As received	A	PD	YES		100.8	72.0	65.0	1.1	96.1	0.12	0.17	
RBH04	24.25	C30	Red/Brown SANDSTONE As received	D	PL	YES	98.7	100.9	100.9	98.9	0.5	100.9	0.05	0.07	
RBH04	24.25	C30	Red/Brown SANDSTONE As received	A	PD	YES		100.7	86.5	71.5	2.6	105.3	0.23	0.32	
RBH04	24.94	C31	Red/Brown SANDSTONE As received	D	PL	YES	83.9	100.8	100.8	98.8	1.9	100.8	0.18	0.25	
RBH04	24.94	C31	Red/Brown SANDSTONE As received	A	PD	YES		100.8	94.6	89.6	2.0	110.2	0.17	0.24	
RBH04	27.09	C33	Red/Brown SADNSTONE As received	D	PL	YES	78.4	101.3	101.3	97.3	0.7	101.3	0.07	0.09	
RBH04	27.09	C33	Red/Brown SADNSTONE As received	A	PD	YES		101.4	53.4	54.4	1.2	83.0	0.17	0.22	
RBH04	28.04	C34	Red/Brown SADNSTONE As received	D	PL	YES	83.4	100.6	100.6	98.6	0.5	100.6	0.05	0.07	
RBH04	28.04	C34	Red/Brown SADNSTONE As received	A	PD	YES		101.5	95.6	85.6	1.7	111.1	0.14	0.20	
RBH04	29.1	C35	Red/Brown SADNSTONE As received	D	PL	YES	42.2	99.3	99.3	97.3	0.2	99.3	0.02	0.03	
RBH04	29.1	C35	Red/Brown SADNSTONE As received	A	PD	YES		99.5	46.2	41.2	1.4	76.5	0.24	0.29	
RBH04	31.05	C37	Red/Brown SADNSTONE As received	A	PD	YES		100.2	79.3	65.3	1.5	100.6	0.15	0.21	
RBH04	33.87	C39	Red/Brown SADNSTONE As received	D	PL	YES	86.8	99.9	99.9	96.9	1.5	99.9	0.15	0.21	
RBH04	33.87	C39	Red/Brown SADNSTONE As received	A	PD	YES		97.0	113.7	102.7	1.4	118.5	0.10	0.15	
RBH04	36.1	C40	Red/Brown SANDSTONE As received	D	PL	YES	63.0	100.2	100.2	98.2	0.2	100.2	0.02	0.03	
RBH04	36.1	C40	Red/Brown SANDSTONE As received	A	PD	YES		100.1	68.9	58.9	0.3	93.7	0.04	0.05	
RBH04	38	C42	Red/Brown SANDSTONE As received	D	U	YES	28.7	101.2	101.2	93.2	0.0	101.2	0.00	0.01	
RBH04	39.5	C41	Red/Brown SANDSTONE As received	A	PD	YES		99.6	90.1	71.1	0.3	106.9	0.03	0.04	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Test Report - 42206 / 3

Site:	St John's Masterplan
Job Number:	42206
Originating Client:	Curtins Consulting

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Date: 22/08/2018

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F.A.O.

Test Report - 42206A / 2

Site:	St John's Masterplan
Job Number:	42206A
Originating Client:	Curtins Consulting
Originating Reference:	42206
Date Sampled:	30/07/2018
Date Scheduled:	02/08/2018
Date Testing Started:	08/08/2018
Date Testing Finished:	14/08/2018
Remarks:	

Authorised By:

Tim Robinson
Quality Technician

Date: 20/08/2018

Constructionline

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AGS

IAN FARMER ASSOCIATES	Laboratory Test Report	42206A / 2

Site: St John's Masterplan **Job Number:** 42206A

Client: Curtins Consulting **Page:** 2

ROCK INDEX TESTS - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content[1] %	Caliper[2]		Buoyancy[3]		Natural Bulk density Mg/m^3	Remarks
					Dry density Mg/m^3	Porosity %	Dry density Mg/m^3	Porosity %		
BH04B	11.72	C6	Red/Brown SANDSTONE	12.9			1.94	27.3	2.19	
BH04B	14.90	C14	Red/Brown SANDSTONE	9.9			2.21	18.9	2.43	
BH04B	19.00	C19	Red/Brown SANDSTONE	10.7			2.08	21.7	2.31	
BH04B	24.25	C26	Red/Brown SANDSTONE	12.5			1.93	27.3	2.17	
RBH06	11.29	C13	Red/Brown SANDSTONE	12.0			2.00	24.2	2.24	
RBH06	17.16	C24	Red/Brown SANDSTONE	11.8			1.99	26.3	2.22	
RBH06	22.59	C34	Red/Brown SANDSTONE	12.3			1.97	26.4	2.21	
RBH06	27.16	C42	Red/Brown SANDSTONE	11.2			2.05	23.7	2.28	
RBH06	31.34	C46	Red/Brown SANDSTONE	8.9			2.10	20.5	2.29	
RBH06	37.00	C49	Red/Brown SANDSTONE	10.5			2.09	21.1	2.31	
RBH06	43.00	C53	Red/Brown SANDSTONE	10.6			2.05	23.8	2.27	
RBH06	51.07	C57	Red/Brown SANDSTONE	10.2			2.03	23.3	2.24	

Notes
1. ISRM p87 test 1, water content at 105 ± 3 °C, specimen as received at the laboratory
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper
3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

IAN FARMER ASSOCIATES

Laboratory Test Report 42206A / 2

Site: St John's Masterplan **Job Number:** 42206A

Client: Curtins Consulting **Page:** 3

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH04B	9.66	C2	Red/Brown SANDSTONE	101.5	104.8	*1	2.12	10.8	as received	0.3460	AC	8.8	
BH04B	11.72	C6	Red/Brown SANDSTONE	100.6	149.4	*1.5	2.21	11.4	as received	0.3526	AC	14.5	
BH04B	13.05	C11	Red/Brown SANDSTONE	101.5	108.5	*1.1	2.19	10.5	as received	0.3460	AC	8.6	
BH04B	14.90	C14	Red/Brown SANDSTONE	100.7	178.0	*1.8	2.24	7.0	as received	0.3512	S	8.9	
BH04B	18.26	C18	Red/Brown SANDSTONE	100.9	124.8	*1.2	2.23	11.3	as received	0.3499	AC	9.1	
BH04B	20.14	C21	Red/Brown SANDSTONE	101.2	215.1	*2.1	2.29	8.5	as received	0.3482	AC	12.2	
BH04B	20.73	C22	Red/Brown SANDSTONE	101.4	146.0	*1.4	1.95	9.6	as received	0.3468	AC	7.7	
RBH06	12.47	C15	Red/Brown SANDSTONE	100.5	101.6	*1	2.14	13.4	as received	0.3528	AC	3.4	
RBH06	14.00	C18	Red/Brown SANDSTONE	99.7	107.1	*1.1	2.26	11.2	as received	0.3586	AC	6.3	
RBH06	15.10	C21	Red/Brown SANDSTONE	100.8	112.4	*1.1	2.20	11.8	as received	0.3507	AC	3.9	
RBH06	17.16	C24	Red/Brown SANDSTONE	99.7	107.4	*1.1	2.21	9.7	as received	0.3589	AC	9.2	
RBH06	19.09	C27	Red/Brown SANDSTONE	101.2	207.0	*2	2.22	10.0	as received	0.3479	AC	15.5	
RBH06	21.56	C31	Red/Brown SANDSTONE	100.1	193.6	*1.9	2.22	11.8	as received	0.3561	AC	13.0	
RBH06	22.59	C34	Red/Brown SANDSTONE	100.2	226.0	*2.3	2.25	10.4	as received	0.3552	AC	11.0	
RBH06	24.06	C38	Red/Brown SANDSTONE	100.7	198.8	*2	2.19	12.3	as received	0.3519	S	8.3	
RBH06	25.76	C40	Red/Brown SANDSTONE	100.3	172.8	*1.7	2.21	11.1	as received	0.3546	AC	10.5	
RBH06	27.16	C42	Red/Brown SANDSTONE	100.4	218.3	*2.2	2.19	10.9	as received	0.3535	AC	10.7	
RBH06	29.00	C44	Red/Brown SANDSTONE	100.3	203.6	*2	2.27	10.7	as received	0.3546	AC	9.6	
RBH06	30.21	C45	Red/Brown SANDSTONE	100.7	196.9	*2	2.31	9.4	as received	0.3514	AC	26.0	
RBH06	31.34	C46	Red/Brown SANDSTONE	100.7	240.7	*2.4	2.33	7.4	as received	0.3519	AC	14.3	
RBH06	35.73	C48	Red/Brown SANDSTONE	100.1	183.9	*1.8	2.38	8.1	as received	0.3558	AC	13.7	
RBH06	38.00	C50	Red/Brown SANDSTONE	99.9	250.5	2.5	2.35	8.9	as received	0.3575	AC	20.8	
RBH06	41.47	C52	Red/Brown SANDSTONE	101.0	298.6	3	2.33	8.8	as received	0.3497	AC	25.0	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

IAN FARMER ASSOCIATES

Laboratory Test Report 42206A / 2

Site: St John's Masterplan **Job Number:** 42206A

Client: Curtins Consulting **Page:** 4

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
RBH06	43.00	C53	Red/Brown SANDSTONE	101.2	238.9	*2.4	2.26	9.2	as received	0.3480	AC	16.3	
RBH06	46.47	C55	Red/Brown SANDSTONE	100.8	299.9	3	2.38	5.5	as received	0.3511	AC	16.9	
RBH06	51.07	C57	Red/Brown SANDSTONE	101.2	245.4	*2.4	2.27	8.4	as received	0.3482	AC	13.8	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

IAN FARMER ASSOCIATES	Laboratory Test Report	42206A / 2

Site: St John's Masterplan **Job Number:** 42206A

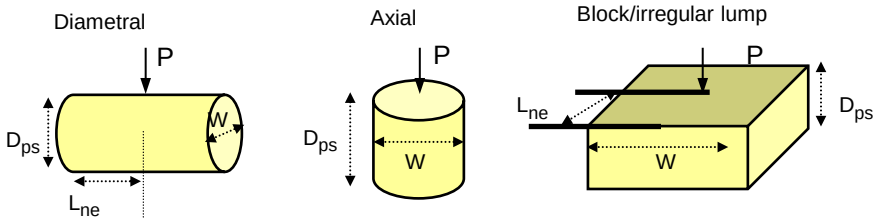
Client: Curtins Consulting **Page:** 5

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
BH04B	8.5	C1	Red/Brown SANDSTONE As received	D	PL	YES	44.7	99.6	99.6	95.6	0.9	99.6	0.09	0.12	
BH04B	8.5	C1	Red/Brown SANDSTONE As received	A	PD	YES		101.3	46.9	41.9	1.8	77.8	0.30	0.36	
BH04B	10.77	C4	Red/Brown SANDSTONE As received	D	PL	YES	52.1	99.0	99.0	96.0	0.1	99.0	0.01	0.02	
BH04B	10.77	C4	Red/Brown SANDSTONE As received	A	PD	YES		99.1	63.0	59.0	0.9	89.1	0.11	0.15	
BH04B	12.31	C8	Red/Brown SANDSTONE As received	D	PL	YES	50.1	101.0	101.0	99.0	0.7	101.0	0.07	0.10	
BH04B	12.31	C8	Red/Brown SANDSTONE As received	A	PD	YES		100.7	49.7	46.7	1.2	79.8	0.18	0.23	
BH04B	14.1	C12	Red/Brown SANDSTONE As received	D	PL	YES	52.2	100.5	100.5	97.5	0.9	100.5	0.09	0.12	
BH04B	14.1	C12	Red/Brown SANDSTONE As received	A	PD	YES		100.6	44.4	38.4	1.6	75.4	0.28	0.34	
BH04B	16	C16	Red/Brown SANDSTONE As received	D	PL	YES	81.9	100.6	100.6	95.6	0.8	100.6	0.07	0.10	
BH04B	16	C16	Red/Brown SANDSTONE As received	A	PD	YES		100.4	75.6	68.6	1.9	98.3	0.20	0.27	
BH04B	17	C17	Red/Brown SANDSTONE As received	D	PL	YES	82.3	101.1	101.1	96.1	1.0	101.1	0.09	0.13	
BH04B	17	C17	Red/Brown SANDSTONE As received	A	PD	YES		101.2	74.3	41.3	2.4	97.8	0.25	0.33	
BH04B	19	C19	Red/Brown SANDSTONE As received	D	PL	YES	100.9	101.5	101.5	96.5	0.8	101.5	0.08	0.11	
BH04B	19	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.5	90.4	83.4	0.5	108.1	0.04	0.06	
BH04B	21.55	C23	Red/Brown SANDSTONE As received	D	PL	YES	51.8	100.7	100.7	98.7	1.4	100.7	0.14	0.19	
BH04B	21.55	C23	Red/Brown SANDSTONE As received	A	PD	YES		100.6	70.1	62.1	2.1	94.7	0.24	0.32	
BH04B	23.14	C24	Red/Brown SANDSTONE As received	D	PL	YES	64.9	100.7	100.7	96.7	0.3	100.7	0.03	0.04	
BH04B	23.14	C24	Red/Brown SANDSTONE As received	A	PD	YES		100.3	109.6	91.6	0.2	118.3	0.01	0.02	
BH04B	24.04	C25	Red/Brown SANDSTONE As received	D	PL	YES	76.0	100.4	100.4	96.4	1.2	100.4	0.12	0.16	
BH04B	24.04	C25	Red/Brown SANDSTONE As received	A	PD	YES		101.4	74.0	58.0	2.4	97.7	0.25	0.33	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206A / 2

Site: St John's Masterplan **Job Number:** 42206A

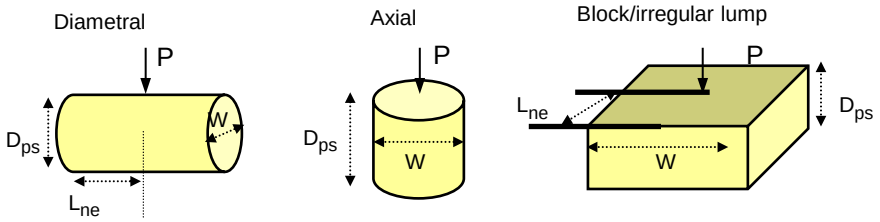
Client: Curtins Consulting **Page:** 6

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH06	8	C10	Red/Brown SANDSTONE As received	D	PL	YES	46.5	98.9	98.9	95.9	0.4	98.9	0.04	0.05	
RBH06	8	C10	Red/Brown SANDSTONE As received	A	PD	YES		98.2	57.7	53.7	0.6	84.9	0.08	0.10	
RBH06	9.63	C11	Red/Brown SANDSTONE As received	D	PL	YES	47.2	98.8	98.8	92.8	0.2	98.8	0.03	0.03	
RBH06	9.63	C11	Red/Brown SANDSTONE As received	A	PD	YES		98.0	55.7	51.7	0.7	83.4	0.10	0.13	
RBH06	11.29	C13	Red/Brown SANDSTONE As received	D	PL	YES	53.2	101.3	101.3	97.3	0.3	101.3	0.03	0.04	
RBH06	11.29	C13	Red/Brown SANDSTONE As received	A	PD	YES		101.3	82.0	70.0	0.7	102.8	0.07	0.09	
RBH06	13	C16	Red/Brown SANDSTONE As received	D	PL	YES	49.9	100.4	100.4	97.4	0.4	100.4	0.04	0.05	
RBH06	13	C16	Red/Brown SANDSTONE As received	A	PD	YES		100.2	52.5	45.5	1.1	81.8	0.17	0.21	
RBH06	14.17	C19	Red/Brown SANDSTONE As received	A	PD	YES		99.6	58.3	54.3	0.2	86.0	0.03	0.04	
RBH06	16.55	C22	Red/Brown SANDSTONE As received	D	PL	YES	40.5	99.5	99.5	96.5	0.4	99.5	0.04	0.06	
RBH06	16.55	C22	Red/Brown SANDSTONE As received	A	PD	YES		98.6	47.6	43.6	0.8	77.3	0.14	0.17	
RBH06	18.06	C25	Red/Brown SANDSTONE As received	D	PL	YES	50.0	95.8	95.8	91.8	0.2	95.8	0.03	0.03	
RBH06	18.06	C25	Red/Brown SANDSTONE As received	A	PD	YES		98.9	57.2	50.2	0.9	84.8	0.12	0.16	
RBH06	20.21	C29	Red/Brown SANDSTONE As received	D	PL	YES	55.7	99.6	99.6	96.6	0.7	99.6	0.07	0.10	
RBH06	20.21	C29	Red/Brown SANDSTONE As received	A	PD	YES		100.3	53.7	49.7	1.3	82.8	0.19	0.23	
RBH06	21	C30	Red/Brown SANDSTONE As received	D	PL	YES	83.4	100.8	100.8	98.8	1.0	100.8	0.10	0.14	
RBH06	21	C30	Red/Brown SANDSTONE As received	A	PD	YES		100.9	79.4	68.4	3.0	101.0	0.29	0.40	
RBH06	23.6	C37	Red/Brown SANDSTONE As received	D	PL	YES	83.7	100.1	100.1	97.1	0.6	100.1	0.06	0.08	
RBH06	23.6	C37	Red/Brown SANDSTONE As received	A	PD	YES		100.1	72.5	63.5	1.6	96.1	0.18	0.24	
RBH06	25	C39	Red/Brown SANDSTONE As received	D	PL	YES	64.3	100.9	100.9	97.9	0.9	100.9	0.09	0.13	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206A / 2

Site: St John's Masterplan **Job Number:** 42206A

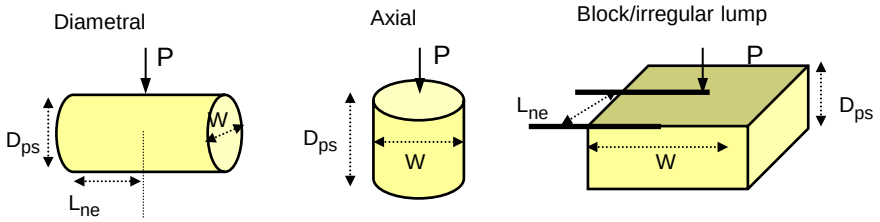
Client: Curtins Consulting **Page:** 7

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH06	25	C39	Red/Brown SANDSTONE As received	A	PD	YES		101.0	53.0	43.0	0.6	82.5	0.09	0.12	
RBH06	26.71	C41	Red/Brown SANDSTONE As received	D	PL	YES	63.7	100.4	100.4	99.4	0.7	100.4	0.07	0.09	
RBH06	26.71	C41	Red/Brown SANDSTONE As received	A	PD	YES		100.2	60.7	50.7	1.1	88.0	0.15	0.19	
RBH06	28.07	C43	Red/Brown SANDSTONE As received	D	PL	YES	78.3	100.5	100.5	97.5	0.4	100.5	0.04	0.05	
RBH06	28.07	C43	Red/Brown SANDSTONE As received	A	PD	YES		100.5	71.4	66.4	1.5	95.6	0.17	0.23	
RBH06	33.31	C47	Red/Brown SANDSTONE As received	D	PL	YES	89.7	99.9	99.9	96.9	0.9	99.9	0.09	0.13	
RBH06	33.31	C47	Red/Brown SANDSTONE As received	A	PD	YES		100.3	89.6	82.6	2.2	107.0	0.19	0.27	
RBH06	37	C49	Red/Brown SANDSTONE As received	D	PL	YES	87.3	99.8	99.8	96.8	0.9	99.8	0.09	0.13	
RBH06	37	C49	Red/Brown SANDSTONE As received	A	PD	YES		99.6	66.1	60.1	1.4	91.6	0.17	0.22	
RBH06	40.03	C51	Red/Brown SANDSTONE As received	D	PL	YES	74.1	100.4	100.4	98.4	1.7	100.4	0.17	0.23	
RBH06	40.03	C51	Red/Brown SANDSTONE As received	A	PD	YES		100.0	97.0	88.0	2.4	111.1	0.19	0.28	
RBH06	45	C54	Red/Brown SANDSTONE As received	D	PL	YES	87.5	100.7	100.7	98.7	1.4	100.7	0.13	0.18	
RBH06	45	C54	Red/Brown SANDSTONE As received	A	PD	YES		100.9	83.0	78.0	2.2	103.2	0.20	0.28	
RBH06	49.07	C56	Red/Brown SANDSTONE As received	D	PL	YES	74.9	100.8	100.8	98.8	0.5	100.8	0.04	0.06	
RBH06	49.07	C56	Red/Brown SANDSTONE As received	A	PD	YES		100.7	70.7	65.7	0.9	95.2	0.10	0.13	
RBH06	53.25	C58	Red/Brown SANDSTONE As received	D	PL	YES	57.5	100.8	100.8	95.8	1.0	100.8	0.10	0.14	
RBH06	53.25	C58	Red/Brown SANDSTONE As received	A	PD	YES		100.4	43.7	38.7	0.8	74.7	0.14	0.17	
RBH06	54.87	C59	Red/Brown SANDSTONE As received	D	PL	YES	65.3	100.5	100.5	97.5	0.7	100.5	0.07	0.10	
RBH06	54.87	C59	Red/Brown SANDSTONE As received	A	PD	YES		100.9	71.5	51.5	2.0	95.8	0.22	0.29	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Test Report - 42206A / 2

Site:	St John's Masterplan
Job Number:	42206A
Originating Client:	Curtins Consulting

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Date: 20/08/2018

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washington@ianfarmer.co.uk www.ianfarmer.co.uk

F.A.O.

Test Report - 42206B / 1

Site:	St John's Masterplan
Job Number:	42206B
Originating Client:	Curtins Consulting
Originating Reference:	42206
Date Sampled:	02/08/2018
Date Scheduled:	13/08/2018
Date Testing Started:	17/08/2018
Date Testing Finished:	29/08/2018
Remarks:	

Authorised By:

Tim Robinson
Quality Technician

Date: 30/08/2018

Constructionline

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AGS

IAN FARMER ASSOCIATES	Laboratory Test Report	42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

Client: Curtins Consulting **Page:** 2

ROCK INDEX TESTS - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content1 %	Caliper2		Buoyancy3		Natural Bulk density Mg/m3	Remarks
					Dry density Mg/m3	Porosity %	Dry density Mg/m3	Porosity %		
BH02	13.16	C23	Red SANDSTONE	12.0			2.05	24.3	2.30	
BH02	18.19	C28	Red SANDSTONE	11.2			2.05	23.5	2.27	
BH02	24.30	C38	Red SANDSTONE	9.5			2.04	23.1	2.23	
BH03	11.19	C19	Red SANDSTONE	10.5			1.98	24.1	2.19	
BH03	16.98	C23	Red SANDSTONE	10.6			2.00	23.3	2.21	
BH03	24.38	C30	Red SANDSTONE	11.2			1.91	27.3	2.12	
RBH05	10.28	C19	Red SANDSTONE	9.9			2.05	22.6	2.25	
RBH05	16.17	C28	Red SANDSTONE	13.6			1.88	29.4	2.13	
RBH05	22.00	C37	Red SANDSTONE	12.4			1.91	27.6	2.15	
RBH05	28.18	C43	Red SANDSTONE	7.9			2.06	21.7	2.23	
RBH05	32.19	C47	Red SANDSTONE	8.1			2.01	21.4	2.17	
RBH05	36.38	C50	Red SANDSTONE	10.9			2.13	18.9	2.37	
RBH05	39.50	C52	Red SANDSTONE	11.0			1.96	25.6	2.17	

Notes
1. ISRM p87 test 1, water content at 105 ± 3 oC, specimen as received at the laboratory
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper
3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

IAN FARMER ASSOCIATES

Laboratory Test Report 42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

Client: Curtins Consulting **Page:** 3

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH02	13.16	C23	Red/Brown SANDSTONE	99.2	60.4	*0.6	2.19	11.6	as received	0.3623	AC	7.4	
BH02	17.13	C27	Red/Brown SANDSTONE	100.7	69.1	*0.7	2.30	8.4	as received	0.3629	AC	21.7	
BH02	18.19	C28	Red/Brown SANDSTONE	100.4	83.4	*0.8	2.21	11.2	as received	0.3537	AC	12.0	
BH02	21.00	C31	Red/Brown SANDTONE	100.2	201.0	*2	2.22	11.7	as received	0.3552	S	8.4	
BH02	22.56	C37	Red/Brown SANDSTONE	100.3	218.1	*2.2	2.27	10.5	as received	0.3543	S	8.7	
BH02	24.30	C38	Red/Brown SANDSTONE	101.8	259.6	2.6	2.26	9.5	as received	0.3442	AC	7.3	
BH03	10.15	C18	Red/Brown SANDSTONE	100.0	94.3	*0.9	2.24	10.1	as received	0.3566	AC	14.7	
BH03	12.28	C20	Red/Brown SANDSTONE	100.7	154.2	*1.5	2.22	10.8	as received	0.3516	AC	14.7	
BH03	13.16	C20	Red/Brown SANDTONE	100.7	199.4	*2	2.27	11.1	as received	0.3519	S	17.2	
BH03	18.29	C24	Red/Brown SANDTONE	100.3	149.6	*1.5	2.32	9.4	as received	0.3544	AC	23.9	
BH03	19.06	C25	Red/Brown SANDSTONE	100.6	192.3	*1.9	2.31	10.3	as received	0.3523	AC	14.5	
BH03	20.89	C27	Red/Brown SANDSTONE	100.5	263.4	2.6	2.31	10.2	as received	0.3530	S	12.6	
BH03	23.01	C29	Red/Brown SANDSTONE	101.3	274.7	2.7	2.18	11.9	as received	0.3475	S	11.9	
BH03	24.38	C30	Red/Brown SANDSTONE	100.6	250.3	2.5	2.22	11.2	as received	0.3522	AC	14.6	
RBH05	12.57	C23	Red/Brown SANDSTONE	101.0	76.0	*0.8	2.24	9.9	as received	0.3492	AC	7.1	
RBH05	14.09	C24	Red/Brown SANDSTONE	100.4	118.1	*1.2	2.16	12.4	as received	0.3540	AC	6.5	
RBH05	16.17	C28	Red/Brown SANDSTONE	101.7	221.4	*2.2	2.14	12.3	as received	0.3447	S	10.6	
RBH05	19.10	C32	Red/Brown SANDSTONE	100.8	228.0	*2.3	2.36	7.7	as received	0.3510	S	13.1	
RBH05	22.00	C37	Red/Brown SANDSTONE	101.3	128.7	*1.3	2.19	37.7	as received	0.3476	AC	5.8	
RBH05	23.05	C38	Red/Brown SANDSTONE	99.7	131.2	*1.3	2.29	9.9	as received	0.3584	AC	10.6	
RBH05	24.61	C40	Red/Brown SANDSTONE	100.2	219.8	*2.2	2.34	8.5	as received	0.3554	AC	8.5	
RBH05	26.00	C41	Red/Brown SANDSTONE	100.7	244.9	*2.4	2.28	10.1	as received	0.3518	S	11.0	
RBH05	28.18	C43	Red/Brown SANDSTONE	100.8	168.4	*1.7	2.23	9.3	as received	0.3505	AC	7.0	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

IAN FARMER ASSOCIATES

Laboratory Test Report 42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

Client: Curtins Consulting **Page:** 4

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
RBH05	31.19	C46	Red/Brown SANDSTONE	100.8	254.2	2.5	2.32	8.6	as received	0.3509	AC	18.5	
RBH05	35.20	C49	Red/Brown SANDSTONE	100.3	78.0	*0.8	2.44	6.2	as received	0.3541	AC	35.6	
RBH05	38.04	C51	Red/Brown SANDSTONE	100.4	103.0	*1	2.26	9.7	as received	0.3535	AC	1.8	
RBH05	39.50	C52	Red/Brown SANDSTONE	100.5	276.2	2.7	2.24	9.8	as received	0.3533	AC	8.0	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

IAN FARMER ASSOCIATES	Laboratory Test Report	42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

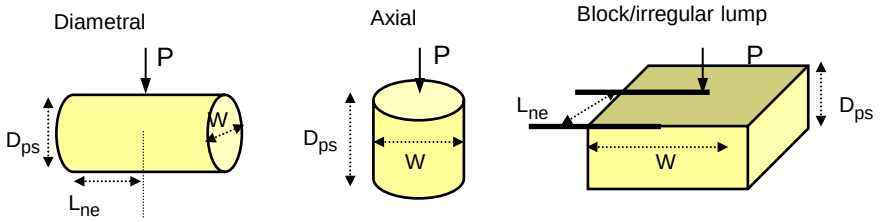
Client: Curtins Consulting **Page:** 5

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
BH02	8.43	C20	Red/Brown SANDSTONE As received	D	PL	YES	39.5	100.1	100.1	98.1	0.2	100.1	0.02	0.03	
BH02	8.43	C20	Red/Brown SANDSTONE As received	A	PD	YES		101.3	69.5	59.5	0.6	94.6	0.07	0.09	
BH02	10.1	C21	Red/Brown SANDSTONE As received	A	PD	YES		100.3	57.2	49.2	0.3	85.5	0.05	0.06	
BH02	11.91	C22	Red/Brown SANDSTONE As received	D	PL	YES	34.7	98.9	98.9	95.9	0.1	98.9	0.01	0.01	
BH02	11.91	C22	Red/Brown SANDSTONE As received	A	PD	YES		98.3	81.3	75.3	0.4	100.9	0.04	0.05	
BH02	14.13	C34	Red/Brown SANDSTONE As received	D	PL	YES	39.9	99.9	99.9	96.9	1.0	99.9	0.10	0.13	
BH02	14.13	C34	Red/Brown SANDSTONE As received	A	PD	YES		98.7	98.8	86.8	1.3	111.4	0.10	0.15	
BH02	15.07	C25	Red/Brown SANDSTONE As received	D	PL	YES		100.7	100.7	94.7	1.6	100.7	0.16	0.21	
BH02	16.22	C26	Red/Brown SANDSTONE As received	D	PL	YES	84.3	99.7	99.7	90.7	0.3	99.7	0.03	0.04	
BH02	16.22	C26	Red/Brown SANDSTONE As received	A	PD	YES		99.6	86.9	69.9	0.3	105.0	0.03	0.04	
BH02	19	C29	Red/Brown SANDSTONE As received	D	PL	YES	41.5	100.9	100.9	98.9	0.3	100.9	0.03	0.04	
BH02	19	C29	Red/Brown SANDSTONE As received	A	PD	YES		100.5	46.5	44.5	0.5	77.2	0.08	0.09	
BH02	20	C30	Red/Brown SANDSTONE As received	D	PL	YES	40.1	99.2	99.2	97.2	0.3	99.2	0.03	0.04	
BH02	20	C30	Red/Brown SANDSTONE As received	A	PD	YES		99.2	49.2	44.2	0.5	78.8	0.07	0.09	
BH02	22	C36	Red/Brown SANDSTONE As received	D	PL	YES	46.1	98.9	98.9	94.9	0.4	98.9	0.04	0.05	
BH02	22	C36	Red/Brown SANDSTONE As received	A	PD	YES		99.1	53.2	47.2	0.3	81.9	0.04	0.05	
BH02	23.83	C39	Red/Brown SANDSTONE As received	D	PL	YES	37.7	99.9	99.9	95.9	0.3	99.9	0.03	0.05	
BH02	23.83	C39	Red/Brown SANDSTONE As received	A	PD	YES		100.0	38.8	33.8	0.6	70.3	0.13	0.15	
BH03	8.52	C16	Red/Brown SANDSTONE As received	D	PL	YES	70.2	100.8	100.8	97.8	0.7	100.8	0.07	0.10	
BH03	8.52	C16	Red/Brown SANDSTONE As received	A	PD	YES		98.8	58.9	64.9	1.2	86.1	0.16	0.20	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

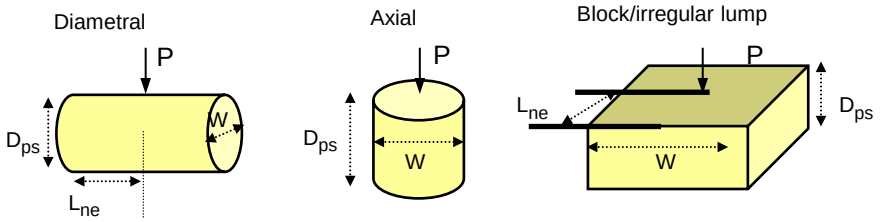
Client: Curtins Consulting **Page:** 6

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
BH03	9.56	C17	Red/Brown SANDSTONE As received	D	PL	YES	75.8	99.9	99.9	96.9	0.4	99.9	0.04	0.05	
BH03	9.56	C17	Red/Brown SANDSTONE As received	A	PD	YES		98.7	70.9	62.9	1.0	94.4	0.12	0.15	
BH03	11.19	C19	Red/Brown SANDSTONE As received	D	PL	YES	47.0	100.1	100.1	98.1	0.4	100.1	0.04	0.05	
BH03	11.19	C19	Red/Brown SANDSTONE As received	A	PD	YES		100.5	55.2	51.2	0.9	84.1	0.13	0.17	
BH03	14.03	C21	Red/Brown SANDSTONE As received	A	PD	YES		97.0	68.2	62.2	1.9	91.7	0.23	0.30	
BH03	16.08	C22	Red/Brown SANDSTONE As received	D	PL	YES	65.6	100.0	100.0	96.0	1.4	100.0	0.14	0.19	
BH03	16.08	C22	Red/Brown SANDSTONE As received	A	PD	YES		99.5	62.3	55.3	1.4	88.8	0.18	0.23	
BH03	16.98	C23	Red/Brown SANDSTONE As received	D	PL	YES	60.4	100.8	100.8	98.8	1.0	100.8	0.09	0.13	
BH03	16.98	C23	Red/Brown SANDSTONE As received	A	PD	YES		100.2	58.6	53.6	2.1	86.5	0.28	0.35	
BH03	19.9	C26	Red/Brown SANDSTONE As received	D	PL	YES	65.5	100.4	100.4	100.4	1.2	100.4	0.12	0.16	
BH03	19.9	C26	Red/Brown SANDSTONE As received	A	PD	YES		100.7	70.1	70.1	2.4	94.7	0.26	0.35	
BH03	21.83	C28	Red/Brown SANDSTONE As received	D	PL	YES	98.7	101.1	101.1	101.1	1.2	101.1	0.12	0.16	
BH03	21.83	C28	Red/Brown SANDSTONE As received	A	PD	YES		101.0	107.8	107.8	3.0	117.7	0.22	0.32	
BH03	24.83	C30	Red/Brown SANDSTONE As received	D	PL	YES	49.2	100.3	100.3	97.3	0.8	100.3	0.08	0.10	
BH03	24.83	C30	Red/Brown SANDSTONE As received	A	PD	YES		100.4	61.2	55.2	3.5	88.5	0.45	0.58	
RBH05	8.54	C16	Red/Brown SANDSTONE As received	D	PL	YES	44.7	100.4	100.4	96.4	0.6	100.4	0.06	0.09	
RBH05	8.54	C16	Red/Brown SANDSTONE As received	A	PD	YES		100.7	79.8	61.8	0.8	101.2	0.08	0.11	
RBH05	9.51	C17	Red/Brown SANDSTONE As received	A	PD	YES		99.8	58.7	53.7	0.9	86.3	0.12	0.15	
RBH05	10.28	C19	Red/Brown SANDSTONE As received	D	PL	YES	37.9	100.8	100.8	96.8	0.9	100.8	0.08	0.11	
RBH05	10.28	C19	Red/Brown SANDSTONE As received	A	PD	YES		100.8	35.8	20.8	1.0	67.8	0.22	0.25	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

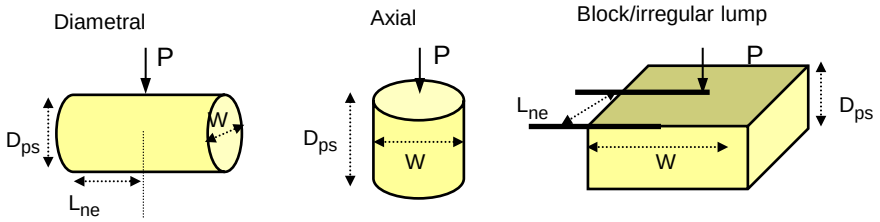
Client: Curtins Consulting **Page:** 7

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH05	11.37	C20	Red/Brown SANDSTONE As received	A	PD	YES		95.4	124.6	117.6	1.1	123.0	0.08	0.11	
RBH05	12.05	C21	Red/Brown SANDSTONE As received	D	PL	YES	61.8	96.6	96.6	93.6	0.1	96.6	0.01	0.02	
RBH05	14.93	C26	Red/Brown SANDSTONE As received	D	PL	YES	34.3	101.7	101.7	97.7	0.5	101.7	0.05	0.06	
RBH05	14.93	C26	Red/Brown SANDSTONE As received	A	PD	YES		102.0	52.2	50.2	0.4	82.3	0.06	0.08	
RBH05	17.77	C30	Red/Brown SANDSTONE As received	D	PL	YES	94.1	101.1	101.1	97.1	0.7	101.1	0.07	0.09	
RBH05	17.77	C30	Red/Brown SANDSTONE As received	A	PD	YES		101.0	116.0	110.0	1.3	122.2	0.09	0.13	
RBH05	20.06	C34	Red/Brown SANDSTONE As received	D	PL	YES	44.0	100.3	100.3	98.3	0.3	100.3	0.03	0.05	
RBH05	20.06	C34	Red/Brown SANDSTONE As received	A	PD	YES		101.4	62.8	58.8	1.7	90.0	0.20	0.27	
RBH05	21	C35	Red/Brown SANDSTONE As received	A	PD	YES		100.2	63.3	60.3	0.5	89.8	0.06	0.08	
RBH05	23.9	C39	Red/Brown SANDSTONE As received	D	PL	YES	43.0	100.4	100.4	96.4	0.6	100.4	0.06	0.08	
RBH05	23.9	C39	Red/Brown SANDSTONE As received	A	PD	YES		100.5	55.1	49.1	0.7	83.9	0.10	0.12	
RBH05	26.88	C42	Red/Brown SANDSTONE As received	D	PL	YES	57.2	100.3	100.3	98.3	0.9	100.3	0.09	0.12	
RBH05	26.88	C42	Red/Brown SANDSTONE As received	A	PD	YES		100.6	55.5	50.5	1.2	84.3	0.17	0.22	
RBH05	28.9	C44	Red/Brown SANDSTONE As received	A	PD	YES		101.0	67.7	22.7	0.3	93.3	0.04	0.05	
RBH05	29.88	C45	Red/Brown SANDSTONE As received	D	PL	YES	47.9	100.4	100.4	97.4	1.0	100.4	0.10	0.13	
RBH05	29.88	C45	Red/Brown SANDSTONE As received	A	PD	YES		100.6	51.8	46.8	1.1	81.5	0.16	0.20	
RBH05	32.19	C47	Red/Brown SANDSTONE As received	D	PL	YES	42.3	99.7	99.7	95.7	0.3	99.7	0.03	0.04	
RBH05	32.19	C47	Red/Brown SANDSTONE As received	A	PD	YES		99.9	57.4	52.4	1.1	85.4	0.15	0.20	
RBH05	34	C48	Red/Brown SANDSTONE As received	D	PL	YES	46.4	101.2	101.2	99.2	1.4	101.2	0.14	0.19	
RBH05	34	C48	Red/Brown SANDSTONE As received	A	PD	YES		100.8	52.9	49.9	2.0	82.4	0.30	0.37	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

IAN FARMER ASSOCIATES	Laboratory Test Report	42206B / 1

Site: St John's Masterplan **Job Number:** 42206B

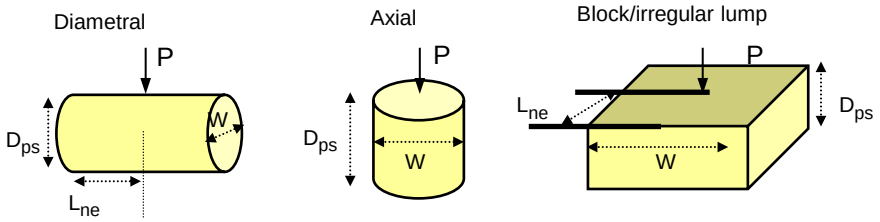
Client: Curtins Consulting **Page:** 8

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
RBH05	36.38	C50	Red/Brown SANDSTONE As received	D	PL	YES	47.3	100.3	100.3	98.3	1.2	100.3	0.12	0.16	
RBH05	36.38	C50	Red/Brown SANDSTONE As received	A	PD	YES		101.3	54.6	49.6	1.5	83.9	0.21	0.27	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Test Report - 42206B / 1

Site:	St John's Masterplan
Job Number:	42206B
Originating Client:	Curtins Consulting

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Date: 30/08/2018

ISRM - Suggested Methods : 2007

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Sample details				Indirect Tensile Strength test (LF0879C (1000kN) compression frame used)											
Borehole Ref.	Sample Ref.	Depth (m)	Description	D. Tested	Sample Diameter (mm)	Sample Width (mm)	Degree of Saturation (%)	Water Content (%)	Specific Gravity* (Mg/m³)	Stress Rate (N/s)	Test Duration (min:sec)	Failure Sketch	Failure Load (kN)	Tensile Strength (MPa)	Remarks
BH02	33	13.30-13.42	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	99.60	50.00	81.9	12.0	2.72 (a)	200	00:14		2.90	0.37	
BH03	34	16.34-16.48	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.20	48.90	82.6	11.4	2.72 (a)	200	00:21		4.10	0.532	
BH04B	3	9.82-9.90	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	98.50	50.20	80.3	11.6	2.72 (a)	200	00:25		5.00	0.643	
RBH02		13.85-14.00	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.90	50.90	92.6	10.5	2.72 (a)	200	00:19		3.80	0.471	
RBH03		15.11-15.30	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	101.30	50.50	95.4	6.9	2.72 (a)	200	00:36		7.30	0.908	
RBH04		16.92-17.34	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	101.40	50.90	90.5	7.1	2.72 (a)	200	00:45		8.90	1.1	
RBH05	18	10.00-10.10	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	99.90	49.80	75.4	9.2	2.72 (a)	200	00:16		3.30	0.422	
RBH05	29	17.38-17.59	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.50	49.00	81.9	12.0	2.72 (a)	200	00:23		4.60	0.594	
RBH06	17	13.82	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.10	50.30	92.4	11.6	2.72 (a)	200	00:20		3.90	0.493	
RBH06	33	21.80-21.89	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.30	51.20	91.1	12.3	2.72 (a)	200	00:35		6.90	0.855	

* Specific Gravity: (a) assumed or (m) measured/supplied by client.

* Load rate: 200 N/s

Checked and Approved by

CC

C Clergeaud (Snr. Geologist)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

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ISRM - Suggested Methods : 2007

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	BH02
Sample Ref.:	33
Depth (m):	13.30-13.42

Description:
Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

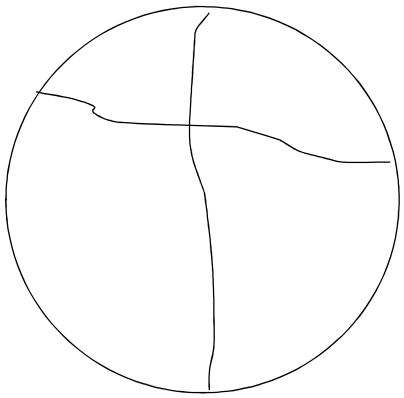
Diameter	99.60 mm
Thickness	50.00 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.18 Mg/m³
Dry Density	1.95 Mg/m³
Water Content	12.0 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	81.9 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:14 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Wedge fracture



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
2.90 kN

Tensile Strength
0.37 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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ISRM - Suggested Methods : 2007

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	BH03
Sample Ref.:	34
Depth (m):	16.34-16.48

Description:
Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

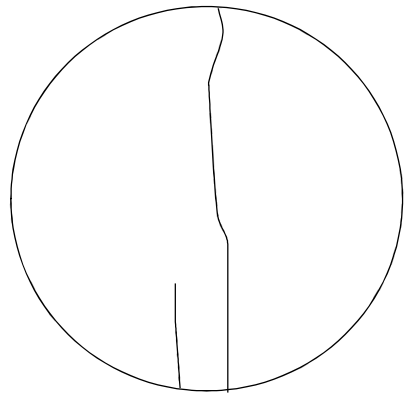
Diameter	100.20 mm
Thickness	48.90 mm
Thickness / Diameter Ratio	0.49
Bulk Density	2.20 Mg/m³
Dry Density	1.98 Mg/m³
Water Content	11.4 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	82.6 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:21 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
4.10 kN

Tensile Strength
0.532 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	BH04B
Sample Ref.:	3
Depth (m):	9.82-9.90

Description:
Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

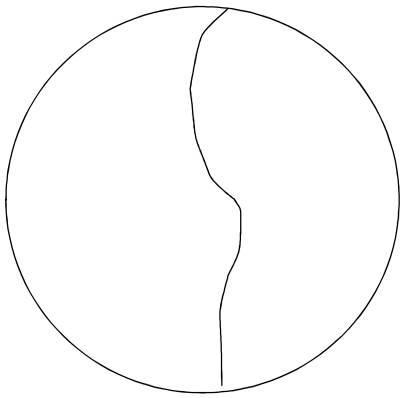
Diameter	98.50 mm
Thickness	50.20 mm
Thickness / Diameter Ratio	0.51
Bulk Density	2.18 Mg/m³
Dry Density	1.95 Mg/m³
Water Content	11.6 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	80.3 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:25 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
5.00 kN

Tensile Strength
0.643 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH02
Sample Ref.:	
Depth (m):	13.85-14.00

Description:
Very weak reddish brown fine grained SANDSTONE. High reaction to HCl.
Moderately weathered

Sample Details

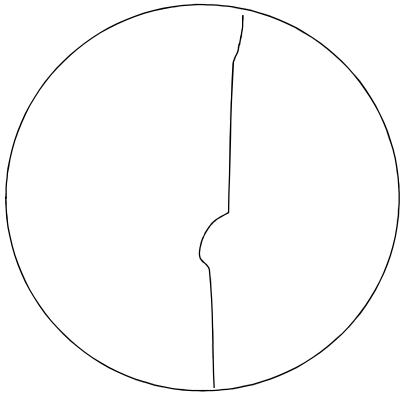
Diameter	100.90 mm
Thickness	50.90 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.30 Mg/m³
Dry Density	2.08 Mg/m³
Water Content	10.5 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	92.6 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:19 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
3.80 kN

Tensile Strength
0.471 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH03
Sample Ref.:	
Depth (m):	15.11-15.30

Description:
Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

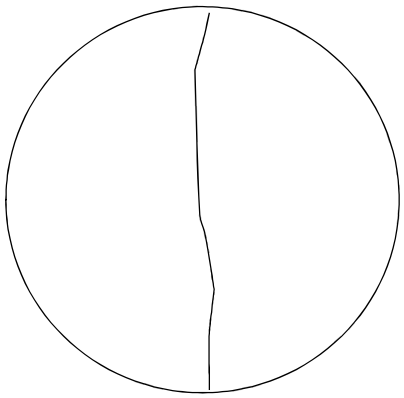
Diameter	101.30 mm
Thickness	50.50 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.43 Mg/m³
Dry Density	2.27 Mg/m³
Water Content	6.9 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	95.4 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:36 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
7.30 kN

Tensile Strength
0.908 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH04
Sample Ref.:	
Depth (m):	16.92-17.34

Description:
Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

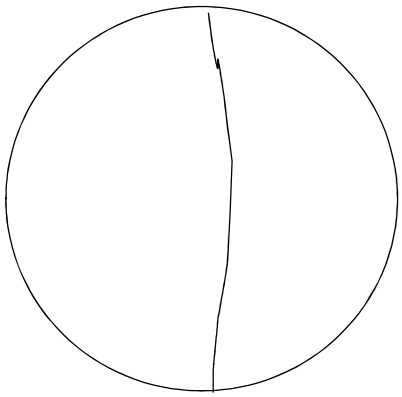
Diameter	101.40 mm
Thickness	50.90 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.40 Mg/m³
Dry Density	2.24 Mg/m³
Water Content	7.1 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	90.5 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:45 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
8.90 kN

Tensile Strength
1.1 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH05
Sample Ref.:	18
Depth (m):	10.00-10.10

Description:
Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

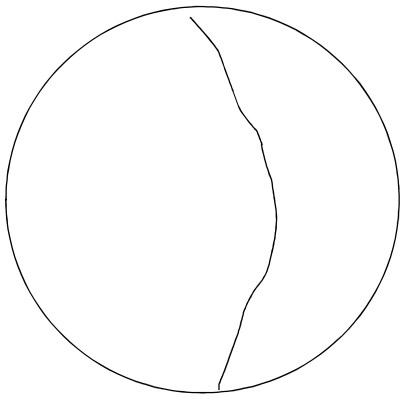
Diameter	99.90 mm
Thickness	49.80 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.23 Mg/m³
Dry Density	2.04 Mg/m³
Water Content	9.2 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	75.4 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:16 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Curved Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
3.30 kN

Tensile Strength
0.422 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
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UKAS TESTING 1982

ISRM - Suggested Methods : 2007

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH05
Sample Ref.:	29
Depth (m):	17.38-17.59

Description:
Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

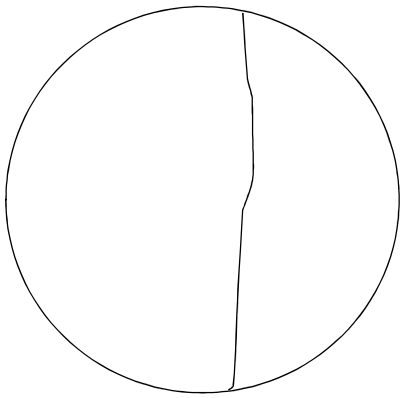
Diameter	100.50 mm
Thickness	49.00 mm
Thickness / Diameter Ratio	0.49
Bulk Density	2.18 Mg/m³
Dry Density	1.94 Mg/m³
Water Content	12.0 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	81.9 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:23 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
4.60 kN

Tensile Strength
0.594 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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ISRM - Suggested Methods : 2007

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH06
Sample Ref.:	17
Depth (m):	13.82

Description:
Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

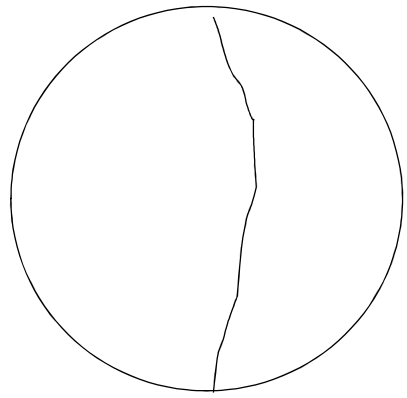
Diameter	100.10 mm
Thickness	50.30 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.26 Mg/m³
Dry Density	2.03 Mg/m³
Water Content	11.6 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	92.4 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:20 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Curved Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
3.90 kN

Tensile Strength
0.493 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
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UKAS TESTING 1982

ISRM - Suggested Methods : 2007

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.:	RBH06
Sample Ref.:	33
Depth (m):	21.80-21.89

Description:
Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

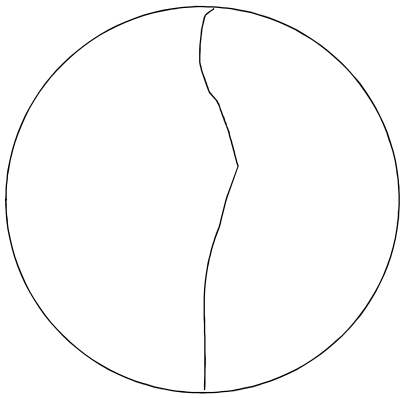
Diameter	100.30 mm
Thickness	51.20 mm
Thickness / Diameter Ratio	0.51
Bulk Density	2.23 Mg/m³
Dry Density	1.99 Mg/m³
Water Content	12.3 %
Specific Gravity (Assumed)	2.72 Mg/m³
Degree of Saturation	91.1 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:35 min:sec
Angle of loading with respect to anisotropy	90 º

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.

LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load
6.90 kN

Tensile Strength
0.855 MPa

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25º) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
42206

GEOLABS

UKAS TESTING 1982

ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	BH02
Sample Ref.:	32
Depth (m):	11.70-11.81

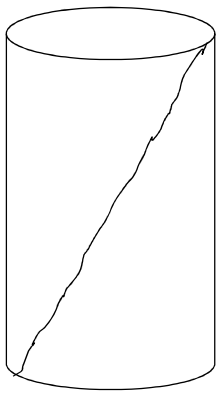
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	53.60 mm
Height	108.30 mm
Bulk Density	2.02 Mg/m³
Dry Density	1.96 Mg/m³
Water Content	3.2 %

Degree of Saturation: 22.7 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



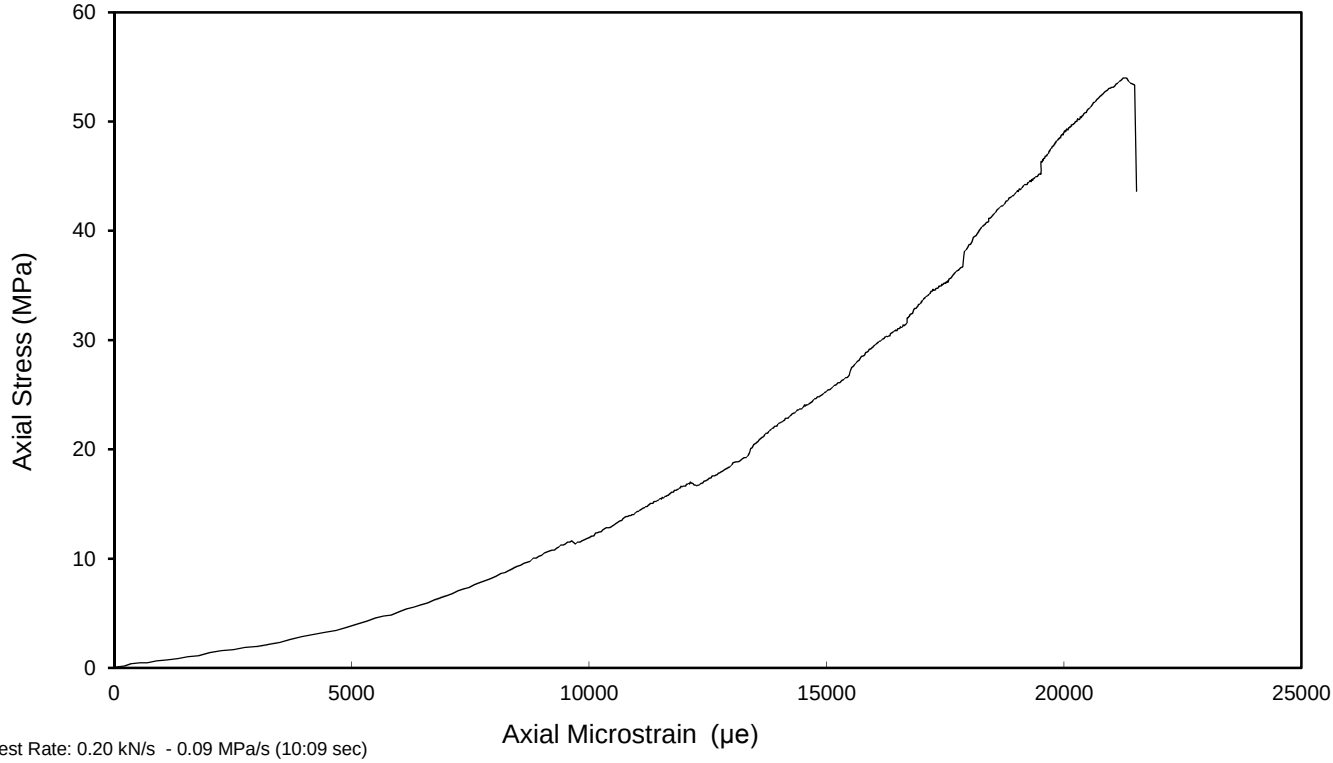
Date tested: 22/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	19.7 MPa
2.00 MPa	26.5 MPa
3.00 MPa	31.3 MPa
4.00 MPa	36.7 MPa
6.00 MPa	45.1 MPa
8.00 MPa	54 MPa



Test Rate: 0.20 kN/s - 0.09 MPa/s (10:09 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

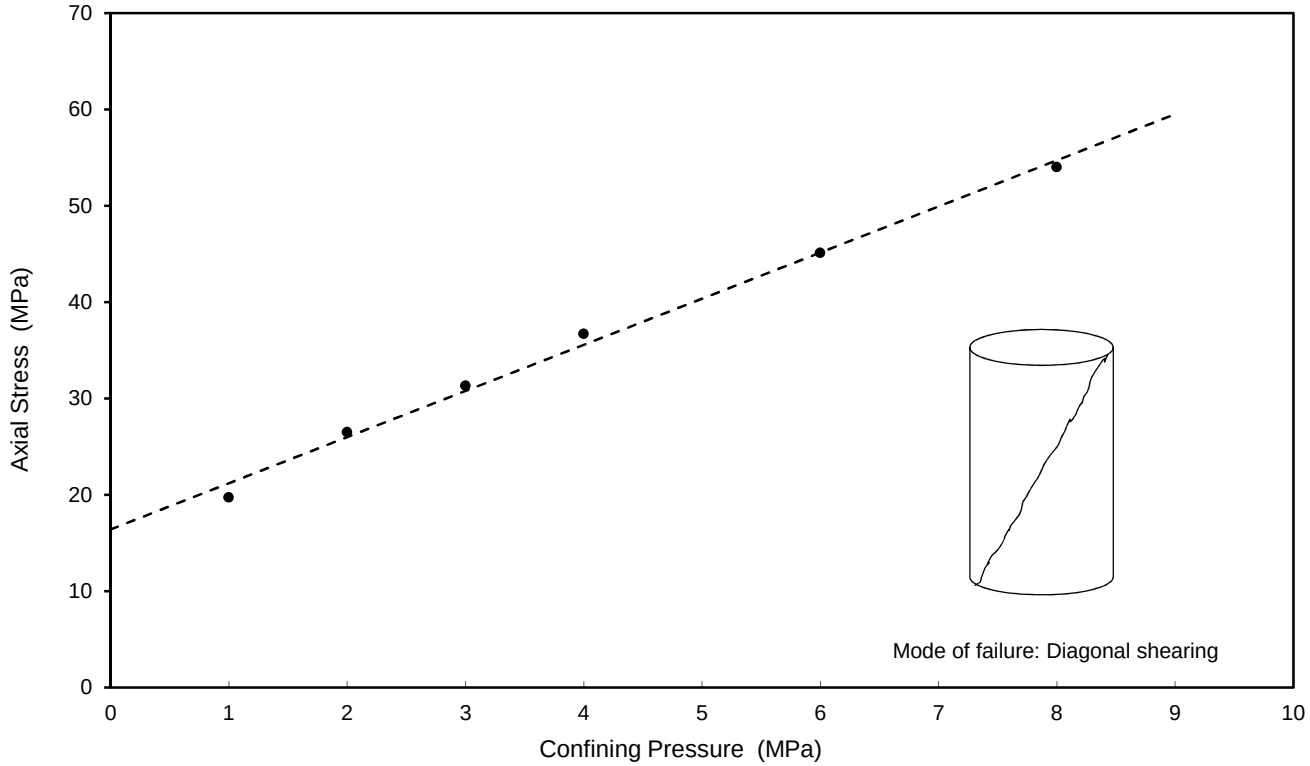
Test Type **Type II - Multiple failure state test** Date Tested: 22-08-18

Borehole Ref.		BH02	BH02	BH02	BH02	BH02	BH02
Sample Ref.		32	32	32	32	32	32
Depth (m)		11.70-11.81	11.70-11.81	11.70-11.81	11.70-11.81	11.70-11.81	11.70-11.81
Diameter	(mm)	53.60	53.60	53.60	53.60	53.60	53.60
Height	(mm)	108.30	108.30	108.30	108.30	108.30	108.30
Bulk Density	(Mg/m³)	2.02	2.02	2.02	2.02	2.02	2.02
Dry Density	(Mg/m³)	1.96	1.96	1.96	1.96	1.96	1.96
Water Content	(%)	3.2	3.2	3.2	3.2	3.2	3.2

Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**19.70**	**26.50**	**31.30**	**36.70**	**45.10**	**54.00**

Gradient of Slope, m **4.788** Internal Friction Angle, φ **40.9 º**

Ordinate of Slope, b **16 MPa** Apparent Cohesion, c **4 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

42206

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	BH03
Sample Ref.:	32
Depth (m):	12.50-12.69

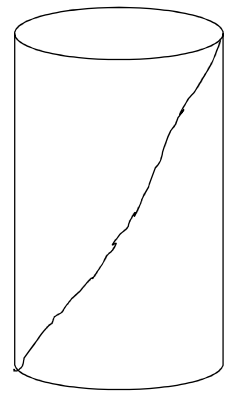
Description:
Medium strong orangish brown fine to medium grained SANDSTONE. Slightly to moderately weathered

LF0879C (1000kN) compression frame used

Diameter	53.60 mm
Height	108.40 mm
Bulk Density	2.19 Mg/m³
Dry Density	2.14 Mg/m³
Water Content	2.7 %

Degree of Saturation: 26.3 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



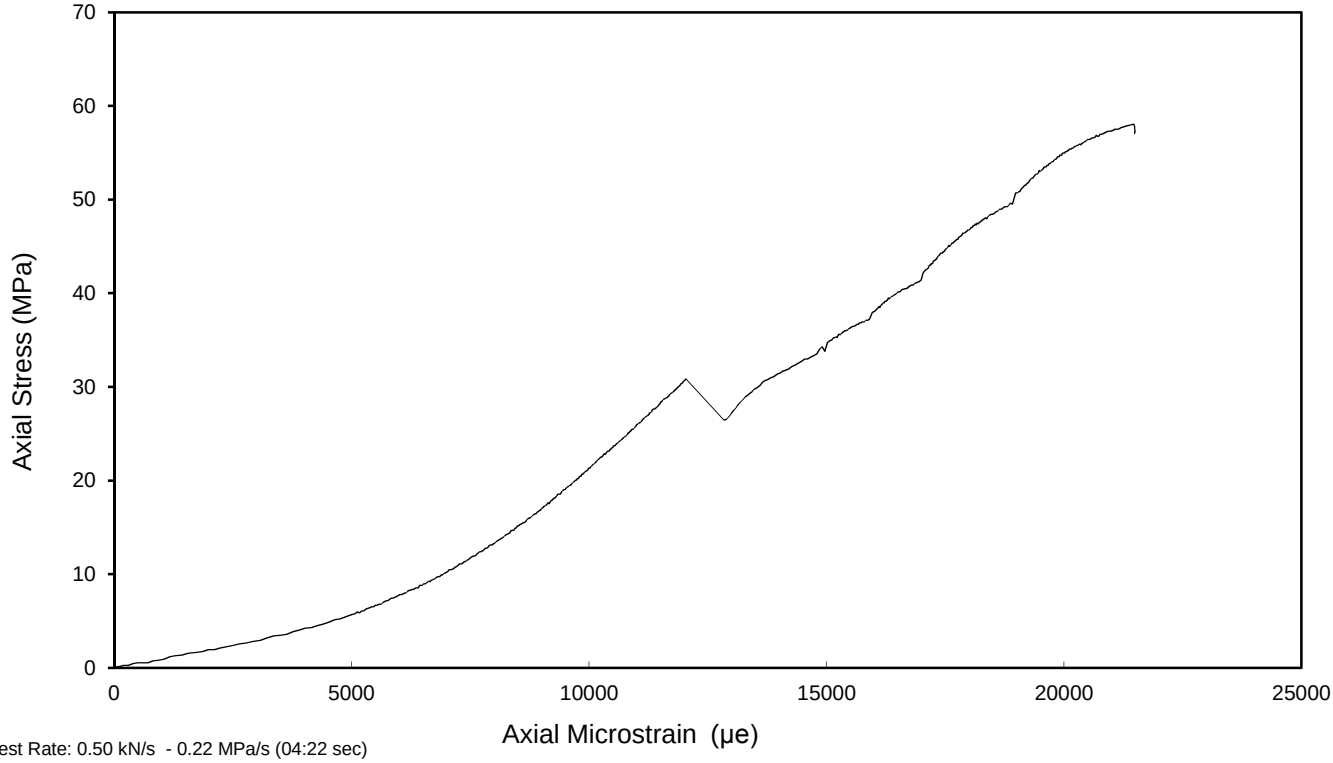
Date tested: 21/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	30.1 MPa
2.00 MPa	33.7 MPa
3.00 MPa	37.1 MPa
4.00 MPa	41.2 MPa
6.00 MPa	49.9 MPa
8.00 MPa	58.1 MPa



Test Rate: 0.50 kN/s - 0.22 MPa/s (04:22 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Slightly to moderately weathered

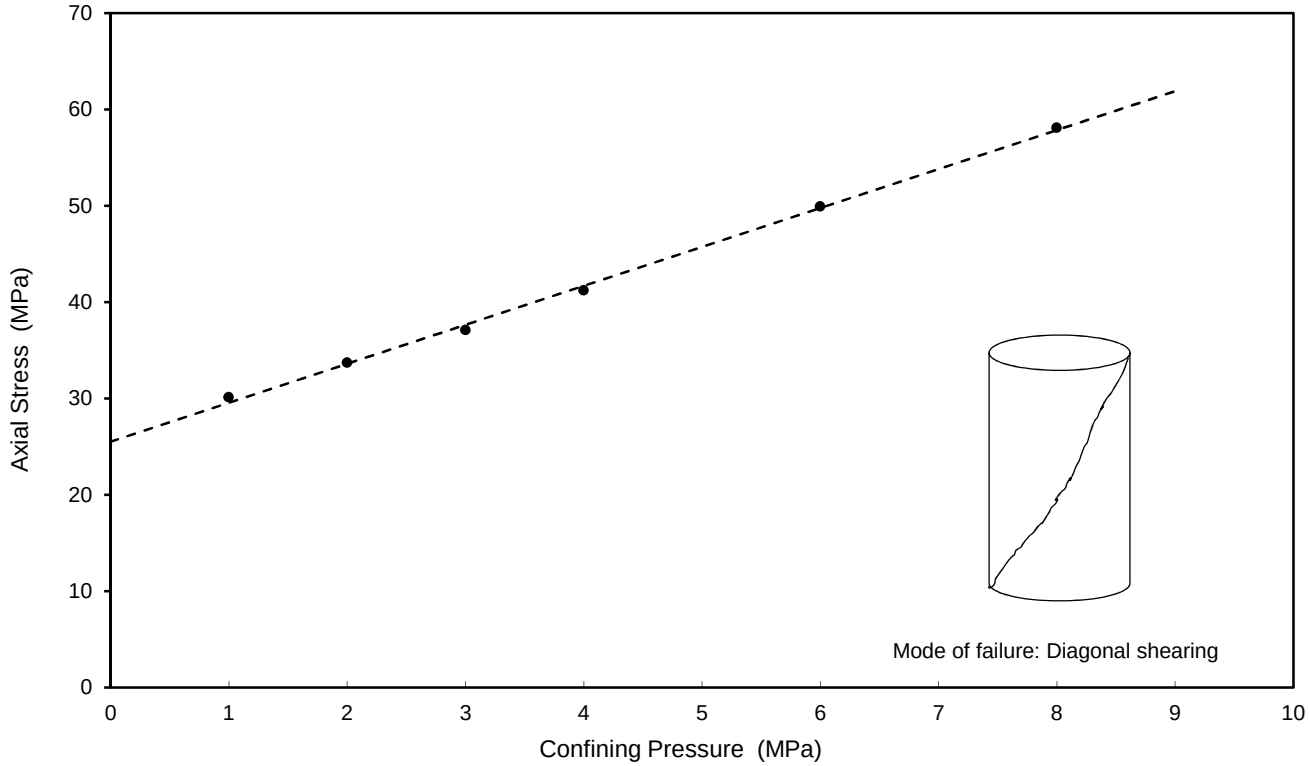
Test Type **Type II - Multiple failure state test** Date Tested: 21-08-18

Borehole Ref.		BH03	BH03	BH03	BH03	BH03	BH03
Sample Ref.		32	32	32	32	32	32
Depth (m)		12.50-12.69	12.50-12.69	12.50-12.69	12.50-12.69	12.50-12.69	12.50-12.69
Diameter	(mm)	53.60	53.60	53.60	53.60	53.60	53.60
Height	(mm)	108.40	108.40	108.40	108.40	108.40	108.40
Bulk Density	(Mg/m³)	2.19	2.19	2.19	2.19	2.19	2.19
Dry Density	(Mg/m³)	2.14	2.14	2.14	2.14	2.14	2.14
Water Content	(%)	2.7	2.7	2.7	2.7	2.7	2.7

Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**30.10**	**33.70**	**37.10**	**41.20**	**49.90**	**58.10**

Gradient of Slope, m **4.041** Internal Friction Angle, φ **37.1 º**

Ordinate of Slope, b **26 MPa** Apparent Cohesion, c **6 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	BH04B
Sample Ref.:	7
Depth (m):	12.03-12.17

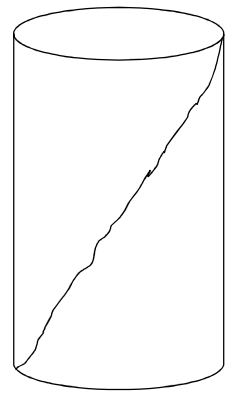
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	54.00 mm
Height	108.20 mm
Bulk Density	2.01 Mg/m³
Dry Density	1.96 Mg/m³
Water Content	2.5 %

Degree of Saturation: 17.6 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



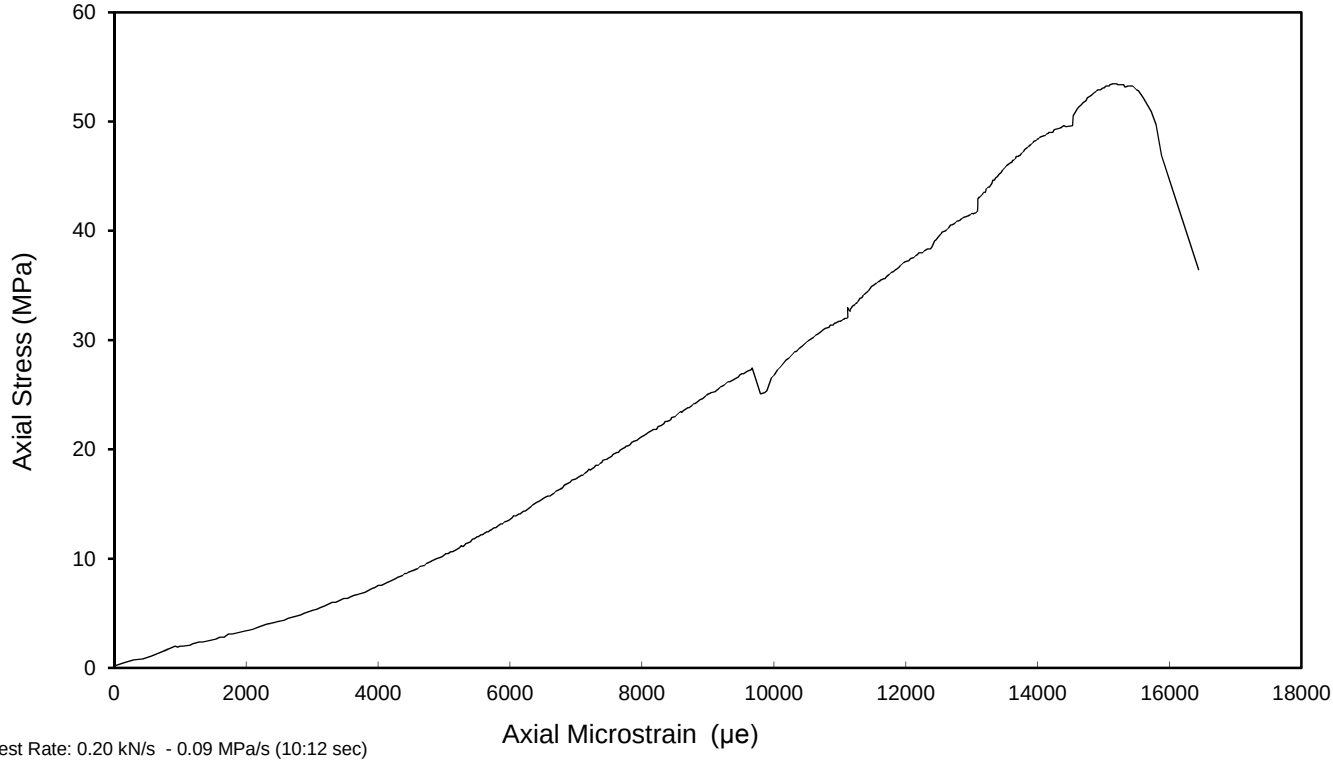
Date tested: 22/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	27.4 MPa
2.00 MPa	32 MPa
3.00 MPa	38.3 MPa
4.00 MPa	41.6 MPa
6.00 MPa	49.5 MPa
8.00 MPa	53.4 MPa



Test Rate: 0.20 kN/s - 0.09 MPa/s (10:12 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type **Type II - Multiple failure state test** Date Tested: 22-08-18

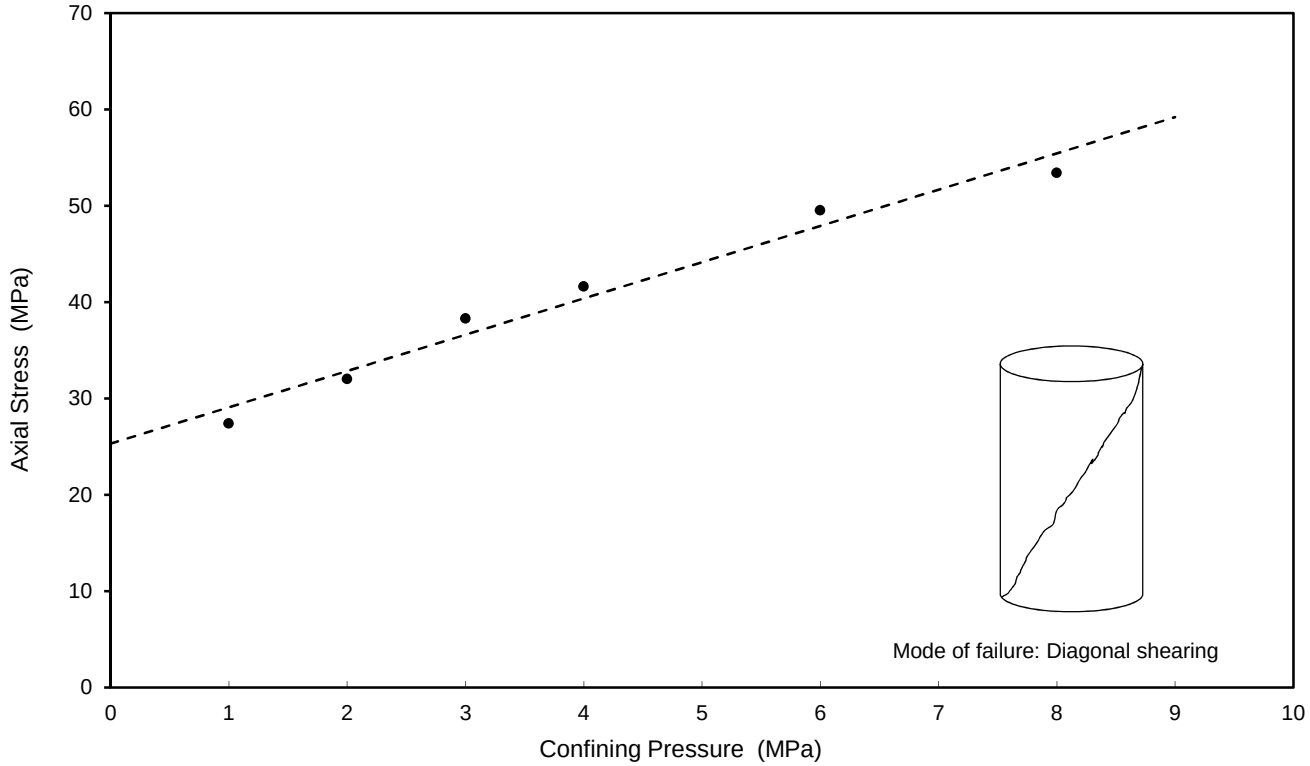
Borehole Ref.		BH04B	BH04B	BH04B	BH04B	BH04B	BH04B
Sample Ref.		7	7	7	7	7	7
Depth (m)		12.03-12.17	12.03-12.17	12.03-12.17	12.03-12.17	12.03-12.17	12.03-12.17
Diameter	(mm)	54.00	54.00	54.00	54.00	54.00	54.00
Height	(mm)	108.20	108.20	108.20	108.20	108.20	108.20
Bulk Density	(Mg/m³)	2.01	2.01	2.01	2.01	2.01	2.01
Dry Density	(Mg/m³)	1.96	1.96	1.96	1.96	1.96	1.96
Water Content	(%)	2.5	2.5	2.5	2.5	2.5	2.5
Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**27.40**	**32.00**	**38.30**	**41.60**	**49.50**	**53.40**

Gradient of Slope, m **3.768**

Ordinate of Slope, b **25 MPa**

Internal Friction Angle, φ **35.5 º**

Apparent Cohesion, c **7 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

42206

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	RBH03
Sample Ref.:	
Depth (m):	11.00-11.20

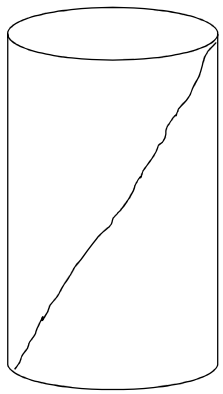
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	53.90 mm
Height	108.10 mm
Bulk Density	1.99 Mg/m³
Dry Density	1.87 Mg/m³
Water Content	6.5 %

Degree of Saturation: 39.2 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



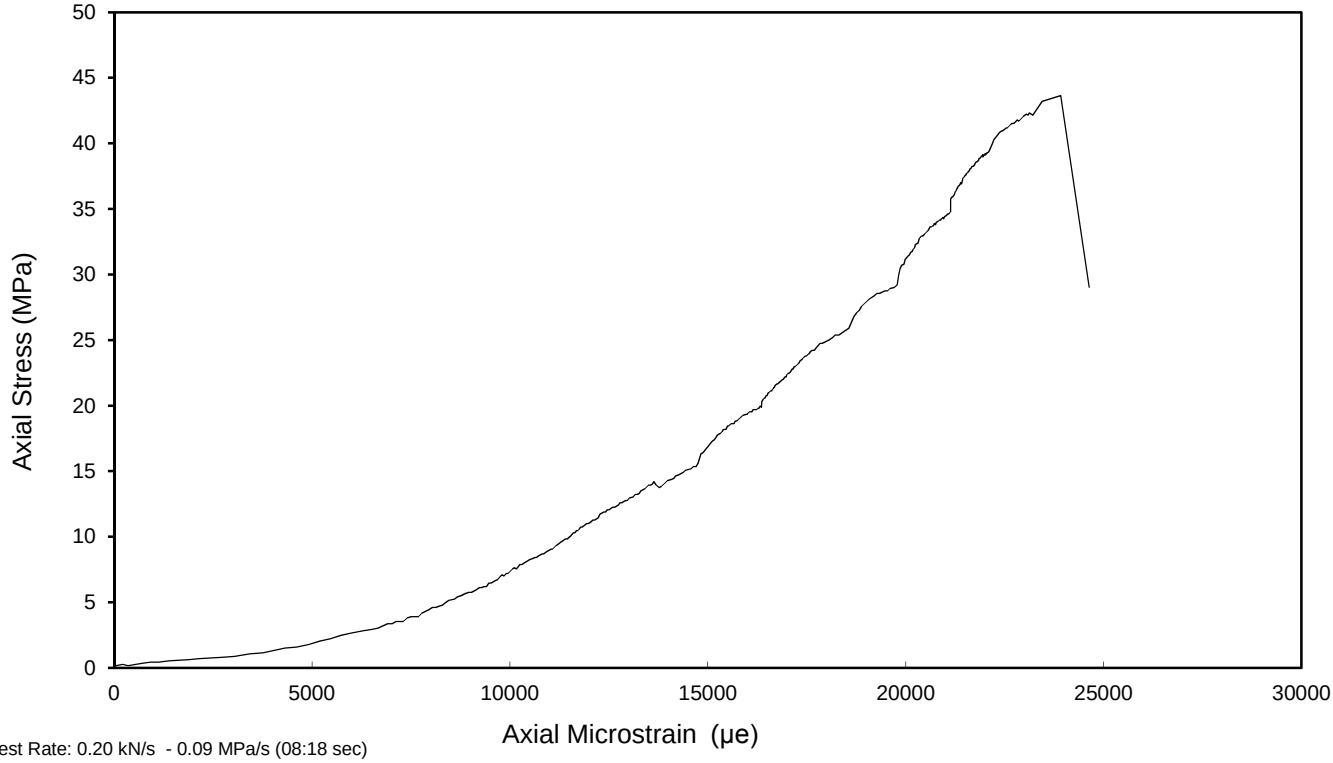
Solid lines for material failures.
Dashed lines for apparent weakness failure.

Date tested: 21/08/2018

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	15.1 MPa
2.00 MPa	19.7 MPa
3.00 MPa	25.4 MPa
4.00 MPa	29.1 MPa
6.00 MPa	34.8 MPa
8.00 MPa	43.7 MPa



Test Rate: 0.20 kN/s - 0.09 MPa/s (08:18 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

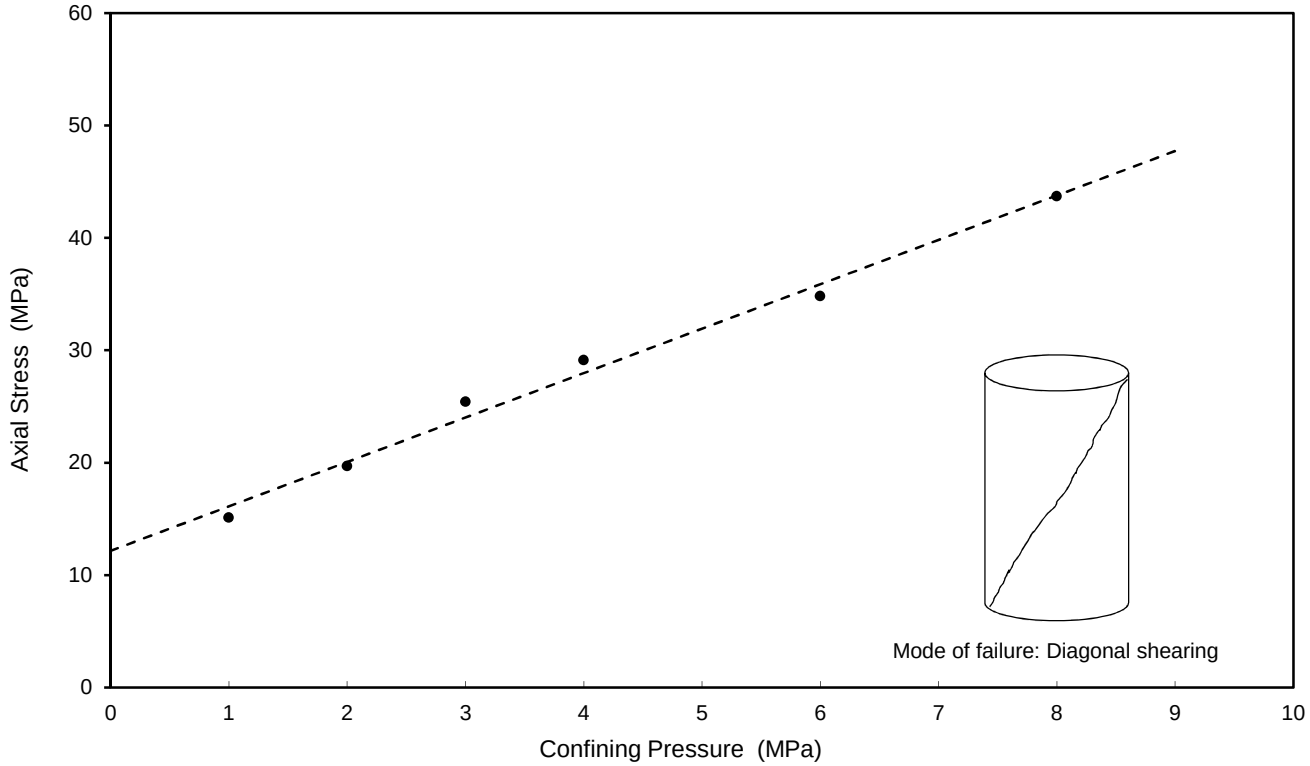
Test Type **Type II - Multiple failure state test** Date Tested: 21-08-18

Borehole Ref.		RBH03	RBH03	RBH03	RBH03	RBH03	RBH03
Sample Ref.							
Depth (m)		11.00-11.20	11.00-11.20	11.00-11.20	11.00-11.20	11.00-11.20	11.00-11.20
Diameter	(mm)	53.90	53.90	53.90	53.90	53.90	53.90
Height	(mm)	108.10	108.10	108.10	108.10	108.10	108.10
Bulk Density	(Mg/m³)	1.99	1.99	1.99	1.99	1.99	1.99
Dry Density	(Mg/m³)	1.87	1.87	1.87	1.87	1.87	1.87
Water Content	(%)	6.5	6.5	6.5	6.5	6.5	6.5

Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**15.10**	**19.70**	**25.40**	**29.10**	**34.80**	**43.70**

Gradient of Slope, m **3.950** Internal Friction Angle, φ **36.6 º**

Ordinate of Slope, b **12 MPa** Apparent Cohesion, c **3 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

42206

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	RBH04
Sample Ref.:	
Depth (m):	16.29-16.50

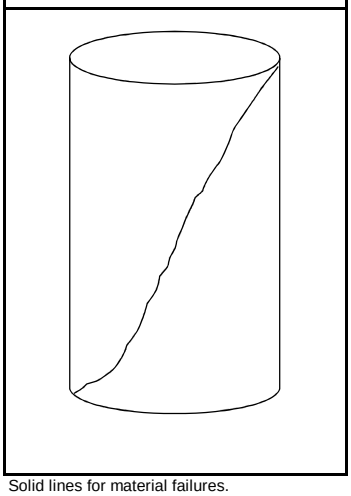
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	53.80 mm
Height	107.88 mm
Bulk Density	2.05 Mg/m³
Dry Density	1.90 Mg/m³
Water Content	7.9 %

Degree of Saturation: 49.8 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



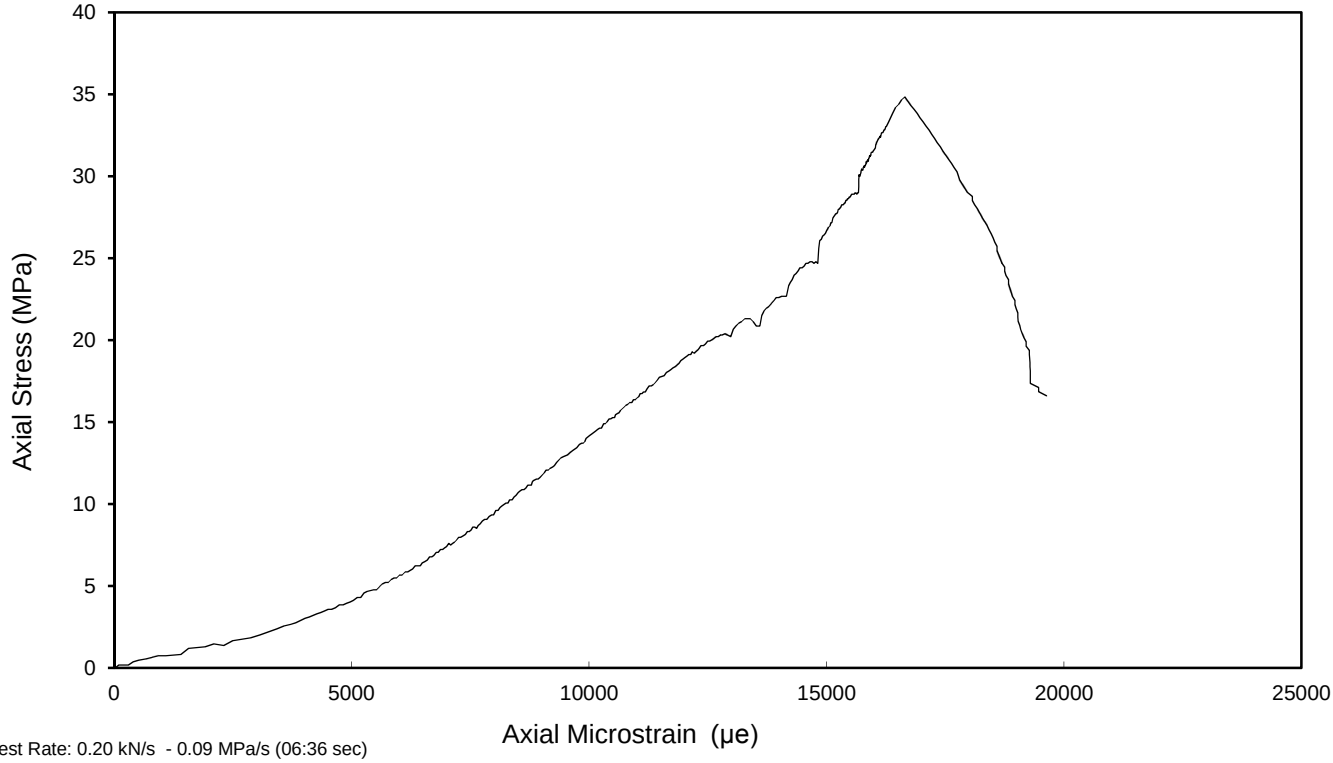
Date tested: 21/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	20.4 MPa
2.00 MPa	21.4 MPa
3.00 MPa	22.7 MPa
4.00 MPa	24.8 MPa
6.00 MPa	29.1 MPa
8.00 MPa	34.8 MPa



Test Rate: 0.20 kN/s - 0.09 MPa/s (06:36 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type **Type II - Multiple failure state test** Date Tested: 21-08-18

Borehole Ref.		RBH04	RBH04	RBH04	RBH04	RBH04	RBH04
Sample Ref.							
Depth (m)		16.29-16.50	16.29-16.50	16.29-16.50	16.29-16.50	16.29-16.50	16.29-16.50
Diameter	(mm)	53.80	53.80	53.80	53.80	53.80	53.80
Height	(mm)	107.88	107.88	107.88	107.88	107.88	107.88
Bulk Density	(Mg/m³)	2.05	2.05	2.05	2.05	2.05	2.05
Dry Density	(Mg/m³)	1.90	1.90	1.90	1.90	1.90	1.90
Water Content	(%)	7.9	7.9	7.9	7.9	7.9	7.9

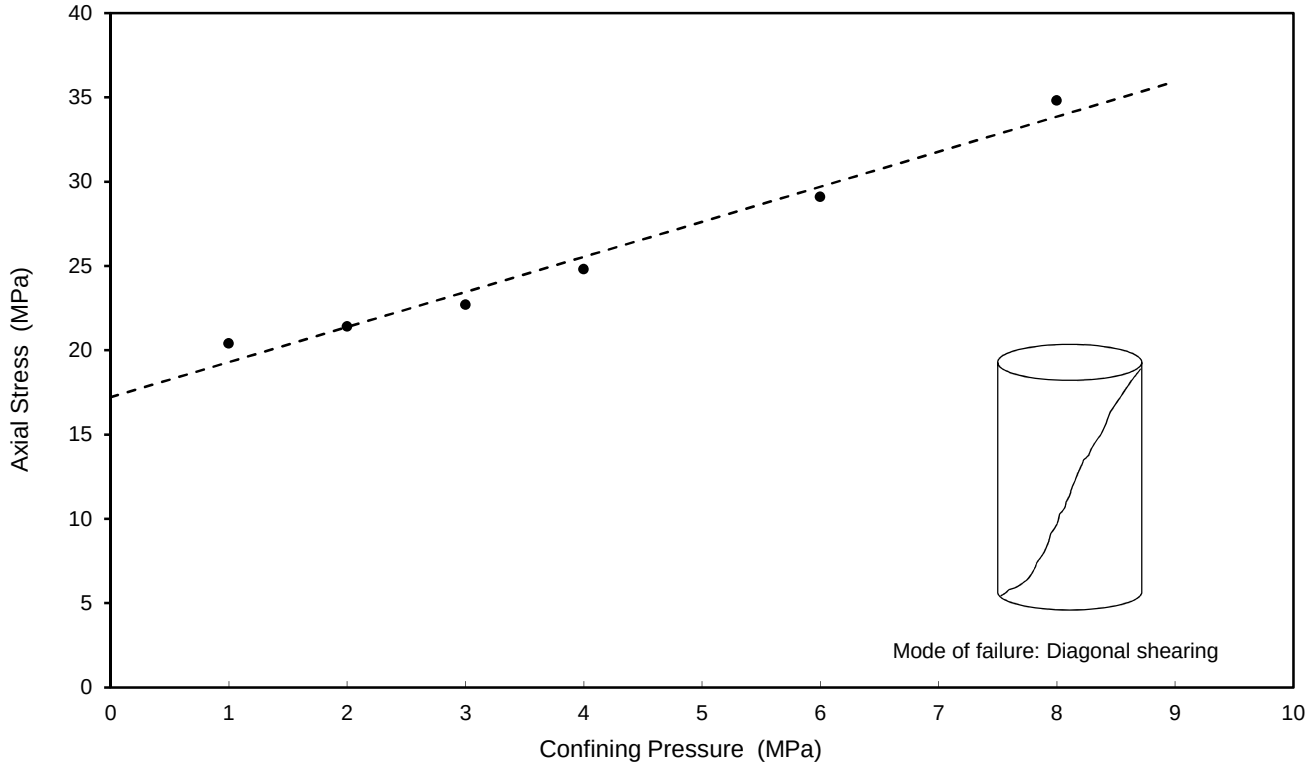
Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**20.40**	**21.40**	**22.70**	**24.80**	**29.10**	**34.80**

Gradient of Slope, m **2.079**

Ordinate of Slope, b **17 MPa**

Internal Friction Angle, φ **20.5 º**

Apparent Cohesion, c **6 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	RBH05
Sample Ref.:	27
Depth (m):	15.91-16.00

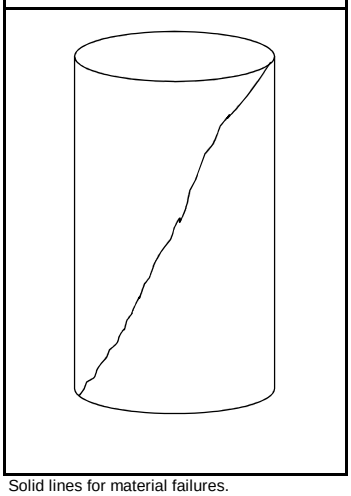
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	37.80 mm
Height	79.70 mm
Bulk Density	2.01 Mg/m³
Dry Density	1.92 Mg/m³
Water Content	4.9 %

Degree of Saturation: 31.6 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



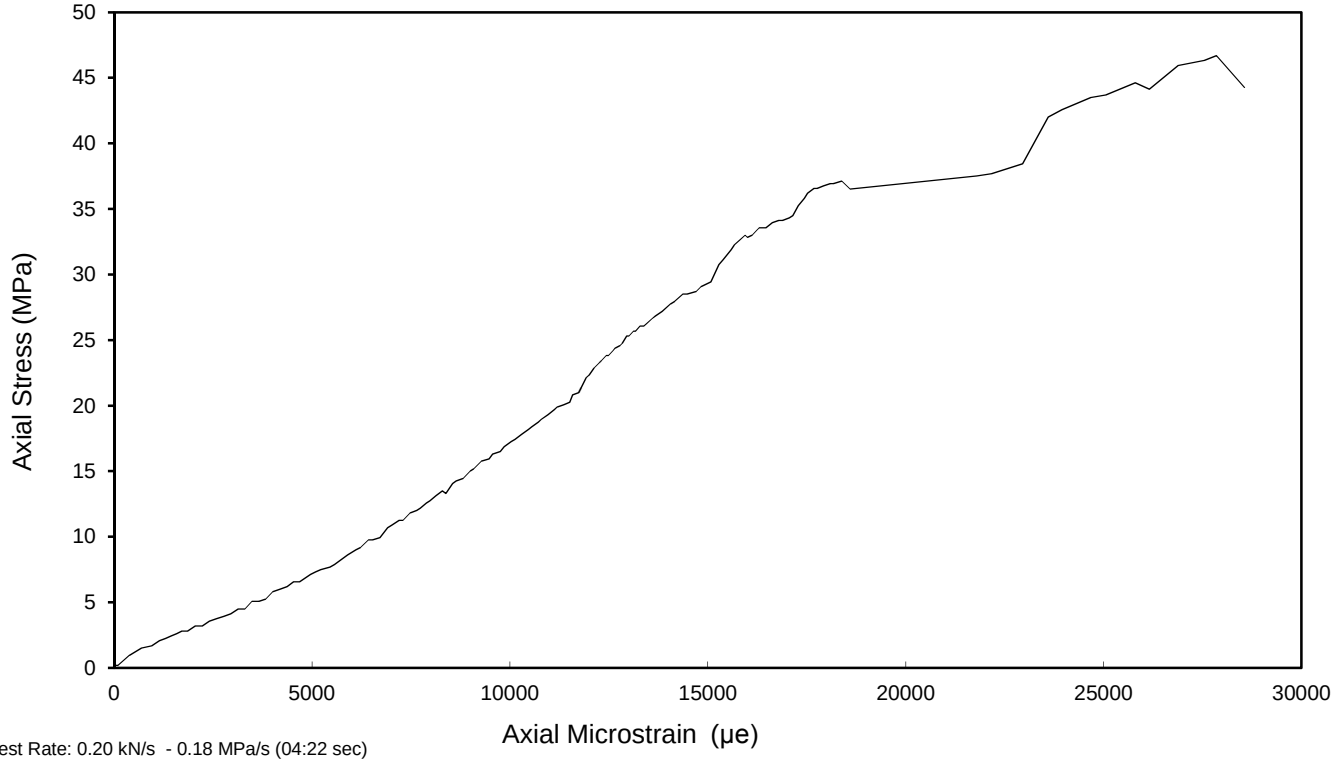
Date tested: 21/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	20.1 MPa
2.00 MPa	28.5 MPa
3.00 MPa	34.3 MPa
4.00 MPa	36.9 MPa
6.00 MPa	44.6 MPa
8.00 MPa	46.7 MPa



Test Rate: 0.20 kN/s - 0.18 MPa/s (04:22 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type **Type II - Multiple failure state test** Date Tested: 21-08-18

Borehole Ref.		RBH05	RBH05	RBH05	RBH05	RBH05	RBH05
Sample Ref.		27	27	27	27	27	27
Depth (m)		15.91-16.00	15.91-16.00	15.91-16.00	15.91-16.00	15.91-16.00	15.91-16.00
Diameter	(mm)	37.80	37.80	37.80	37.80	37.80	37.80
Height	(mm)	79.70	79.70	79.70	79.70	79.70	79.70
Bulk Density	(Mg/m³)	2.01	2.01	2.01	2.01	2.01	2.01
Dry Density	(Mg/m³)	1.92	1.92	1.92	1.92	1.92	1.92
Water Content	(%)	4.9	4.9	4.9	4.9	4.9	4.9

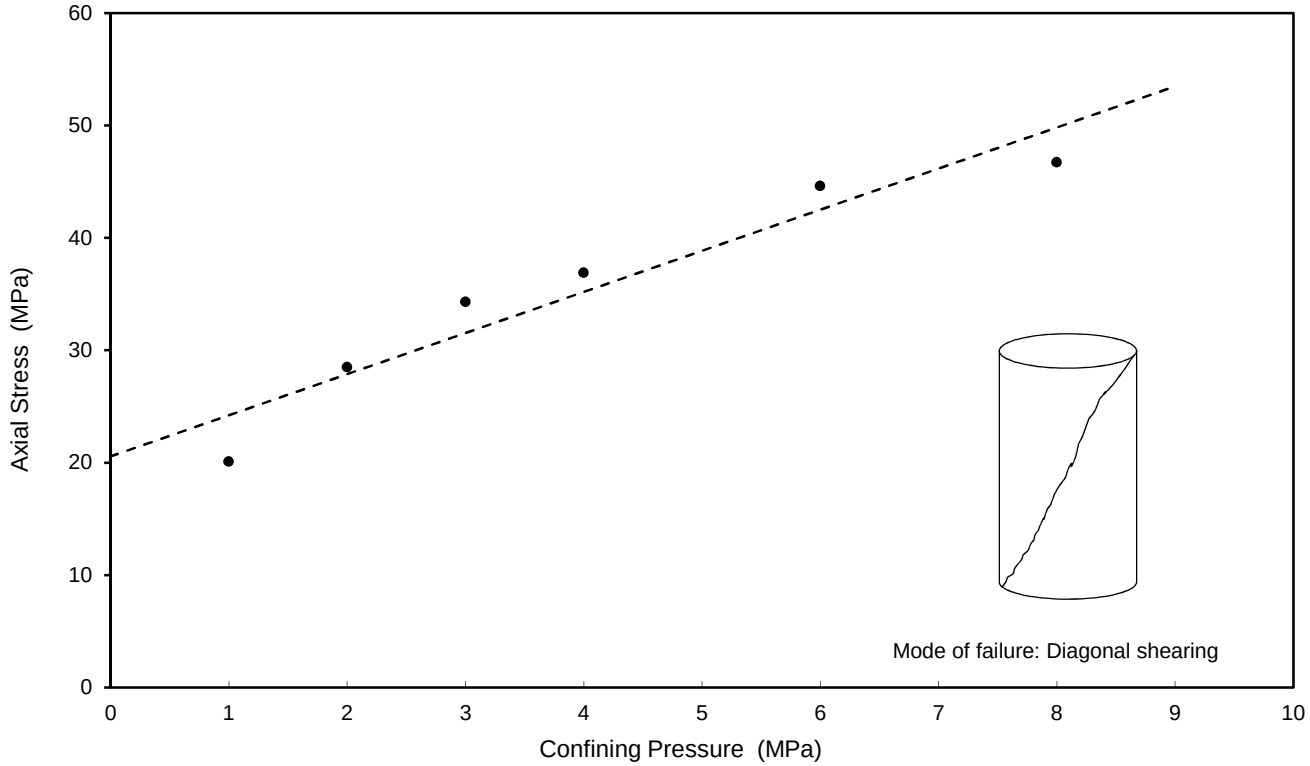
Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**20.10**	**28.50**	**34.30**	**36.90**	**44.60**	**46.70**

Gradient of Slope, m **3.659**

Ordinate of Slope, b **21 MPa**

Internal Friction Angle, φ **34.8 º**

Apparent Cohesion, c **5 MPa**



Checked and Approved by

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C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

42206

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	RBH05
Sample Ref.:	36
Depth (m):	21.80-21.86

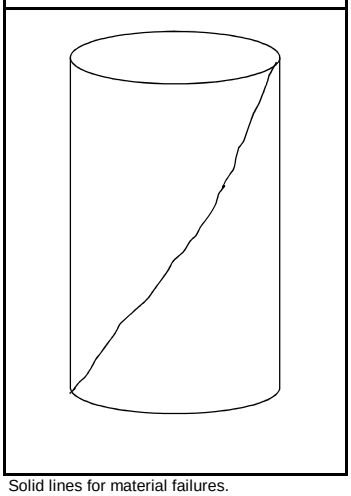
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	37.80 mm
Height	76.10 mm
Bulk Density	1.96 Mg/m³
Dry Density	1.87 Mg/m³
Water Content	4.8 %

Degree of Saturation: 29.1 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



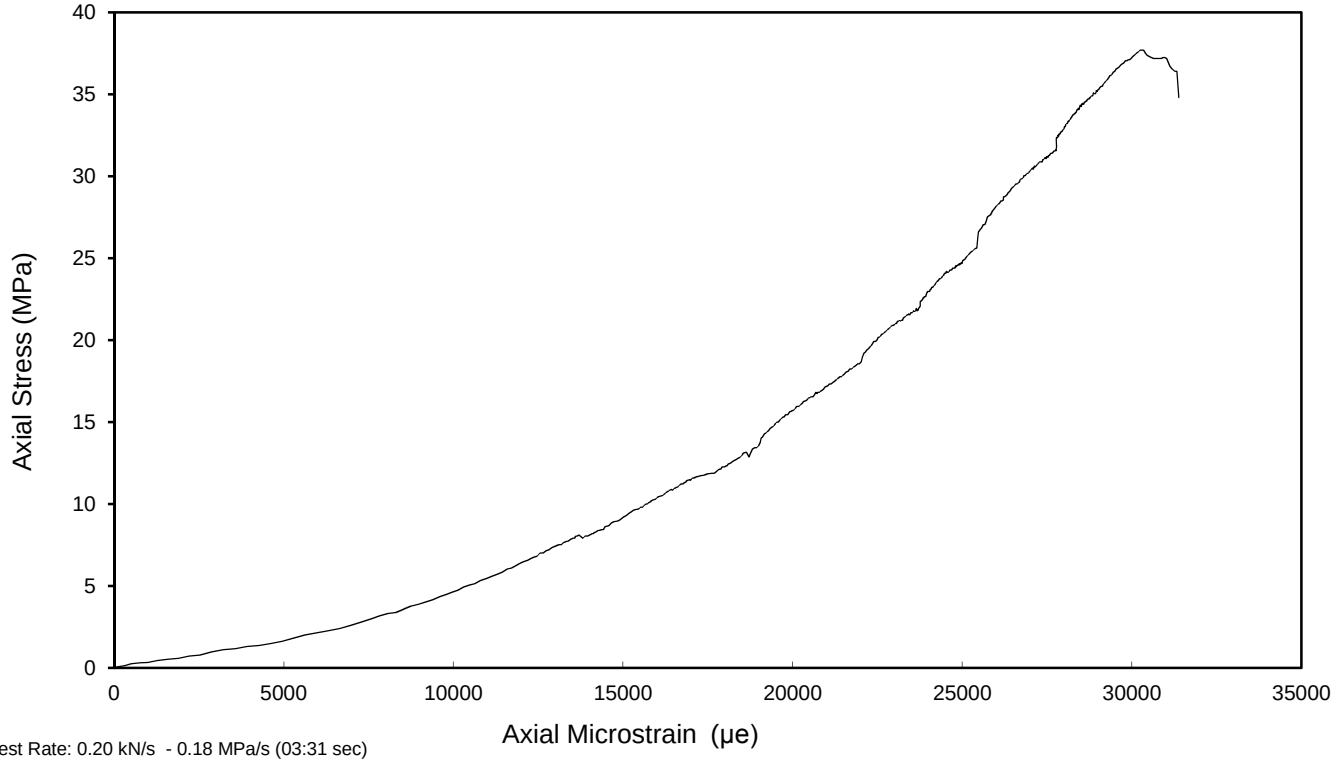
Date tested: 21/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	**C**

Results

Confining Pressure	Axial Strength
1.00 MPa	13.2 MPa
2.00 MPa	18.6 MPa
3.00 MPa	22 MPa
4.00 MPa	25.6 MPa
6.00 MPa	31.6 MPa
8.00 MPa	37.7 MPa



Test Rate: 0.20 kN/s - 0.18 MPa/s (03:31 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type **Type II - Multiple failure state test** Date Tested: 21-08-18

Borehole Ref.		RBH05	RBH05	RBH05	RBH05	RBH05	RBH05
Sample Ref.		36	36	36	36	36	36
Depth (m)		21.80-21.86	21.80-21.86	21.80-21.86	21.80-21.86	21.80-21.86	21.80-21.86
Diameter	(mm)	37.80	37.80	37.80	37.80	37.80	37.80
Height	(mm)	76.10	76.10	76.10	76.10	76.10	76.10
Bulk Density	(Mg/m³)	1.96	1.96	1.96	1.96	1.96	1.96
Dry Density	(Mg/m³)	1.87	1.87	1.87	1.87	1.87	1.87
Water Content	(%)	4.8	4.8	4.8	4.8	4.8	4.8

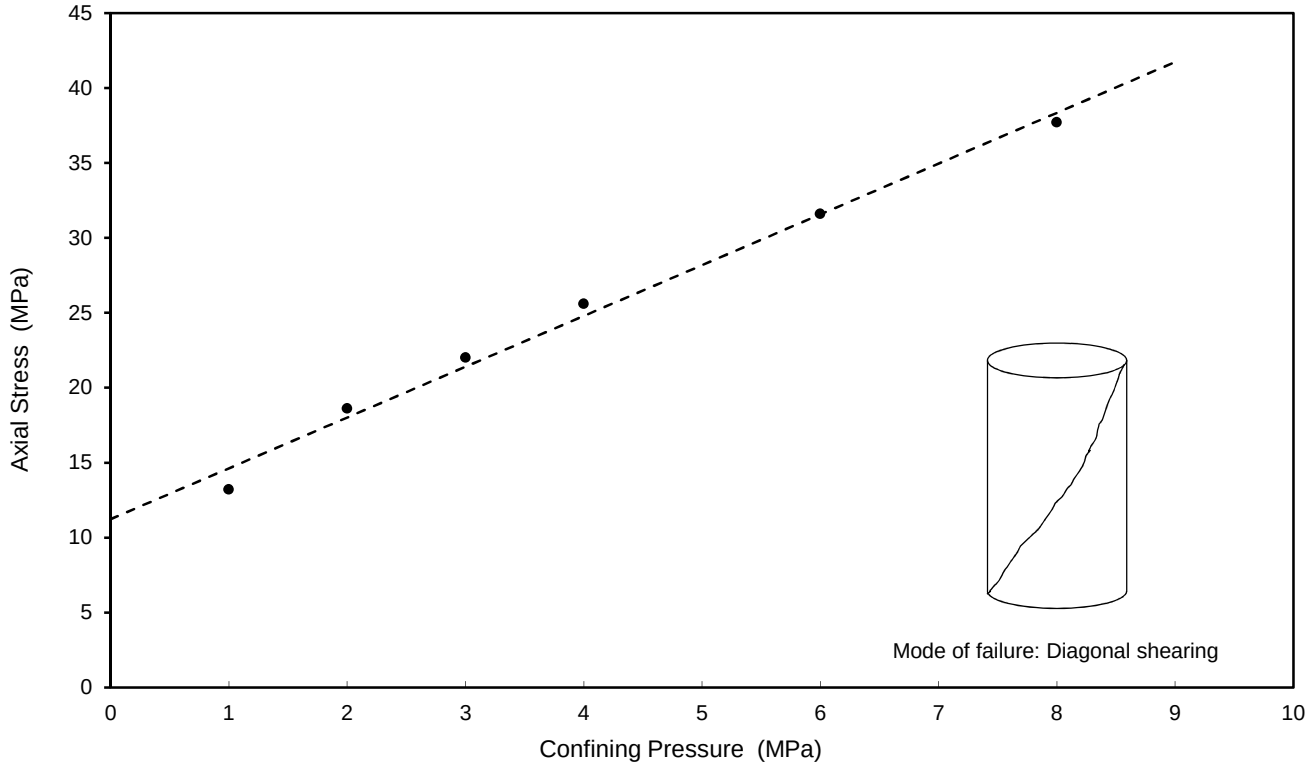
Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**13.20**	**18.60**	**22.00**	**25.60**	**31.60**	**37.70**

Gradient of Slope, m **3.388**

Ordinate of Slope, b **11 MPa**

Internal Friction Angle, φ **33.0 º**

Apparent Cohesion, c **3 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

42206

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ISRM - Suggested Methods : Part 2 : Received 1983

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.:	RBH06
Sample Ref.:	26
Depth (m):	18.16

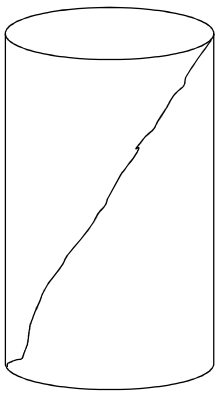
Description:
Medium strong orangish brown fine to medium grained SANDSTONE.
Moderately weathered

LF0879C (1000kN) compression frame used

Diameter	37.60 mm
Height	76.10 mm
Bulk Density	1.96 Mg/m³
Dry Density	1.88 Mg/m³
Water Content	4.4 %

Degree of Saturation: 26.9 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch



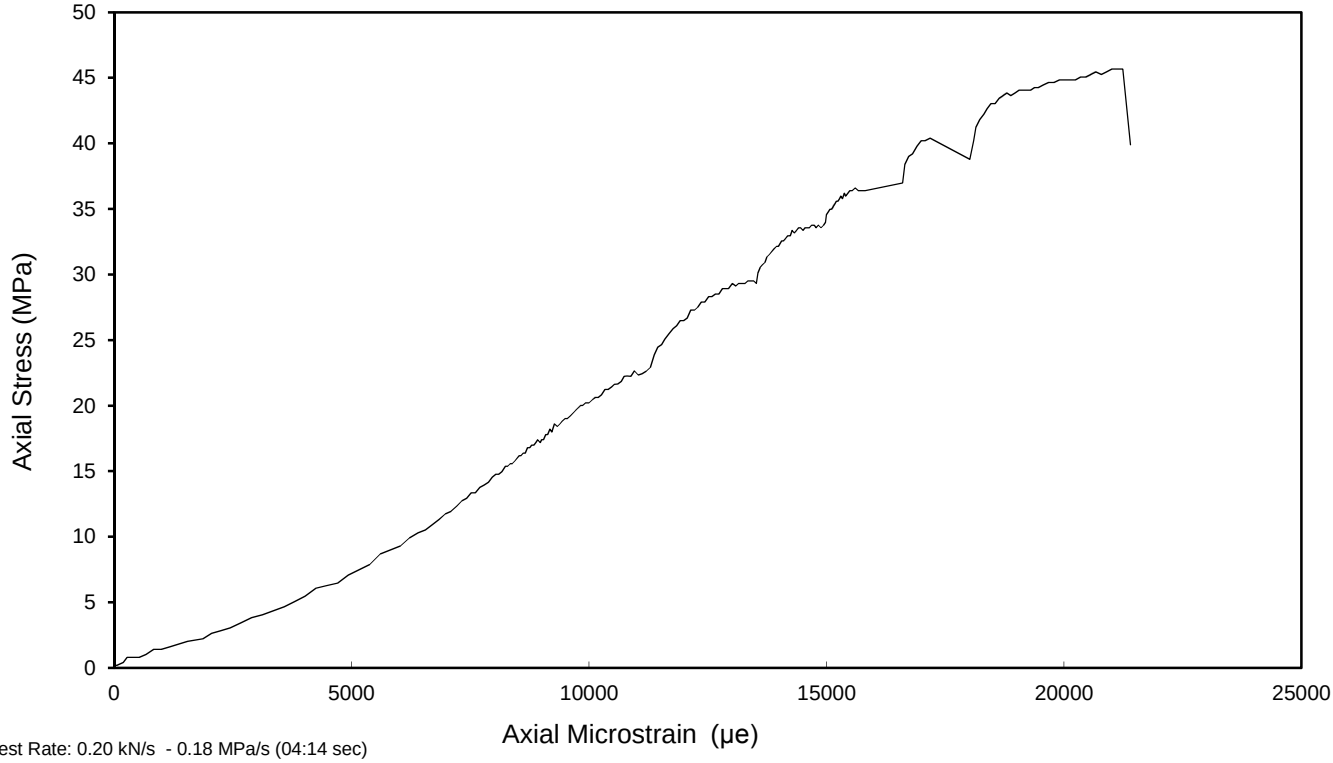
Date tested: 22/08/2018

Solid lines for material failures.
Dashed lines for apparent weakness failure.

Sample type	C

Results

Confining Pressure	Axial Strength
1.00 MPa	22.6 MPa
2.00 MPa	29.5 MPa
3.00 MPa	33.7 MPa
4.00 MPa	36.4 MPa
6.00 MPa	40.4 MPa
8.00 MPa	45.7 MPa



Test Rate: 0.20 kN/s - 0.18 MPa/s (04:14 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

GEOLABS®

ISRM - Suggested Methods : Part 2 : Received 2007

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

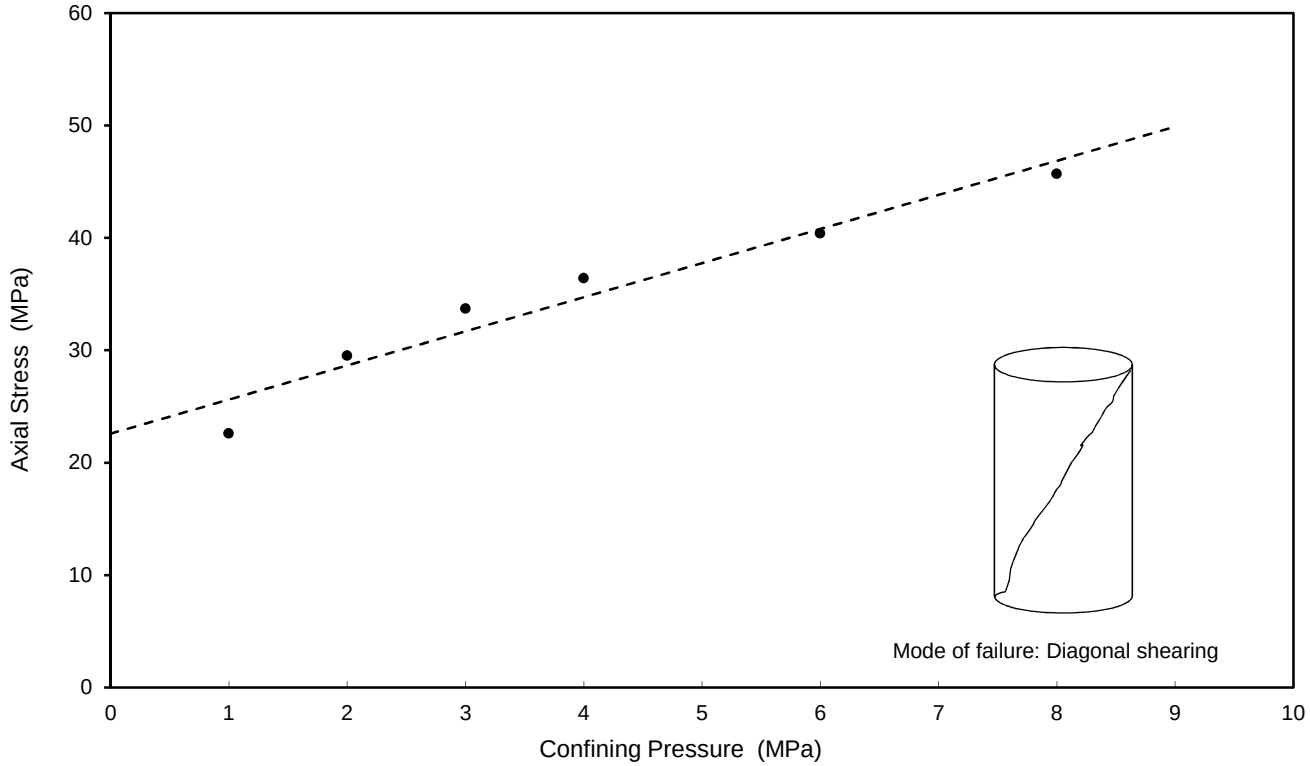
Test Type **Type II - Multiple failure state test** Date Tested: 22-08-18

Borehole Ref.		RBH06	RBH06	RBH06	RBH06	RBH06	RBH06
Sample Ref.		26	26	26	26	26	26
Depth (m)		18.16	18.16	18.16	18.16	18.16	18.16
Diameter	(mm)	37.60	37.60	37.60	37.60	37.60	37.60
Height	(mm)	76.10	76.10	76.10	76.10	76.10	76.10
Bulk Density	(Mg/m³)	1.96	1.96	1.96	1.96	1.96	1.96
Dry Density	(Mg/m³)	1.88	1.88	1.88	1.88	1.88	1.88
Water Content	(%)	4.4	4.4	4.4	4.4	4.4	4.4

Confining Pressure	(MPa)	**1.00**	**2.00**	**3.00**	**4.00**	**6.00**	**8.00**
Axial Strength	(MPa)	**22.60**	**29.50**	**33.70**	**36.40**	**40.40**	**45.70**

Gradient of Slope, m **3.032** Internal Friction Angle, φ **30.3 º**

Ordinate of Slope, b **23 MPa** Apparent Cohesion, c **6 MPa**



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN

42206

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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	BH02
Sample No:	C39
Depth (m):	10.68

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to medium gravel.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	93.2
Maximum Width	*mm*	55.2
Area	*mm²*	4612.0

Shearing Stage

Normal stress	*kPa*	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	352.8	538.9	1207.2
Horizontal displacement at MSS	*mm*	6.3	11.6	21.7
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	322.5	477.3	1113.8
Final cumulative displacement	*mm*	38.9		

Duration	*day(s)*	1

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**124**
Angle of Shearing Resistance	*degrees*	**23.5**
Residual Condition:		
Apparent Cohesion	*kPa*	**102**
Angle of Shearing Resistance	*degrees*	**22.0**

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 07/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

GEOLABS

ISRM Suggested Method

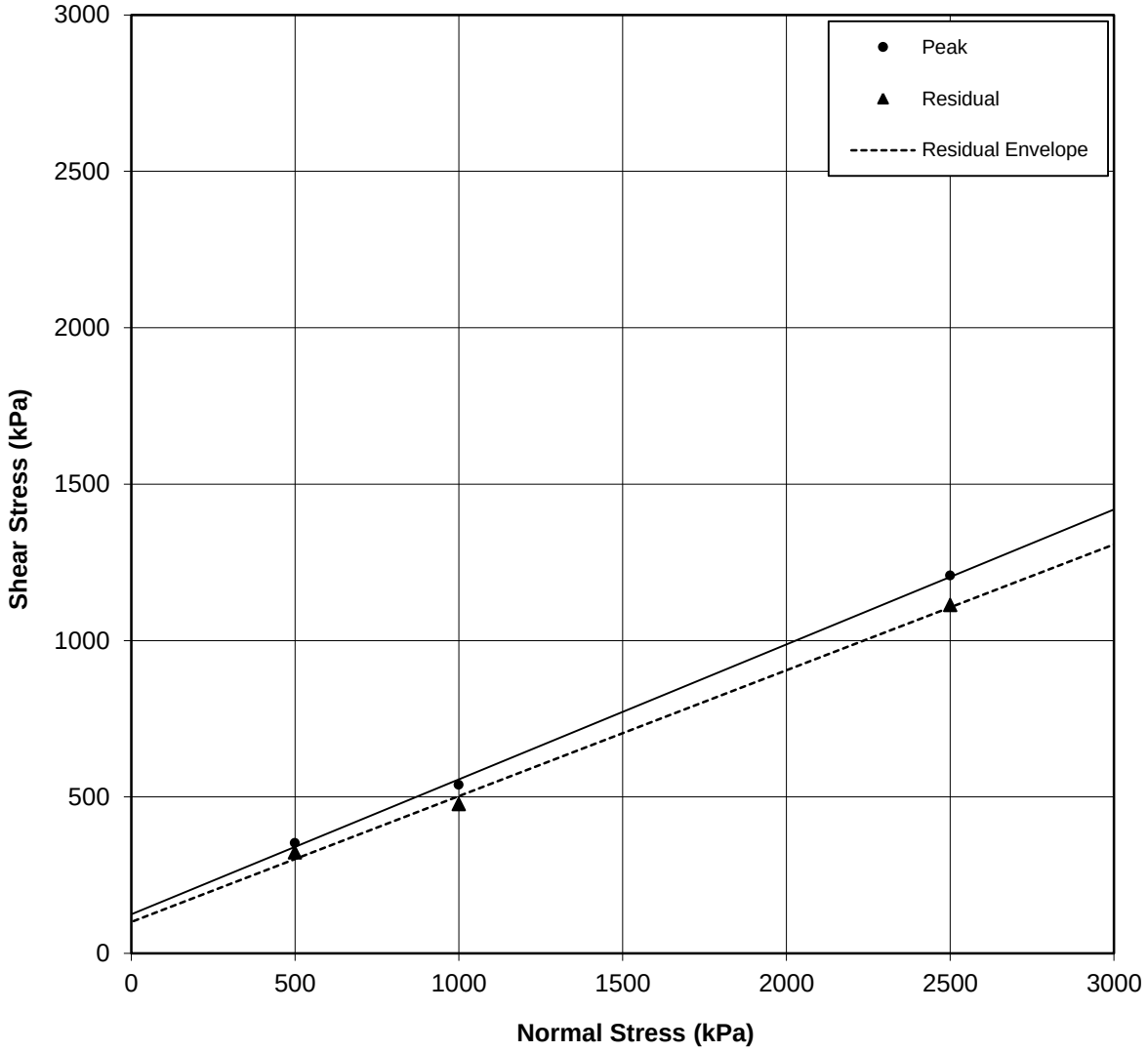
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	BH02
Sample No:	C39
Depth (m):	10.68

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to medium gravel.

Shear Stress v Normal Stress



Peak: c' = 124 Φ' = 23.5 °

Residual: c' = 102 Φ' = 22 °

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 07/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

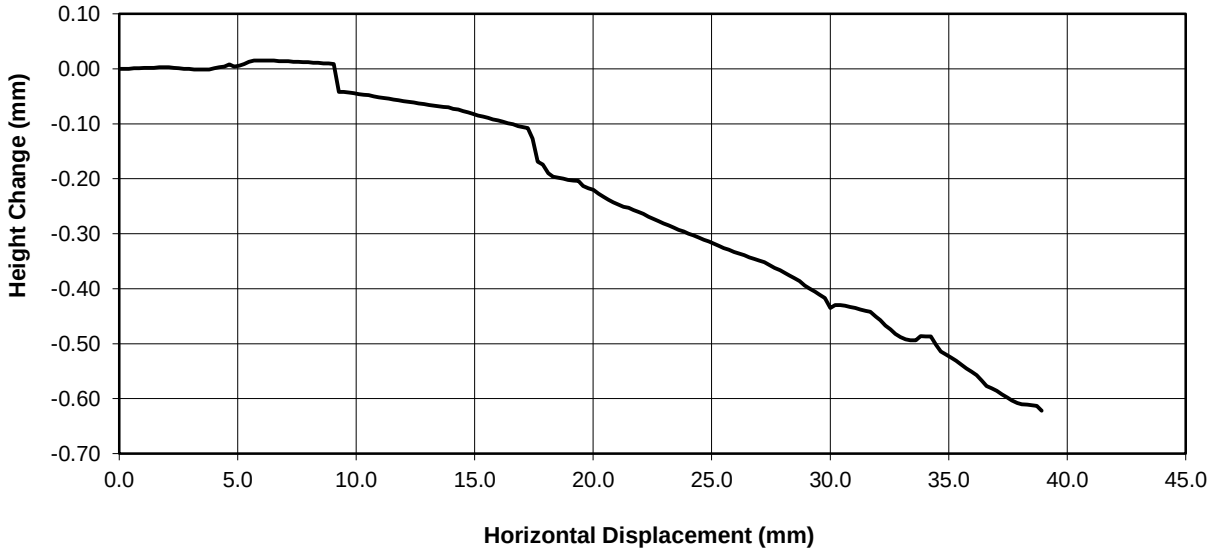
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

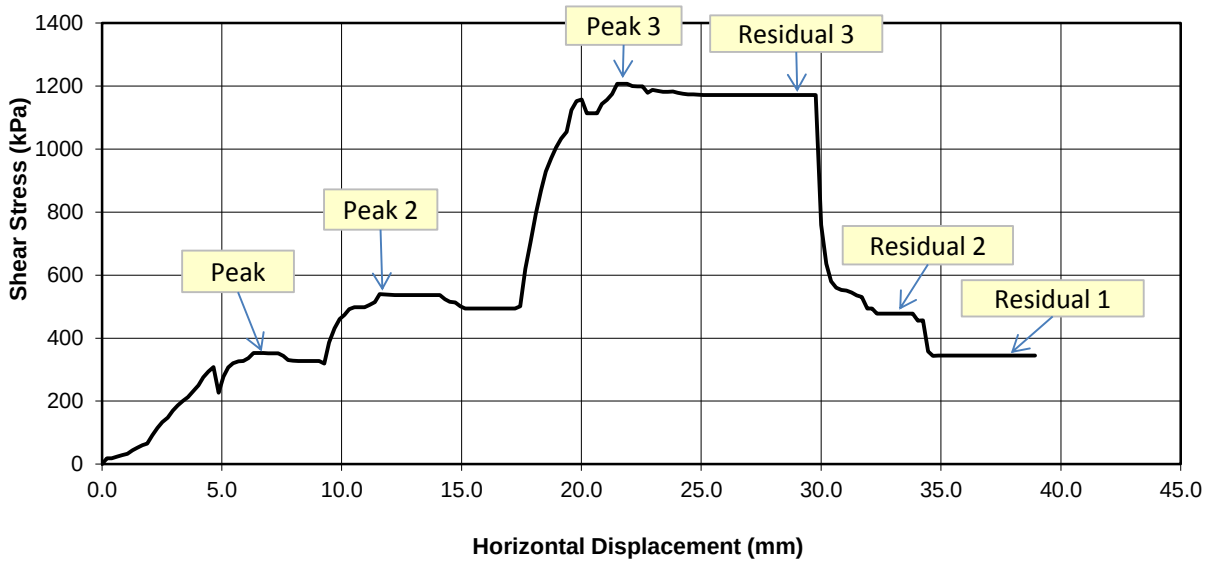
Borehole No:	BH02
Sample No:	C39
Depth (m):	10.68

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to medium gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by SRA S R Allen (Senior Tech) Date: 07/09/2018	Project Number: **GEO / 27859** Project Name: **St John's Masterplan** **Project Ref: 42206**	GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	BH03
Sample No:	C31
Depth (m):	11.53

Description:

Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material. Joint roughness coefficient = 10-12. Debris is fine to coarse sub-angular gravel and sand.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	52.9
Maximum Width	*mm*	48.8
Area	*mm²*	2122.7

Shearing Stage

Normal stress	*kPa*	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	705.2	1022.1	1747.3
Horizontal displacement at MSS	*mm*	4.7	6.0	9.7
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	445.1	608.2	911.0
Final cumulative displacement	*mm*	21.2		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**475**
Angle of Shearing Resistance	*degrees*	**27.0**
Residual Condition:		
Apparent Cohesion	*kPa*	**354**
Angle of Shearing Resistance	*degrees*	**12.5**

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan

Project Ref: 42206

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

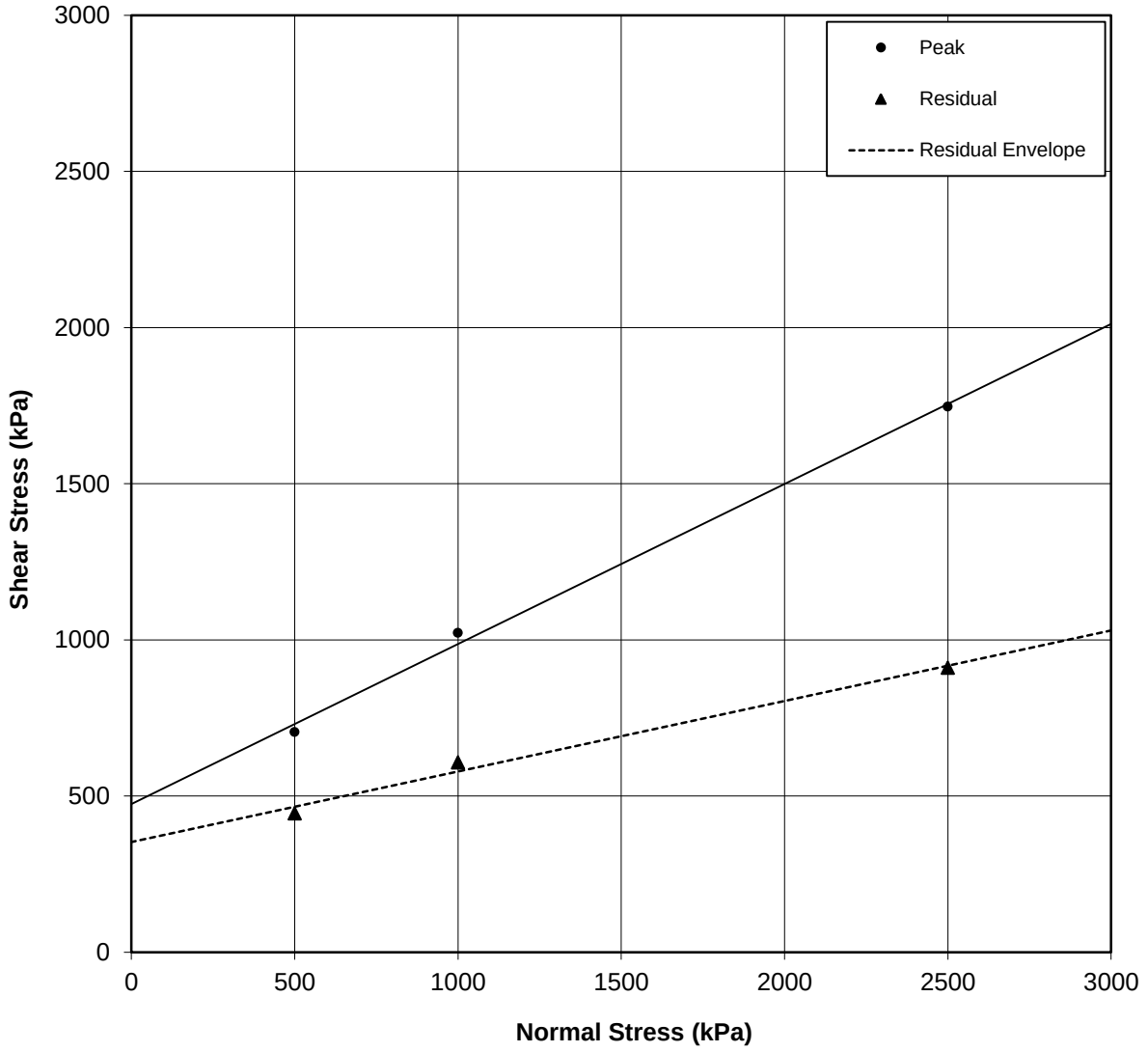
(large shearbox apparatus)

Borehole No:	BH03
Sample No:	C31
Depth (m):	11.53

Description:

Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material. Joint roughness coefficient = 10-12. Debris is fine to coarse sub-angular gravel and sand.

Shear Stress v Normal Stress



Peak: c' = 475 Φ' = 27 °

Residual: c' = 354 Φ' = 12.5 °

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan

Project Ref: 42206

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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

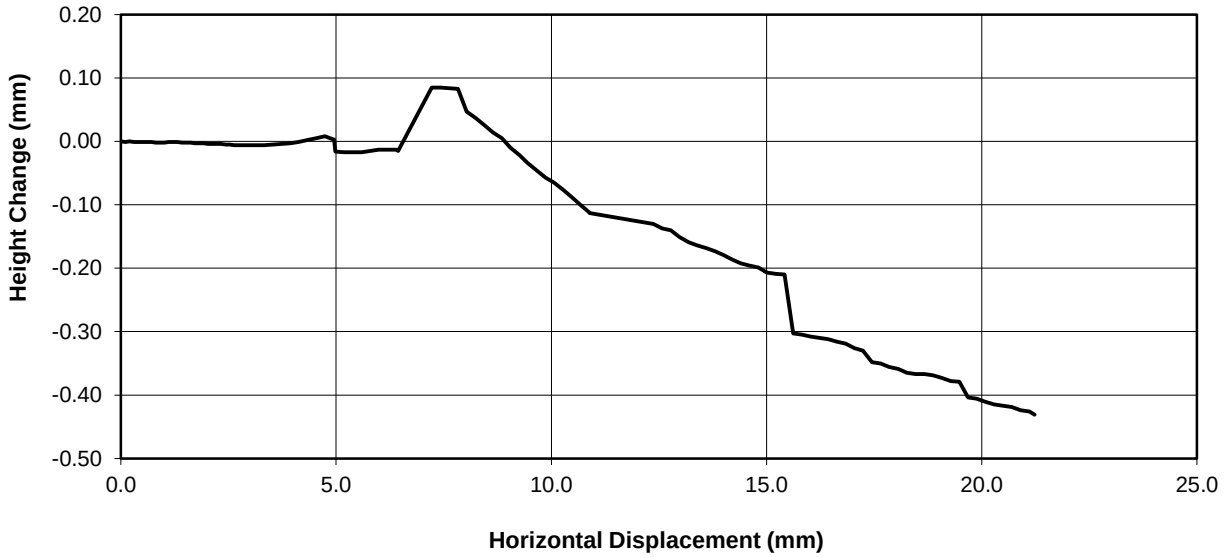
(large shearbox apparatus)

Borehole No:	BH03
Sample No:	C31
Depth (m):	11.53

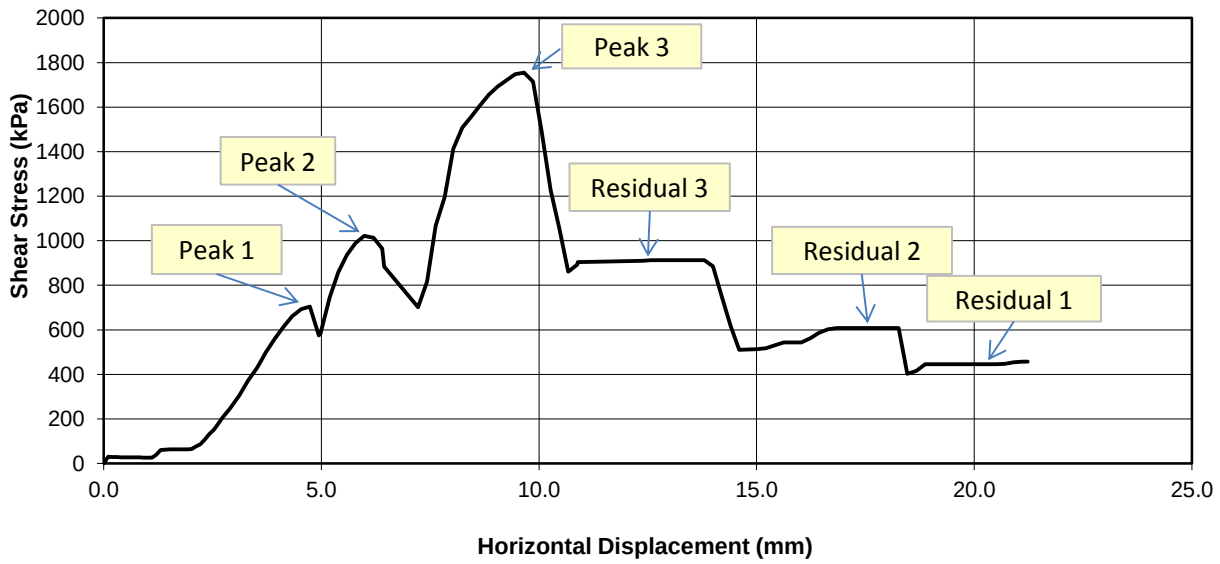
Description:

Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material. Joint roughness coefficient = 10-12. Debris is fine to coarse sub-angular gravel and sand.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by SRA S R Allen (Senior Tech) Date: 29/08/2018	Project Number: **GEO / 27859** Project Name: **St John's Masterplan** **Project Ref: 42206**	GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	BH04B
Sample No:	C13
Depth (m):	14.50

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is negligible.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	52.0
Maximum Width	*mm*	51.7
Area	*mm²*	2137.4

Shearing Stage

Normal stress	*kPa*	100	200	500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	118.0	215.6	515.0
Horizontal displacement at MSS	*mm*	1.5	4.1	11.9
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	95.0	171.6	428.6
Final cumulative displacement	*mm*	30.7		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**18**
Angle of Shearing Resistance	*degrees*	**45.0**
Residual Condition:		
Apparent Cohesion	*kPa*	**8**
Angle of Shearing Resistance	*degrees*	**40.0**

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 03/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

GEOLABS

ISRM Suggested Method

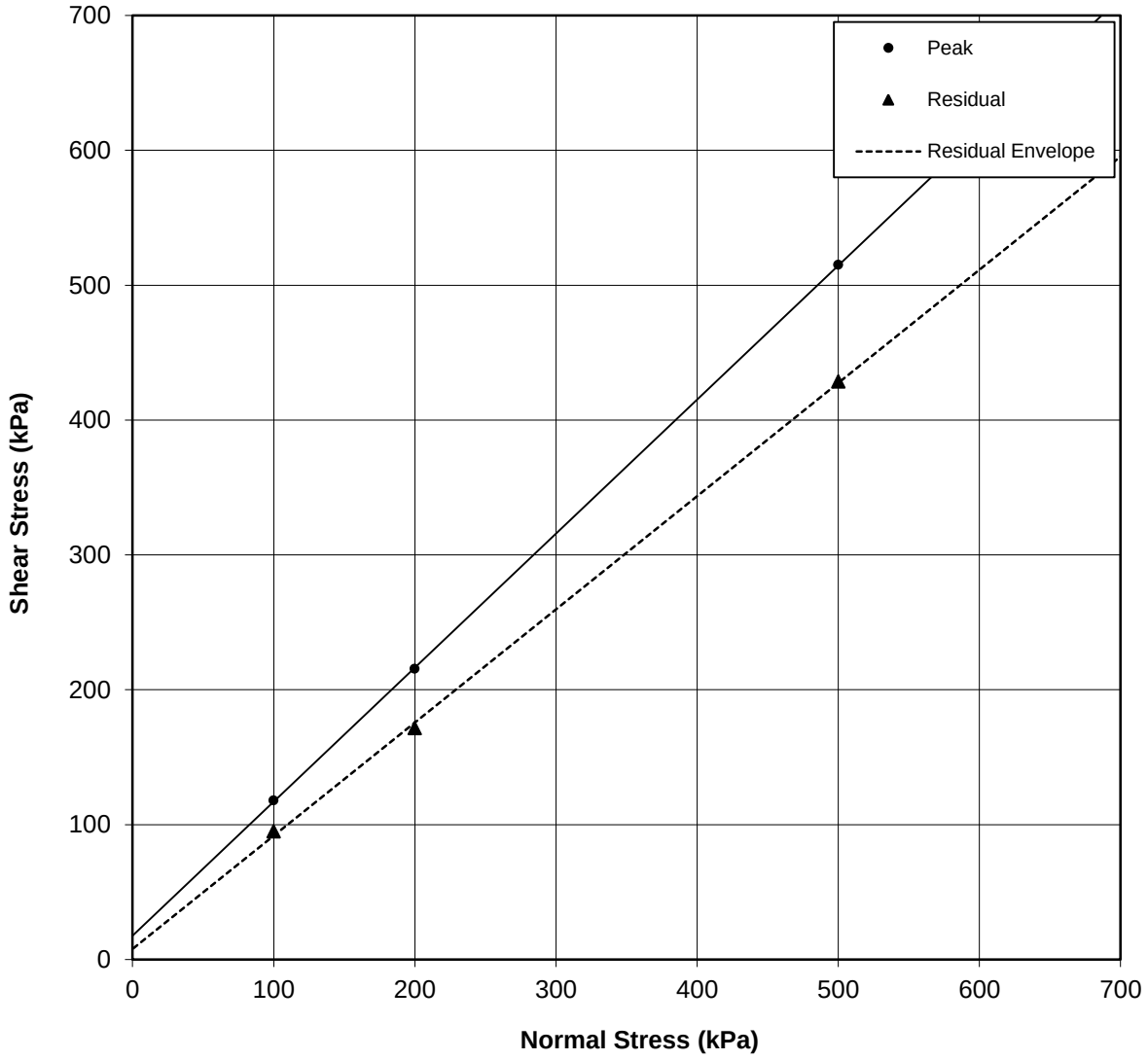
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	BH04B
Sample No:	C13
Depth (m):	14.50

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is negligible.

Shear Stress v Normal Stress



Peak: c' = 18 Φ' = 45 °

Residual: c' = 8 Φ' = 40 °

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 03/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

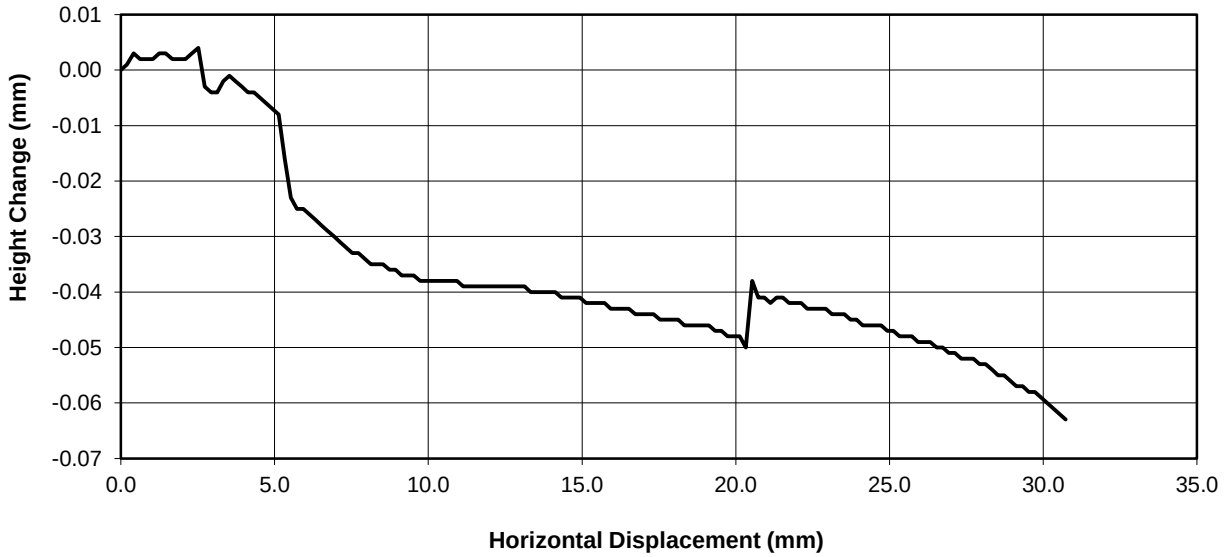
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

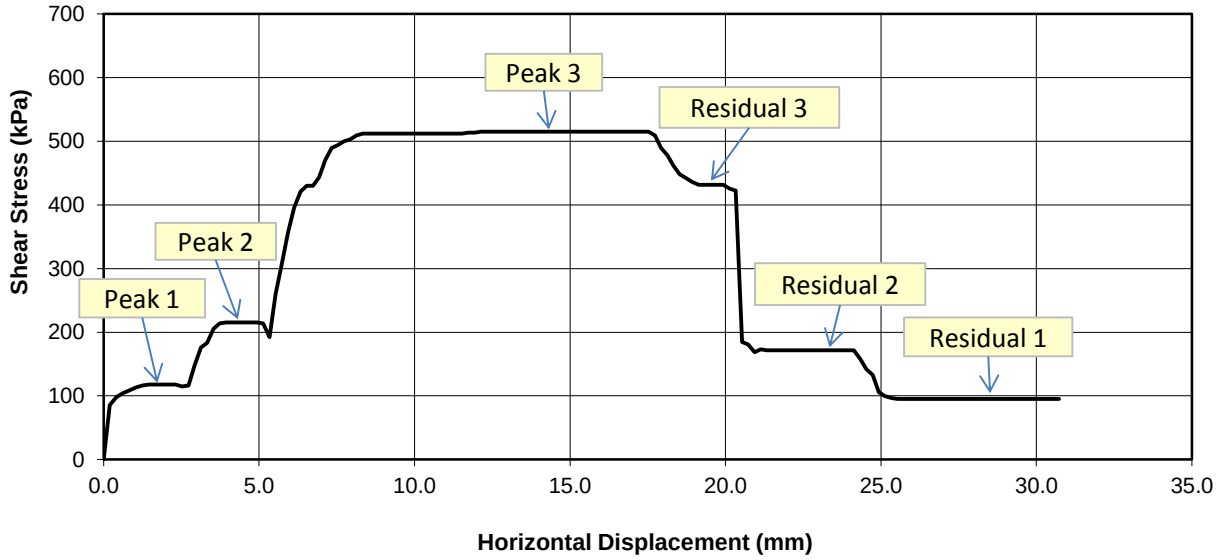
Borehole No:	BH04B
Sample No:	C13
Depth (m):	14.50

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is negligible.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

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S R Allen (Senior Tech)

Date: 03/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH02
Depth (m):	12.80

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is abundant sand and fine to coarse gravel.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	51.2
Maximum Width	*mm*	38.6
Area	*mm²*	1606.1

Shearing Stage

Normal stress	*kPa*	100	200	500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	110.1	186.9	425.5
Horizontal displacement at MSS	*mm*	2.0	8.1	12.4
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	77.5	140.7	314.0
Final cumulative displacement	*mm*	29.5		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**30**
Angle of Shearing Resistance	*degrees*	**38.5**
Residual Condition:		
Apparent Cohesion	*kPa*	**21**
Angle of Shearing Resistance	*degrees*	**30.5**

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

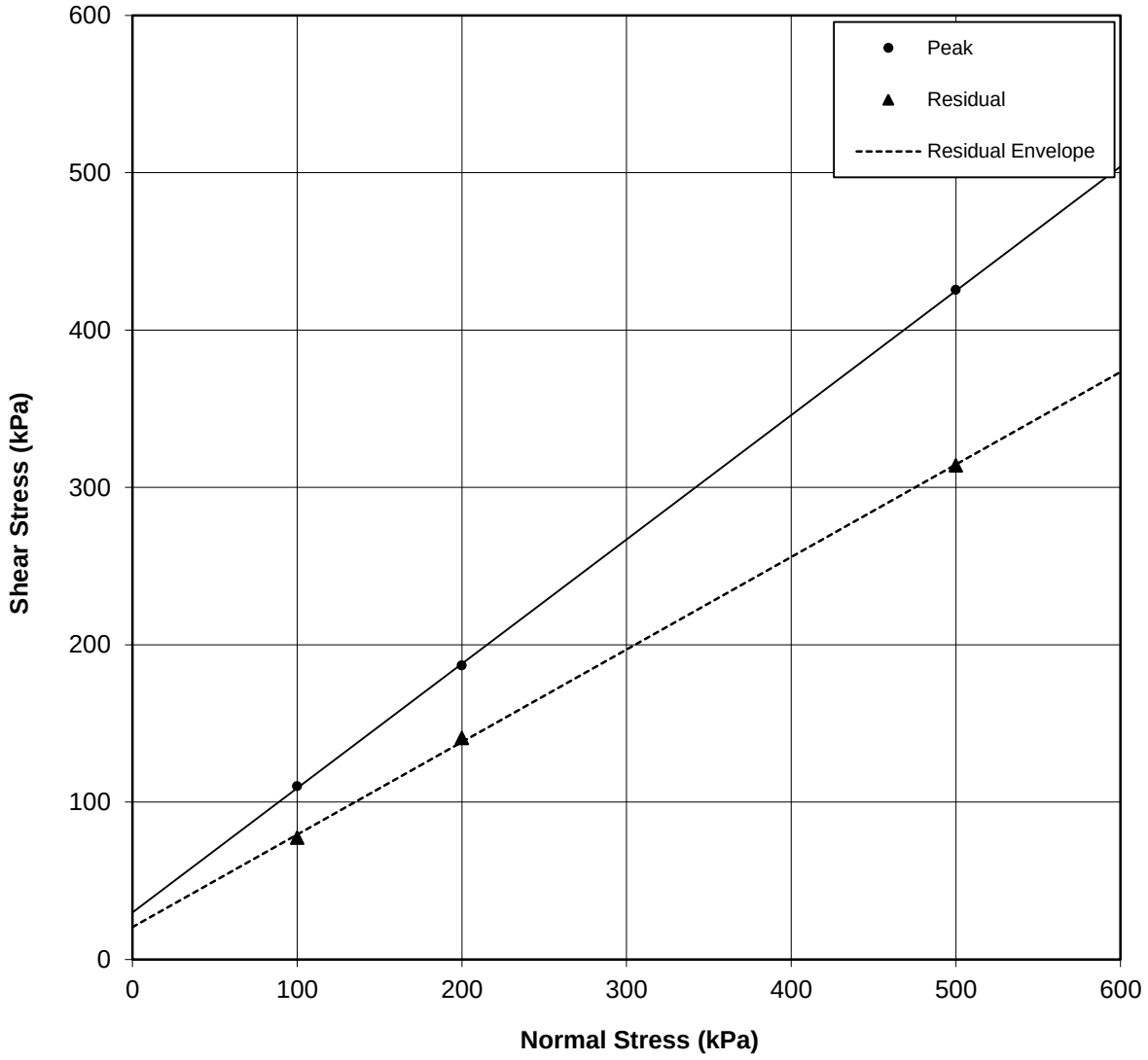
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH02
Depth (m):	12.80

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is abundant sand and fine to coarse gravel.

Shear Stress v Normal Stress



Peak: c' = 30 Φ' = 38.5 °

Residual: c' = 21 Φ' = 30.5 °

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ISRM Suggested Method

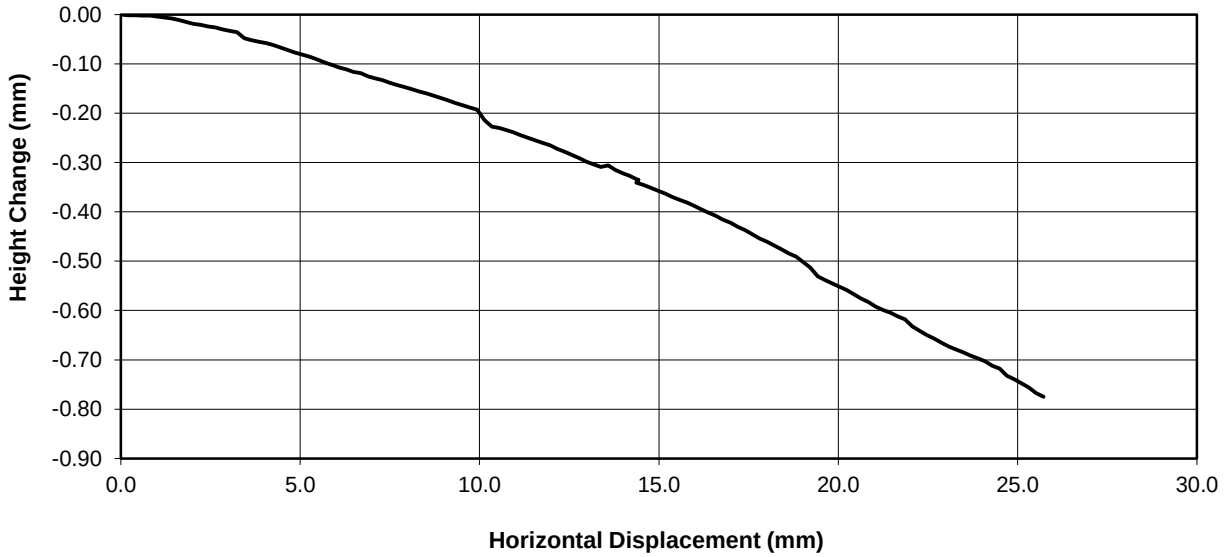
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

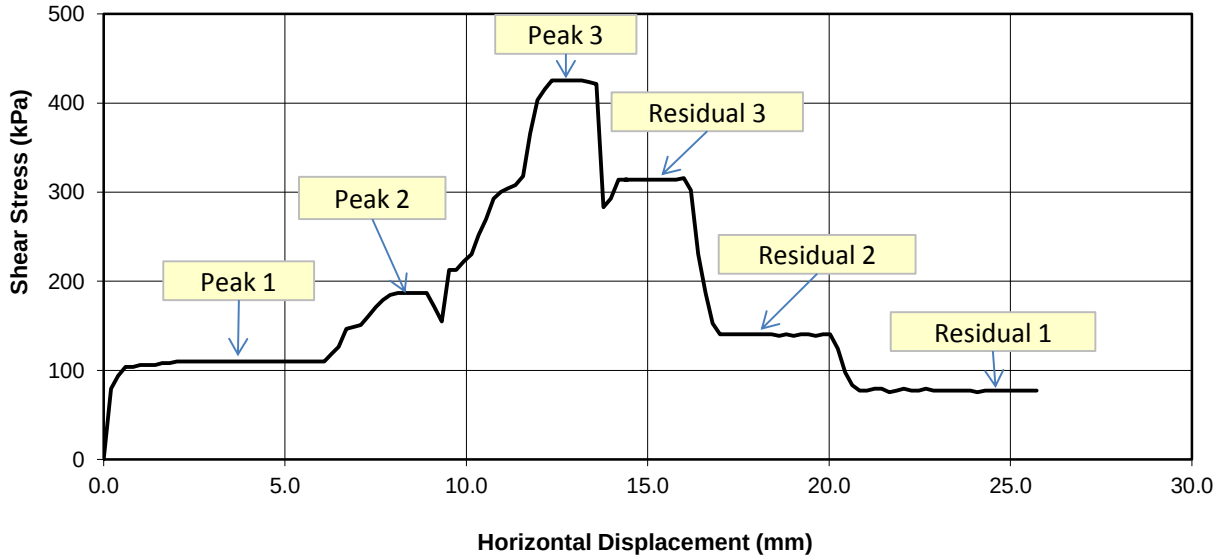
Borehole No:	RBH02
Depth (m):	12.80

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is abundant sand and fine to coarse gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH03
Depth (m):	17.06

Description:
Medium strong to weak orangish brown fine to medum grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is sand and fine to medium sub-angular gravel.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	49.8
Maximum Width	*mm*	47.2
Area	*mm²*	1908.4

Shearing Stage

Normal stress	*kPa*	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	674.9	841.0	1277.5
Horizontal displacement at MSS	*mm*	5.9	7.7	11.1
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	383.2	455.0	671.5
Final cumulative displacement	*mm*	25.3		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**533**
Angle of Shearing Resistance	*degrees*	**16.5**
Residual Condition:		
Apparent Cohesion	*kPa*	**311**
Angle of Shearing Resistance	*degrees*	**8.0**

Notes:

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S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

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Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

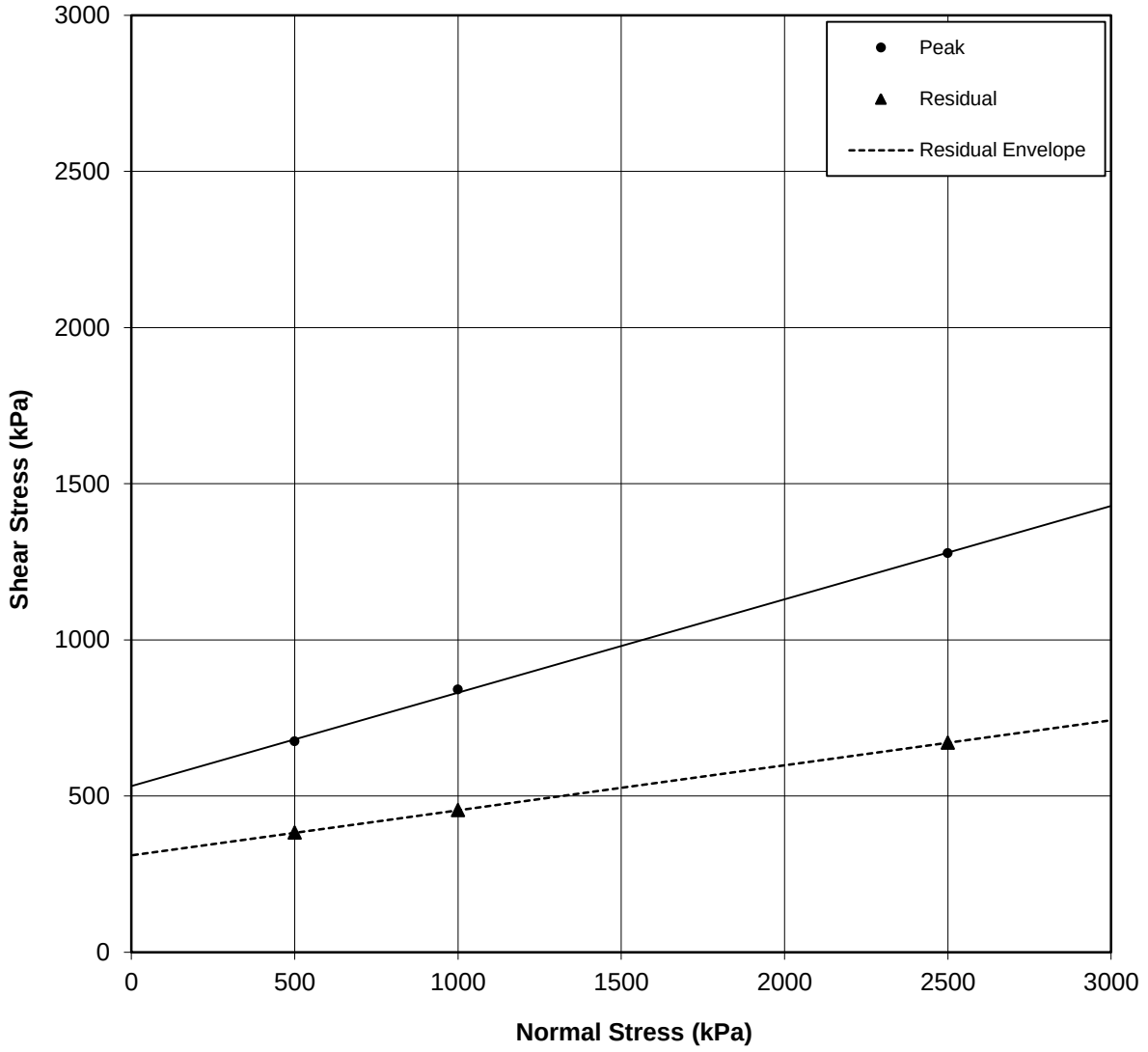
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH03
Depth (m):	17.06

Description:
Medium strong to weak orangish brown fine to medum grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is sand and fine to medium sub-angular gravel.

Shear Stress v Normal Stress



Peak: c' = 533 Φ' = 16.5 °

Residual: c' = 311 Φ' = 8 °

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S R Allen (Senior Tech)

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St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

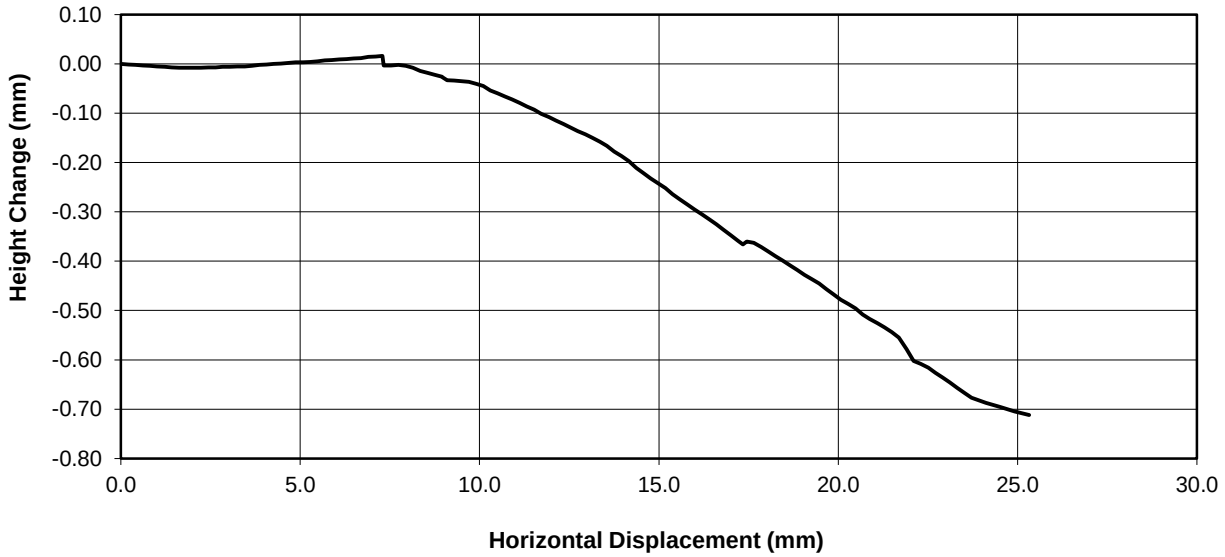
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

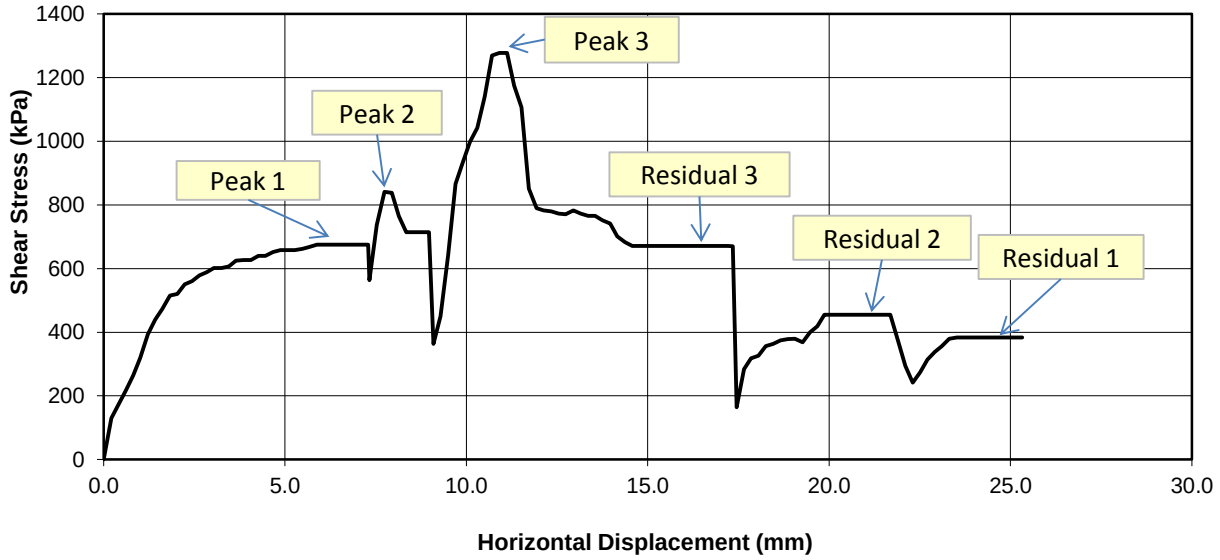
Borehole No:	RBH03
Depth (m):	17.06

Description:
Medium strong to weak orangish brown fine to medum grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is sand and fine to medium sub-angular gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH04
Depth (m):	12.90

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is sand and fine sub-rounded gravel.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	48.1
Maximum Width	*mm*	46.2
Area	*mm²*	1728.5

Shearing Stage

Normal stress	*kPa*	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	441.5	579.8	752.4
Horizontal displacement at MSS	*mm*	2.2	3.9	5.6
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	277.3	369.5	522.7
Final cumulative displacement	*mm*	15.3		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**396**
Angle of Shearing Resistance	*degrees*	**8.5**
Residual Condition:		
Apparent Cohesion	*kPa*	**233**
Angle of Shearing Resistance	*degrees*	**6.5**

Notes:

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S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

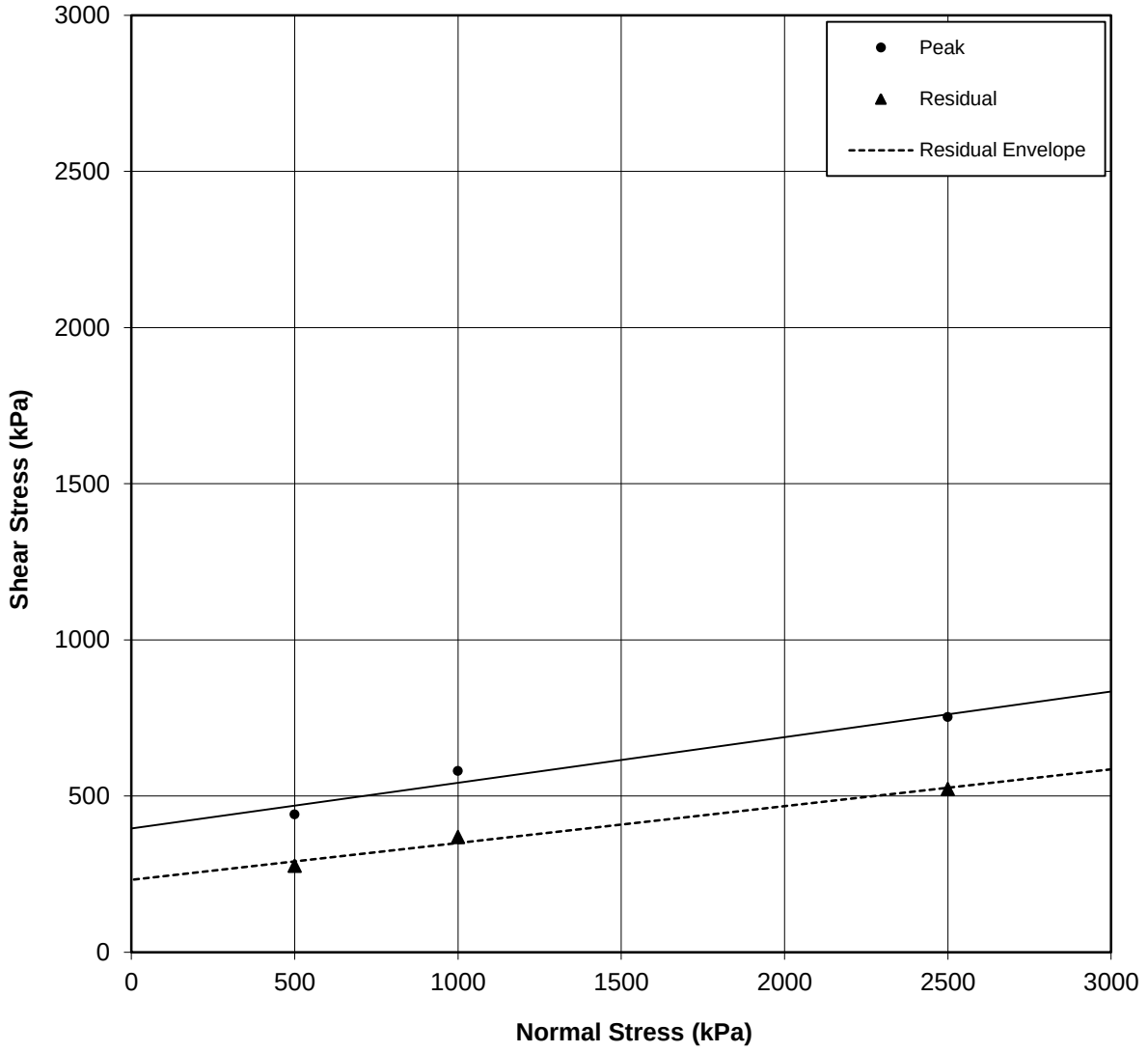
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH04
Depth (m):	12.90

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is sand and fine sub-rounded gravel.

Shear Stress v Normal Stress



Peak: c' = 396 Φ' = 8.5 °

Residual: c' = 233 Φ' = 6.5 °

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St John's Masterplan

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ISRM Suggested Method

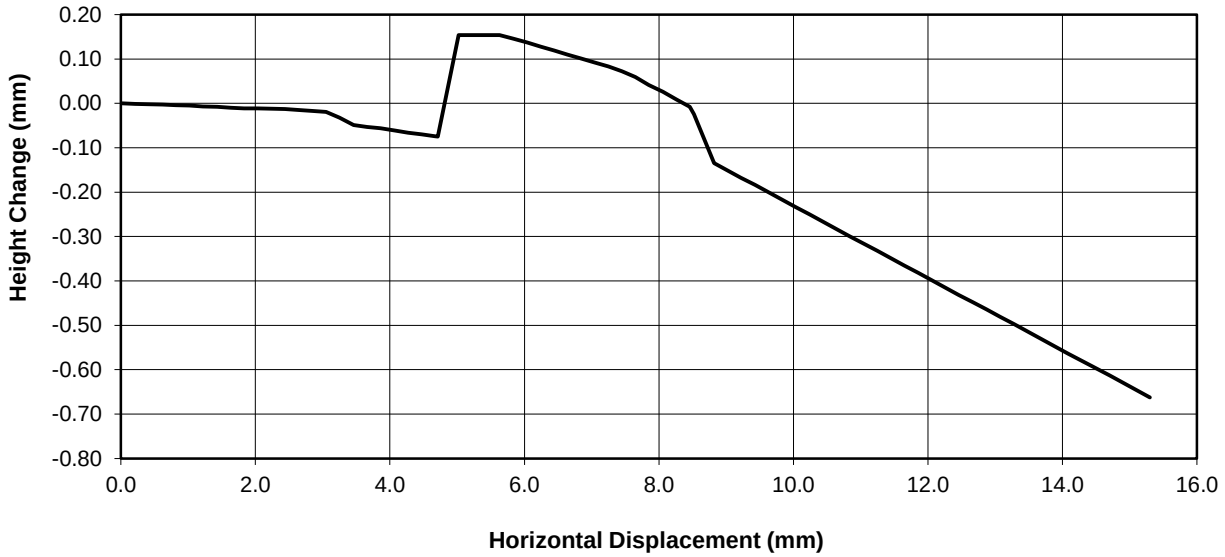
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

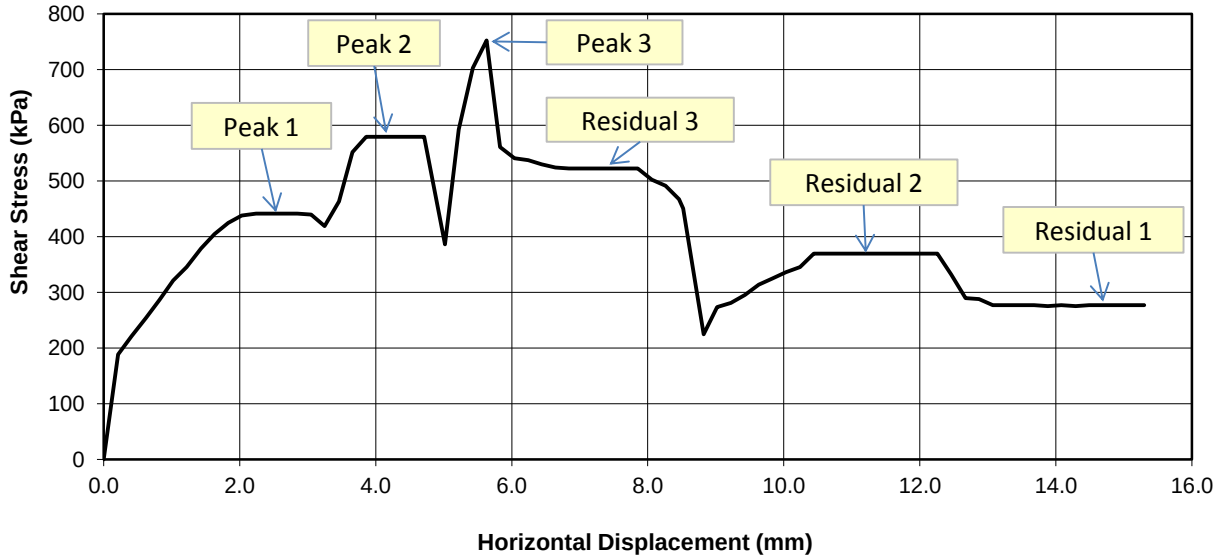
Borehole No:	RBH04
Depth (m):	12.90

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is sand and fine sub-rounded gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH05
Sample No:	C22
Depth (m):	12.27

Description:
Medium strong to weak orangish brown fine to medium SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is abundant sand and fine to coarse gravel.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	47.1
Maximum Width	*mm*	45.4
Area	*mm²*	1671.0

Shearing Stage

Normal stress	*kPa*	100	200	500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	172.0	221.4	366.9
Horizontal displacement at MSS	*mm*	3.1	5.5	8.6
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	158.6	191.1	296.1
Final cumulative displacement	*mm*	24.9		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**124**
Angle of Shearing Resistance	*degrees*	**26.0**
Residual Condition:		
Apparent Cohesion	*kPa*	**123**
Angle of Shearing Resistance	*degrees*	**19.0**

Notes:

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ISRM Suggested Method

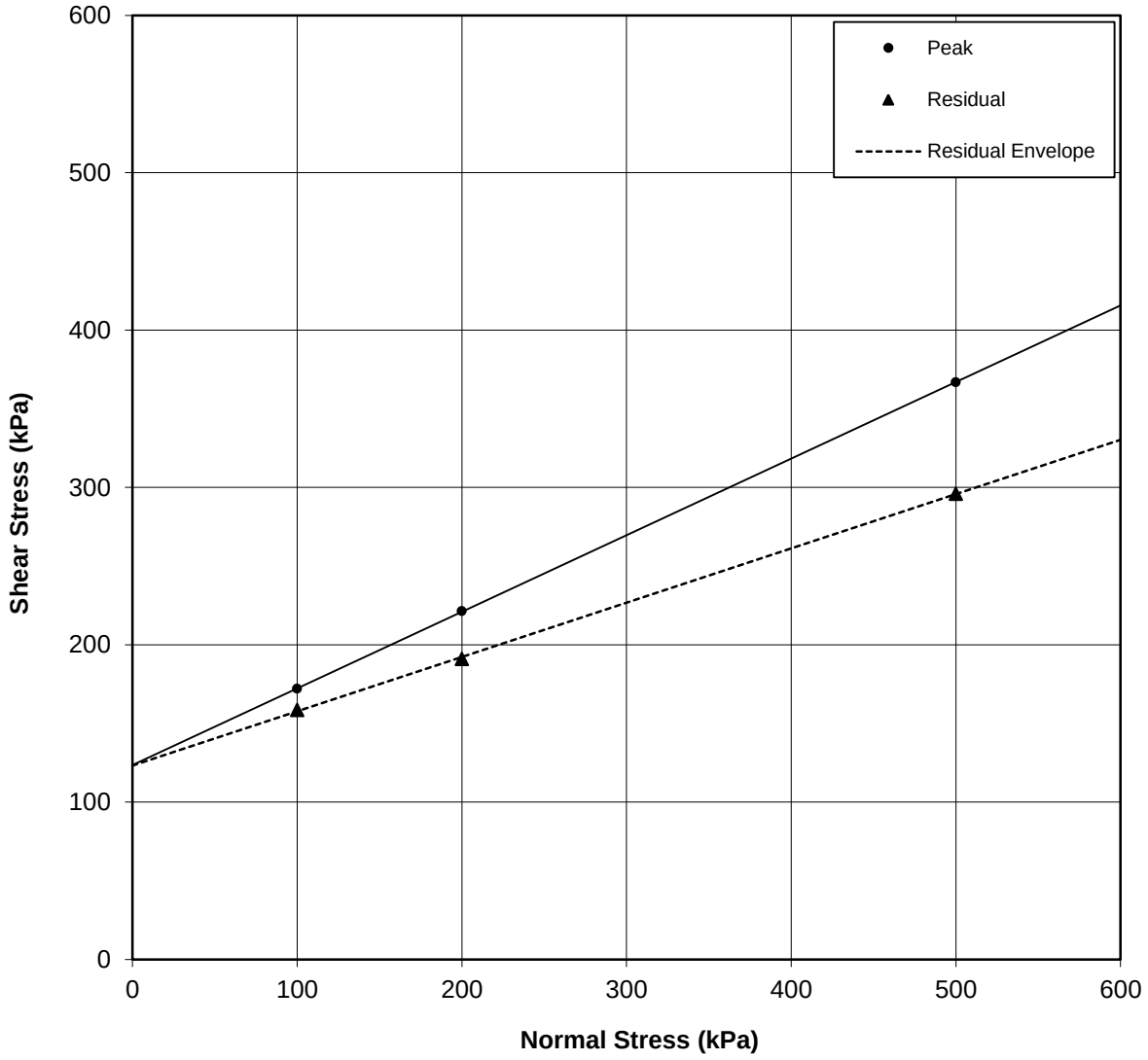
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH05
Sample No:	C22
Depth (m):	12.27

Description:
Medium strong to weak orangish brown fine to medium SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is abundant sand and fine to coarse gravel.

Shear Stress v Normal Stress



Peak: c' = 124 Φ' = 26 °

Residual: c' = 123 Φ' = 19 °

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ISRM Suggested Method

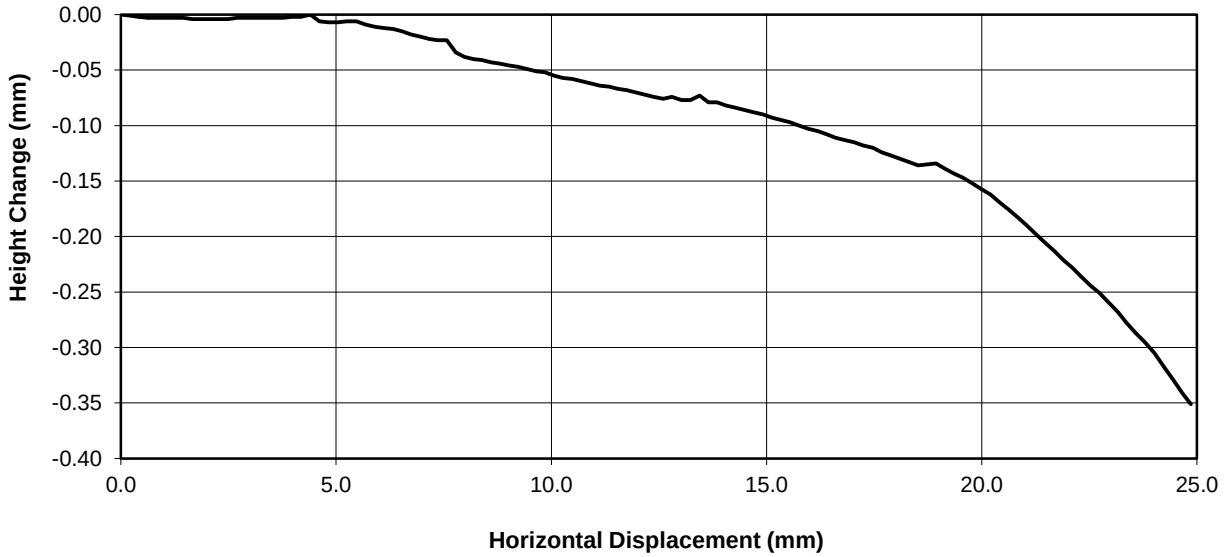
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

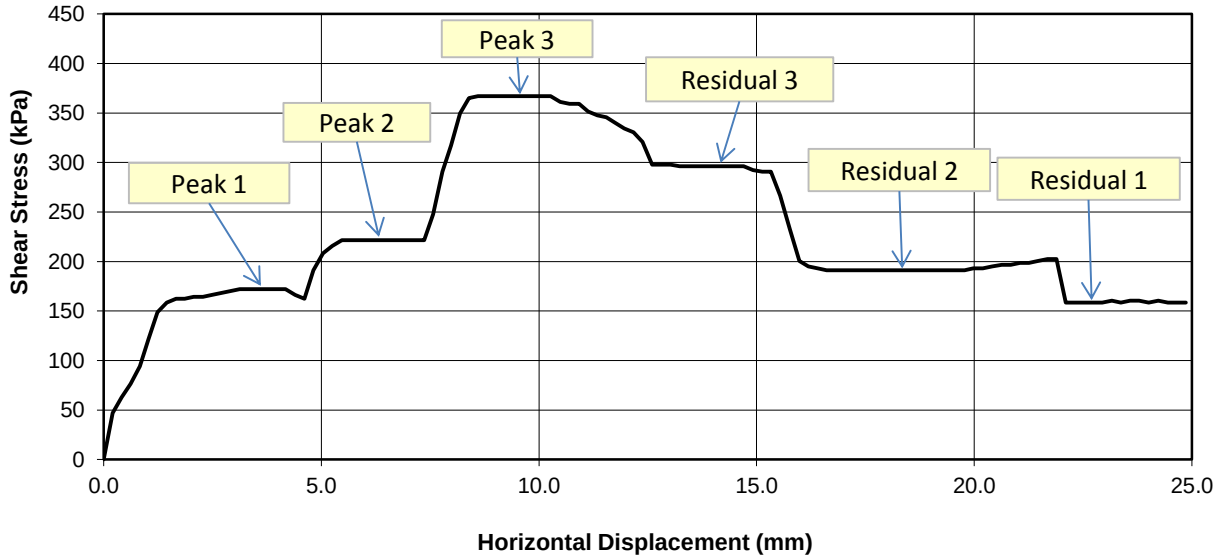
Borehole No:	RBH05
Sample No:	C22
Depth (m):	12.27

Description:
Medium strong to weak orangish brown fine to medium SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is abundant sand and fine to coarse gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH05
Sample No:	C31
Depth (m):	18.40

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is sand and fine to medium gravel.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	53.4
Maximum Width	*mm*	46.1
Area	*mm²*	1907.4

Shearing Stage

Normal stress	*kPa*	100	200	500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	140.6	180.7	319.7
Horizontal displacement at MSS	*mm*	1.5	3.6	6.9
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	85.0	123.3	261.1
Final cumulative displacement	*mm*	23.3		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**93**
Angle of Shearing Resistance	*degrees*	**24.5**
Residual Condition:		
Apparent Cohesion	*kPa*	**38**
Angle of Shearing Resistance	*degrees*	**24.0**

Notes:

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S R Allen (Senior Tech)

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ISRM Suggested Method

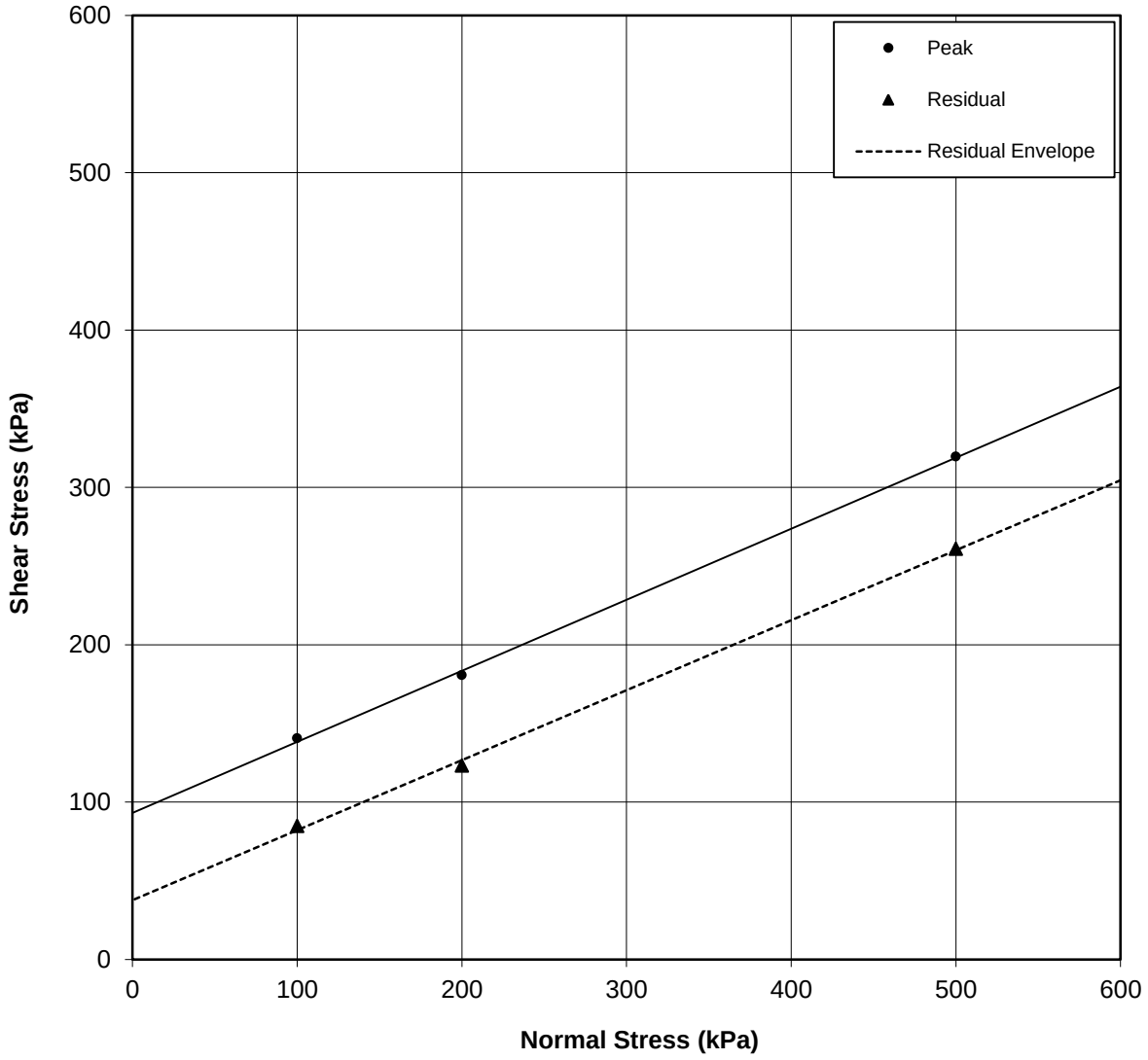
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH05
Sample No:	C31
Depth (m):	18.40

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is sand and fine to medium gravel.

Shear Stress v Normal Stress



Peak: c' = 93 Φ' = 24.5 °

Residual: c' = 38 Φ' = 24 °

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ISRM Suggested Method

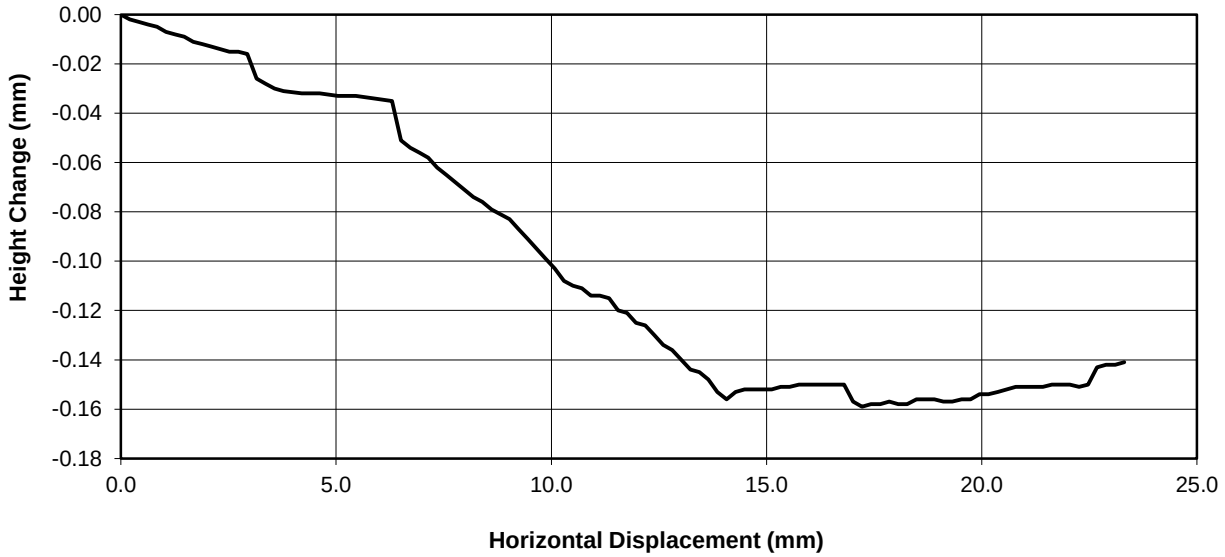
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

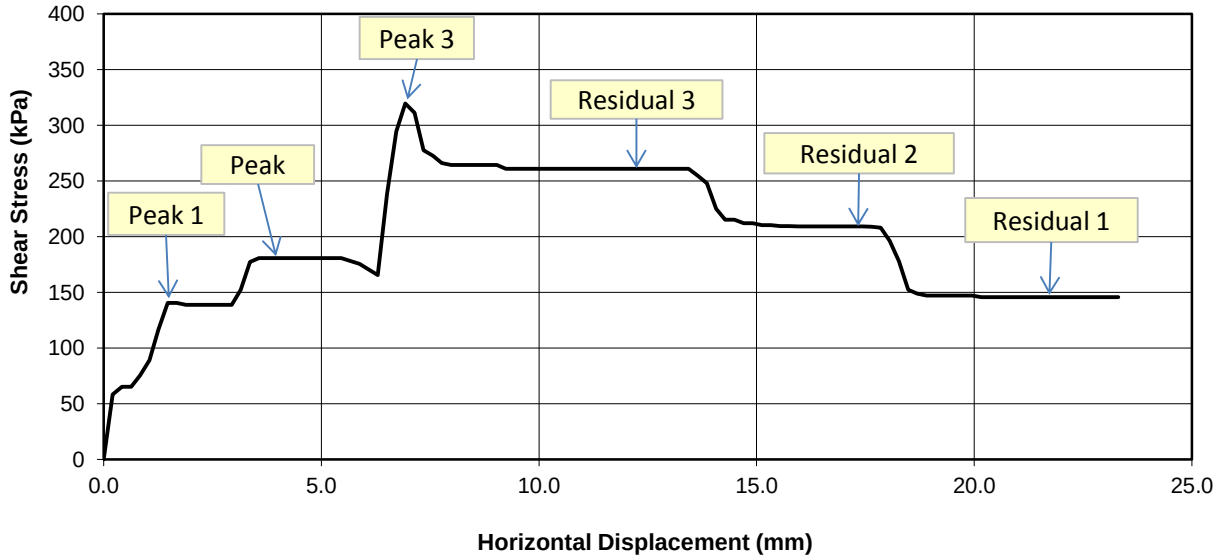
Borehole No:	RBH05
Sample No:	C31
Depth (m):	18.40

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is sand and fine to medium gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH06
Sample No:	C23
Depth (m):	16.63

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to coarse gravel.[1]

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	52.0
Maximum Width	*mm*	50.4
Area	*mm²*	2114.1

Shearing Stage

Normal stress	*kPa*	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	577.7	600.2 [1]	579.2 [1]
Horizontal displacement at MSS	*mm*	3.5	6.1	15.6
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	392.7	339.9 [1]	579.2 [1]
Final cumulative displacement	*mm*	16.6		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**n/a [1]**
Angle of Shearing Resistance	*degrees*	**n/a [1]**
Residual Condition:		
Apparent Cohesion	*kPa*	**n/a [1]**
Angle of Shearing Resistance	*degrees*	**n/a [1]**

Notes: *[1] Specimen disintegrated during shearing rendering the 2nd and 3rd stage shear strengths unreliable.*

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S R Allen (Senior Tech)

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Project Number:

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Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

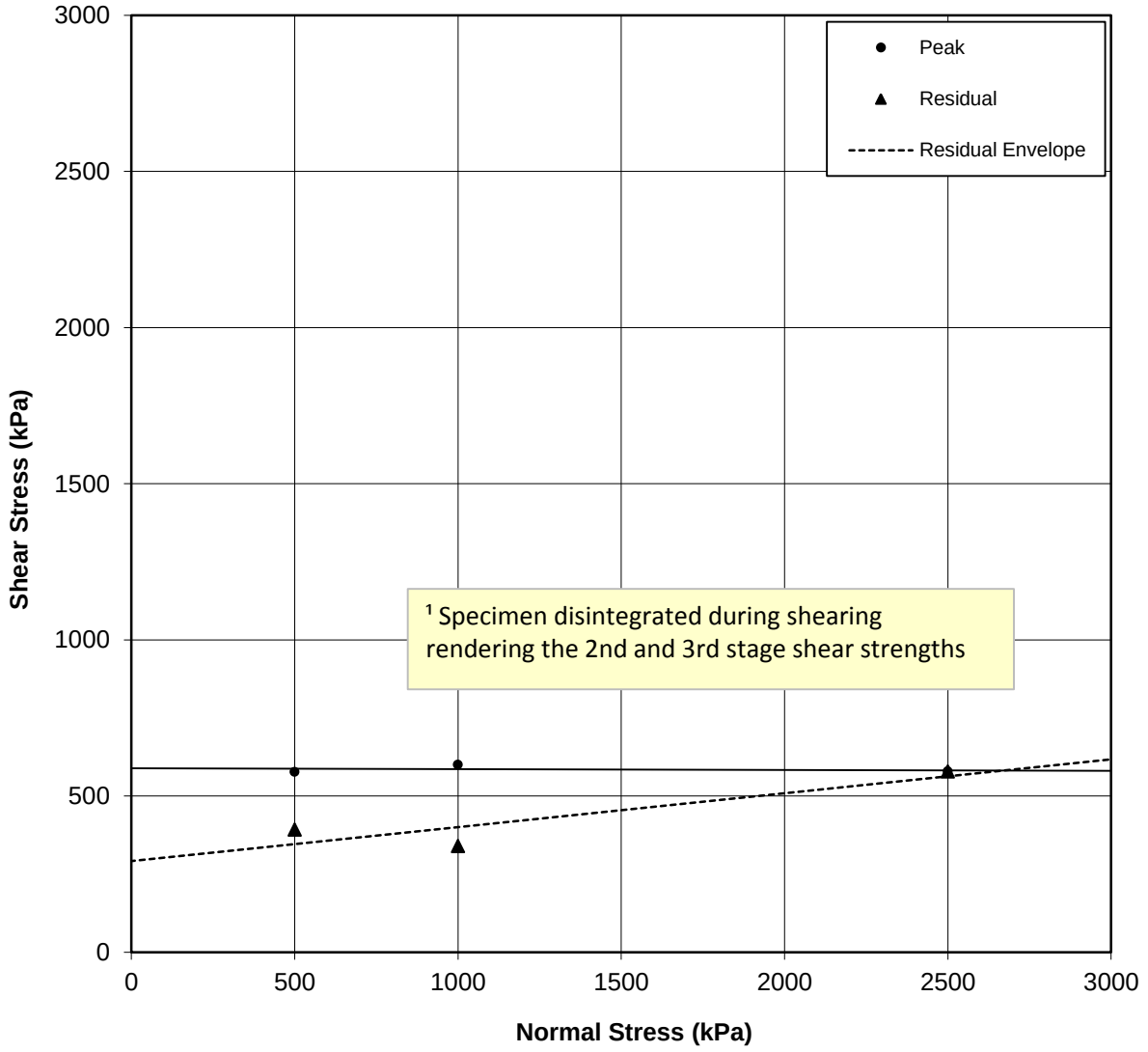
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH06
Sample No:	C23
Depth (m):	16.63

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to coarse gravel.[1]

Shear Stress v Normal Stress



Peak: c' = n/a Φ' = n/a

Residual: c' = n/a Φ' = n/a

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ISRM Suggested Method

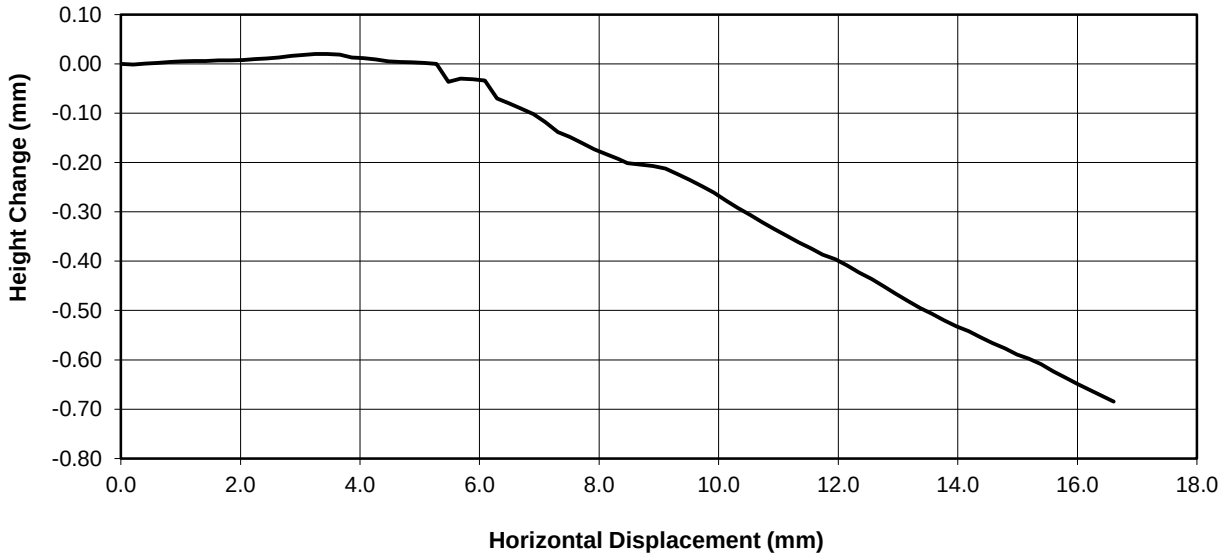
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

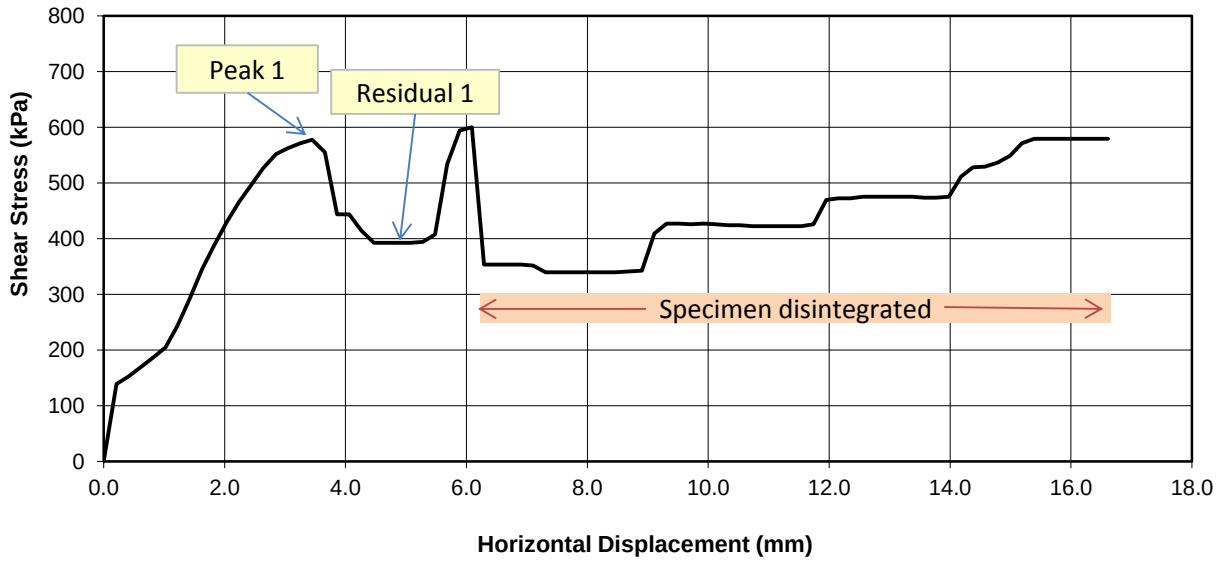
Borehole No:	RBH06
Sample No:	C23
Depth (m):	16.63

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to coarse gravel.[1]

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by SRA S R Allen (Senior Tech) Date: 31/08/2018	Project Number: **GEO / 27859** Project Name: **St John's Masterplan** **Project Ref: 42206**	GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH06
Sample No:	C35
Depth (m):	23.00

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is fine to sub-angular coarse gravel and sand.

Specimen Details

Type of shear plane		Pre existing plane of weakness: Joint
Preparation		Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.
Specimen Number		**1**
Maximum Length	*mm*	54.1
Maximum Width	*mm*	49.7
Area	*mm²*	2125.1

Shearing Stage

Normal stress	*kPa*	1500	3000	6000
Peak Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Maximum shear stress	*kPa*	719.3	1132.4	1926.0
Horizontal displacement at MSS	*mm*	2.9	4.1	5.7
Residual Conditions:				
Rate of horizontal displacement	*mm/min*	0.1	0.1	0.1
Residual shear stress	*kPa*	374.1	641.8	770.2
Final cumulative displacement	*mm*	15.0		
Duration	*day(s)*	1		

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	*kPa*	**323**
Angle of Shearing Resistance	*degrees*	**15.0**
Residual Condition:		
Apparent Cohesion	*kPa*	**310**
Angle of Shearing Resistance	*degrees*	**4.5**

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

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ISRM Suggested Method

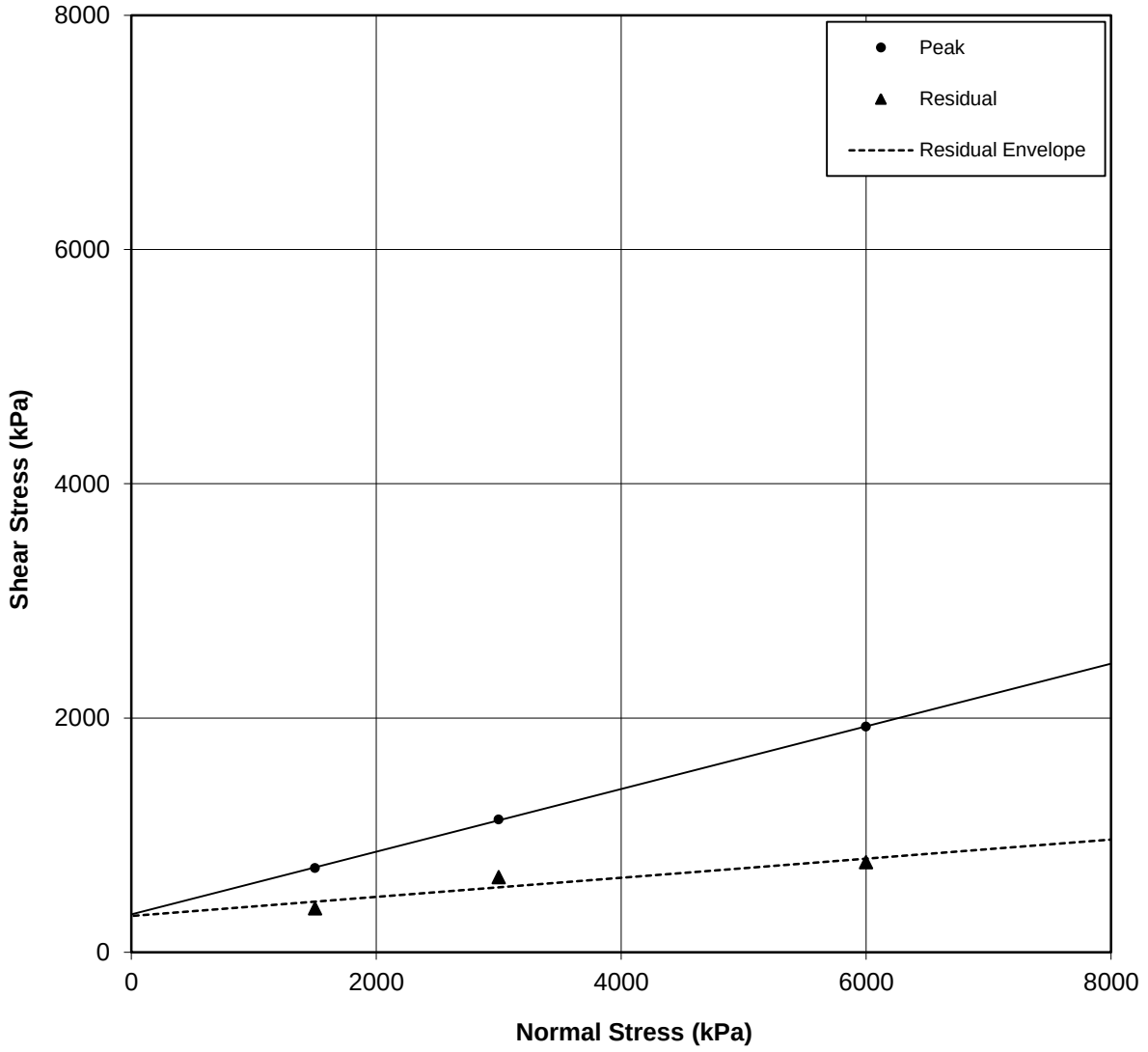
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No:	RBH06
Sample No:	C35
Depth (m):	23.00

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is fine to sub-angular coarse gravel and sand.

Shear Stress v Normal Stress



Peak: c' = 323 Φ' = 15 °

Residual: c' = 310 Φ' = 4.5 °

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S R Allen (Senior Tech)

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ISRM Suggested Method

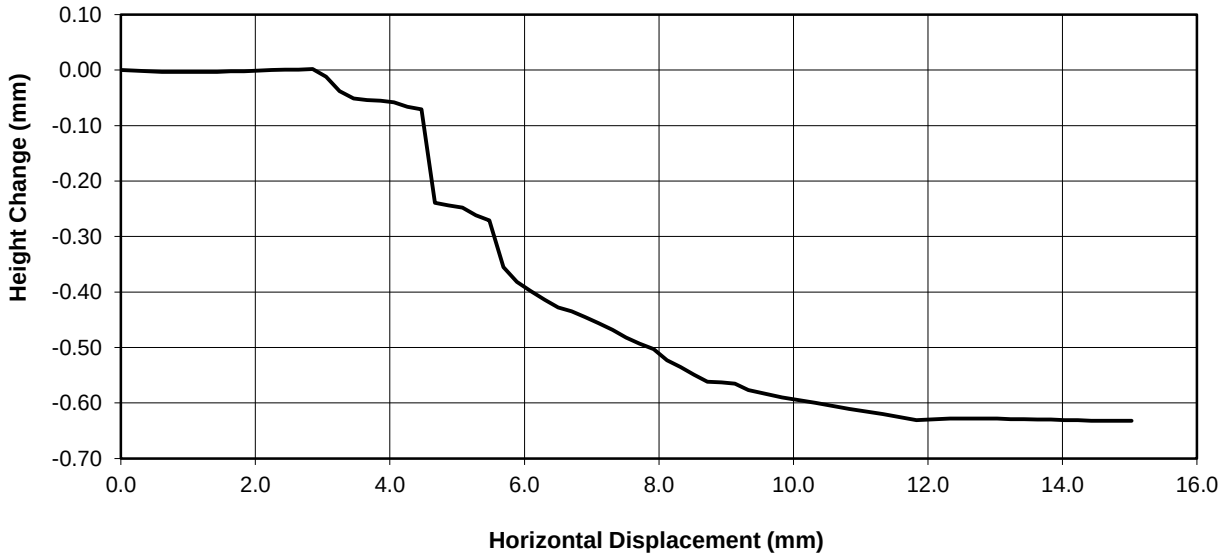
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

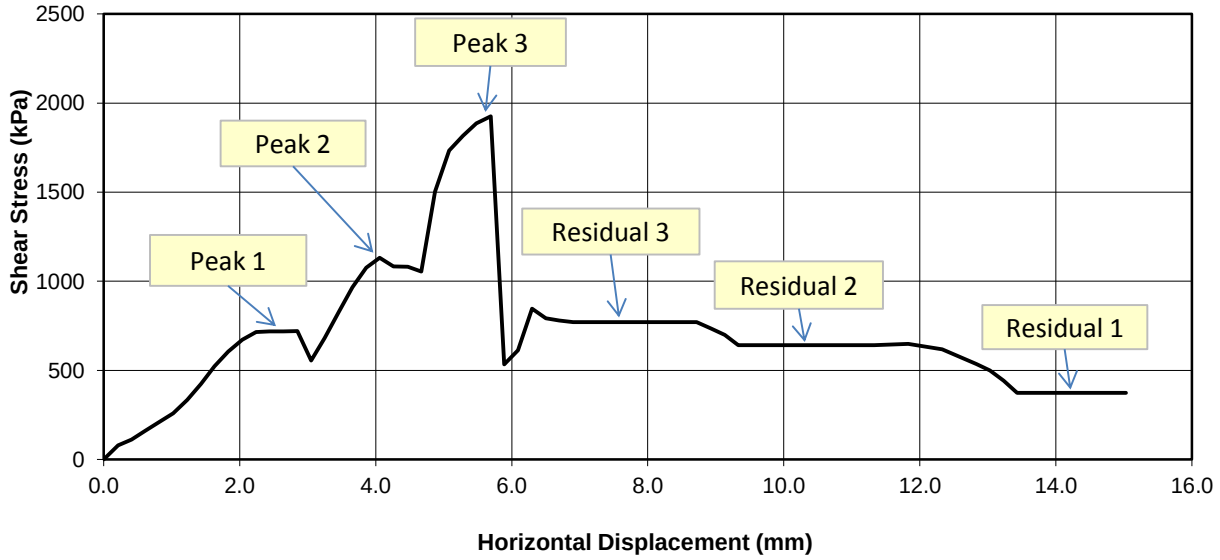
Borehole No:	RBH06
Sample No:	C35
Depth (m):	23.00

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is fine to sub-angular coarse gravel and sand.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by SRA S R Allen (Senior Tech) Date: 29/08/2018	Project Number: **GEO / 27859** Project Name: **St John's Masterplan** **Project Ref: 42206**	GEOLABS

ISRM - Suggested Methods : 2007-2014

SOUND VELOCITY TEST

Sample details									Travel Time		Sound velocity	
Borehole Ref.	Sample Ref.	Depth (m)	Description	D. Tested	Sample Diameter (mm)	Sample Length (mm)	Bulk Density (Mg/m³)	Water Content (%)	Compression wave (µs)	Shear wave (µs)	Compression V_p (m/s)	Shear V_s (m/s)
BH02	35	14.67-14.76	Very weak, thinly laminated, orangish brown SILTSTONE-MUDSTONE. Highly weathered	20/08/18	98.60	56.30	2.19	-	48.5	82.5	1161	682
BH03	33	14.40-14.52	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	99.70	84.30	2.11	-	60.2	112.7	1400	748
BH04B	9	12.65-12.92	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.10	227.70	2.17	-	126.5	219.4	1800	1038
RBH02		17.12-17.29	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.30	141.50	2.13	-	86.3	150.5	1640	940
RBH02		15.12-15.26	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.20	132.10	2.25	-	68.9	120.4	1917	1097
RBH03		13.87-14.09	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.10	188.90	2.18	-	112.6	196.5	1678	961
RBH03		15.11-15.30	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.40	163.10	2.34	-	91.8	160.7	1777	1015
RBH04		14.07-14.24	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	100.90	130.60	2.17	-	78.4	140.7	1666	928
RBH04		16.92-17.34	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.50	131.00	2.34	-	65.7	114.0	1994	1149
RBH05	25	14.44-14.58	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.20	121.50	2.13	-	70.5	123.0	1723	988

Checked and Approved by

CC

C Clergeaud (Snr. Geologist)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
42206

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ISRM - Suggested Methods : 2007-2014

SOUND VELOCITY TEST

Sample details									Travel Time		Sound velocity	
Borehole Ref.	Sample Ref.	Depth (m)	Description	D. Tested	Sample Diameter (mm)	Sample Length (mm)	Bulk Density (Mg/m³)	Water Content (%)	Compression wave (µs)	Shear wave (µs)	Compression V_p (m/s)	Shear V_s (m/s)
RBH05	33	19.72-19.81	Very weak, thinly laminated, orangish brown SILTSTONE-MUDSTONE. Highly to completely weathered	20/08/18	101.10	62.40	2.08	-	48.5	96.5	1287	647
RBH06	14	12.00-12.11	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	93.40	63.20	2.04	-	50.3	98.4	1256	642
RBH06	28	20.00-20.20	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	100.10	168.50	2.17	-	83.2	152.6	2025	1104

Checked and Approved by

CC

C Clergeaud (Snr. Geologist)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
42206

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Appendix E – Ground Gas and Groundwater Monitoring Results

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IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Gas and Groundwater Monitoring Results

Contract Number:	*42206*	**Gas Monitor:**	*GA10157*
Contract Name:	*St John's Masterplan*	**Readings Taken By:**	*PN*
Date:	*26/07/2018*	**Checked By:**	*TW*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Sunny, 25°*	*20.9*	*0.0*	*0.0*	*0*	*0*
	Ground Conditions (dry / wet etc):	*Dry*					
	Atmospheric Pressure (Start):	*1011mb*					
	Atmospheric Pressure (Finish):	*1011mb*					
	Time (Start): 07:15 Time (Finish):	14:30					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Steady	mBGL	mBGL	mBGL
BH02	*0.0*	*19.9*	*0.1*	*0.0*	*0.0*	*0*	*0*	*1.62*	*0.0*	*19.81*	*4.25*	*ND*
BH03	*0.0*	*18.6*	*0.9*	*0.0*	*0.0*	*0*	*0*	*0.97*	*0.0*	*9.48*	*3.92*	*ND*
BH04	*0.0*	*20.6*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.67*	*0.0*	*19.66*	*3.12*	*ND*
RBH02	*0.0*	*20.4*	*0.1*	*0.0*	*0.0*	*0*	*0*	*7.63*	*See remarks*	*18.62*	*3.41*	*ND*
RBH04	*0.0*	*18.2*	*1.2*	*0.0*	*0.0*	*0*	*0*	*1.07*	*-0.1*	*6.23*	*4.44*	*ND*
RBH06	*0.0*	*19.7*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.96*	*0.0*	*10.25*	*3.90*	*ND*
WS04	*0.0*	*12.2*	*4.5*	*0.0*	*0.0*	*0*	*0*	*0.09*	*0.0*	*2.85*	*Dry*	*ND*
WS05	*0.0*	*16.2*	*3.4*	*0.0*	*0.0*	*0*	*0*	*0.06*	*0.0*	*3.03*	*Dry*	*ND*
WS06	*0.0*	*19.7*	*1.6*	*0.0*	*0.0*	*0*	*0*	*0.41*	*0.0*	*3.03*	*Dry*	*ND*
WS10	*0.0*	*18.6*	*1.5*	*0.0*	*0.0*	*0*	*0*	*-0.18*	*0.0*	*21.80*	*3.45*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:	RBH02 Flow - Initial = -7.0 per hour After 5 minutes flow fluctuating between -1.2 per hour and -2.3 per hour. No access to WS11, WS08 and RBH03 due to on site demolition

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Gas and Groundwater Monitoring Results

Contract Number:	*42206*	**Gas Monitor:**	*GA2000*
Contract Name:	*St John's Masterplan*	**Readings Taken By:**	*PN*
Date:	*9th August 2018*	**Checked By:**	*HH*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Sunny, 20°*	*20.8*	*0.0*	*0.0*	*0*	*0*
	Ground Conditions (dry / wet etc):	*Dry*					
	Atmospheric Pressure (Start):	*1011mb*					
	Atmospheric Pressure (Finish):	*1010mb*					
	Time (Start): 08:15 Time (Finish):	13:00					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Steady	mBGL	mBGL	mBGL
BH02	*0.0*	*14.4*	*1.5*	*0.0*	*0.0*	*0*	*0*	*0.31*	*0.0*	*19.78*	*4.26*	*ND*
BH03	*0.0*	*18.1*	*0.8*	*0.0*	*0.0*	*0*	*0*	*0.41*	*0.0*	*9.47*	*3.93*	*ND*
BH04	*0.0*	*20.5*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.18*	*0.0*	*19.64*	*3.14*	*ND*
RBH02	*0.0*	*19.0*	*0.1*	*0.0*	*0.0*	*0*	*0*	*4.17*	*-1.4*	*18.51*	*3.63*	*ND*
RBH04	*0.0*	*17.0*	*1.7*	*0.0*	*0.0*	*0*	*0*	*0.20*	*0.0*	*10.31*	*4.19*	*ND*
RBH06	*Unable to access due to demolition in progress*											
WS04	*0.0*	*12.3*	*4.9*	*0.0*	*0.0*	*0*	*0*	*-0.11*	*0.0*	*2.85*	*Dry*	*NA*
WS05	*0.0*	*16.0*	*3.4*	*0.0*	*0.0*	*0*	*0*	*-0.29*	*0.0*	*3.03*	*Dry*	*NA*
WS06	*0.0*	*19.0*	*1.8*	*0.0*	*0.0*	*0*	*0*	*0.31*	*0.0*	*3.03*	*Dry*	*NA*
WS08	*0.0*	*20.8*	*0.4*	*0.0*	*0.0*	*0*	*0*	*0.22*	*0.0*	*3.05*	*Dry*	*NA*
WS10	*0.0*	*18.5*	*1.4*	*0.0*	*0.0*	*0*	*0*	*0.36*	*0.0*	*21.80*	*3.45*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks: WS11 & RBH03 within demolition area- no access.

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Gas and Groundwater Monitoring Results

Contract Number:	*42206*	**Gas Monitor:**	*GA10157*
Contract Name:	*St John's Masterplan*	**Readings Taken By:**	*PN*
Date:	*23rd August 2018*	**Checked By:**	*HH*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Overcast, 16°*					
	Ground Conditions (dry / wet etc):	*Wet*					
	Atmospheric Pressure (Start):	*1009mb*	*20.8*	*0.0*	*0.0*	*0*	*0*
	Atmospheric Pressure (Finish):	*1009mb*					
	Time (Start): 08:10 Time (Finish):	13:00					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Steady	mBGL	mBGL	mBGL
BH02	*0.0*	*2.5*	*4.0*	*0.0*	*0.0*	*0*	*0*	*0.27*	*0.0*	*19.76*	*4.26*	*ND*
BH03	*0.0*	*18.7*	*0.9*	*0.0*	*0.0*	*0*	*0*	*0.39*	*0.0*	*9.47*	*1.97*	*ND*
BH04	*0.0*	*20.6*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.44*	*0.0*	*19.64*	*3.18*	*ND*
RBH02	*0.0*	*19.8*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.65*	*1.0*	*18.37*	*3.38*	*ND*
RBH04	*0.0*	*19.5*	*0.6*	*0.0*	*0.0*	*0*	*0*	*1.15*	*-0.1*	*10.31*	*4.06*	*ND*
*RBH05**	*0.0*	*20.9*	*0.3*	*0.0*	*0.0*	*0*	*0*	*-1.15*	*0.3*	*19.75*	*4.18*	*ND*
RBH06	*Unable to access due to demolition in progress*											
WS04	*0.0*	*13.0*	*5.2*	*0.0*	*0.0*	*0*	*0*	*-0.33*	*0.0*	*2.85*	*Dry*	*NA*
WS05	*0.0*	*16.1*	*3.3*	*0.0*	*0.0*	*0*	*0*	*-0.35*	*0.0*	*3.03*	*Dry*	*NA*
WS06	*0.0*	*19.1*	*1.1*	*0.0*	*0.0*	*0*	*0*	*0.22*	*0.0*	*3.03*	*Dry*	*NA*
WS08	*0.0*	*17.0*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.40*	*0.0*	*3.05*	*Dry*	*NA*
WS10	*0.0*	*19.1*	*1.3*	*0.0*	*0.0*	*0*	*0*	*0.41*	*0.0*	*21.80*	*3.44*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks: *RBH05 Initial flow = 16.1 1/h Steady after 5 minutes. WS11 & RBH03 within demolition area- no access.

Appendix F – GAC Screening Thresholds

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Adopted Soil Generic Assessment Criteria
Sandy loam with 6% SOM

Contaminants	Residential with home grown produce	Residential without home grown produce	Allotments	Commercial	Public open space near residential housing POS_{resi}	Public park POS_{park}
Metals						
Beryllium	*1.7*	*1.7*	*35*	*12*	*2.2*	*63*
Boron	*290*	*11,000*	*45*	*240,000*	*21,000*	*46,000*
Cadmium	**10**[13] 22	**85**[13] 150	**1.8** 3.9	**230** 410	*120* 220	*560* 880
Chromium III	*910*	*910*	*18,000*	*8,600*	*1,500*	*33,000*
Chromium VI	*6* 21	*6* 21	*1.8* 170	*33* 49	*7.7* 21	*220* 250
Lead	200	310	80	2,300	630	1,300
Mercury *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] [*30*]
Mercury (inorganic)	**170**	**240**	**80**	**3600**	*120*	*240*
Nickel	*130*[10]	*180*[10]	*53*[11]	*980*[10]	*230*	*800*
Vanadium	*410*	*1200*	*91*	*9000*	*2000*	*5000*
Copper	*2400*	*7100*	*520*	*68000*	*12000*	*44000*
Zinc	*3700*	*40000*	*620*	*730000*	*81000*	*170000*
Semi-Metals and non-metals						
Arsenic	**32**[12] 37	**35**[12] 40	**43**[12] 49	**640**[12] 640	*79* 79	*170* 170
Antimony		***550***		***7500***	***1500***	***3300***
Selenium	**350**	**600**	**120**	**13000**	*1100*	*1800*
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_6	*160*	*160*	*3900*	*12000*	*600000*	*180000*
$EC_{>6}$ - EC_8	*530*	*530*	*13000*	*40000*	*620000*	*320000*
$EC_{>8}$ - EC_{10}	*150*	*150*	*1700*	*11000*	*13000*	*21000*
EC_{10}-EC_{12}	*760*	*770*	*7300*	*47000*	*13000*	*24000*
EC_{12}-EC_{16}	*4300*	*4400*	*13000*	*90000*	*13000*	*26000*
$EC_{>16}$ - EC_{35}	*110000*	*110000*	*270000*	*1800000*	*250000*	*490000*
$EC_{>35}$ - EC_{44}	*110000*	*110000*	*270000*	*1800000*	*250000*	*490000*
Aromatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_7	*300*	*1400*	*57*	*86000*	*56000*	*92000*
$EC_{>7}$ - EC_8	*660*	*3900*	*120*	*180000*	*56000*	*100000*
$EC_{>8}$ - EC_{10}	*190*	*270*	*51*	*17000*	*5000*	*9300*
EC_{10} - EC_{12}	*380*	*1200*	*74*	*34000*	*5000*	*10000*
EC_{12} - EC_{16}	*660*	*2500*	*130*	*38000*	*5000*	*10000*
$EC_{>16}$ - EC_{21}	*930*	*1900*	*260*	*28000*	*3800*	*7800*
$EC_{>21}$ - EC_{35}	*1700*	*1900*	*1600*	*28000*	*3800*	*7900*
$EC_{>35}$ - EC_{44}	*1700*	*1900*	*1600*	*28000*	*3800*	*7900*
Aliph + Arom EC >44-70	*1900*	*1900*	*3000*	*28000*	3800	7900
Aromatic						
Benzene	**0.33** 0.87	**1.0** 3.3	**0.07** 0.18	**95** 98	*73* 140	*110* 230
Ethyl benzene	**350**	**840**	**90**	**2800**[8] [66000]	**2800**[8] [*25000*]	**2800**[8] [*27000*]
Toluene	**610**	**2700**	**120**	**4400**[8] [190000]	**4400**[8] [*56000*]	**4400**[8] [*100000*]
Xylene[9]	**230**	**290**	**160**	**2600**[8] [32000]	**2600**[8] [*43000*]	**2600**[8] [*31000*]
Phenol	**420**	**520**	**280**	**3200**[14] (38000)	**3200**[14] (*10000*)	**3200**[14] (*9300*)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	*13*	*13*	*24*	*1100*	*4900*	*3000*
Acenaphthylene	*920*	*6000*	*160*	*100000*	*15000*	*30000*
Acenaphthene	*1100*	*6000*	*200*	*100000*	*15000*	*30000*
Fluorene	*860*	*4500*	*160*	*71000*	*9900*	*20000*
Phenanthrene	*440*	*1500*	*90*	*23000*	*3100*	*6300*
Anthracene	*11000*	*37000*	*2200*	*540000*	*74000*	*150000*
Fluoranthene	*890*	*1600*	*290*	*23000*	*3100*	*6400*
Pyrene	*2000*	*3800*	*620*	*54000*	*7400*	*15000*
Benz(a)anthracene	*13*	*15*	*13*	*180*	*29*	*62*
Chrysene	*27*	*32*	*19*	*350*	*57*	*120*
Benzo(b)fluoranthene	*3.7*	*4.0*	*3.9*	*45*	*7.2*	*16.0*
Benzo(k)fluoranthene	*100*	*110*	*130*	*1200*	*190*	*440*
Benzo(a)pyrene	*3.0* 5.0	*3.2* 5.3	*3.5* 5.7	*36* 77	*5.7* 10	*13* 21
Indeno(123cd)pyrene	*41*	*46*	*39*	*510*	*82*	*180*
Dibenzo(ah)anthracene	*0.3*	*0.32*	*0.43*	*3.6*	*0.58*	*1.4*
Benzo(ghi)perylene	*350*	*360*	*640*	*4000*	*640*	*1600*
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	*0.0014*	*0.0015*	*0.0018*	*0.12*	*3.5*	*5.4*
Trichloroethene (TCE)	*0.075*	*0.08*	*0.21*	*5.7*	*120*	*120*
1,1,1,2 Tetrachlorethane	*6.4*	*8.2*	*4.4*	*560*	*1400*	*2100*
Tetrachlorethene (PCE)	*0.90*	*0.92*	*3.6*	*95*	*1400*	*1500*
1,1,1 Trichlorethane	*39*	*40*	*240*	*3000*	*140000*	*100000*

Notes

1. All values above are in mg/kg
2. **Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters**, *numbers in italics are S4ULs*, ***numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters*** and underlined numbers are C4SLs
3. Soil organic matter (SOM) is assumed to be 6% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
6. For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
15. NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 2.5% SOM

Contaminants	Residential with home grown produce	Residential without home grown produce	Allotments	Commercial	Public open space near residential housing POS_{resi}	Public park POS_{park}
Metals						
Beryllium	*1.7*	*1.7*	*35*	*12*	*2.2*	*63*
Boron	*290*	*11,000*	*45*	*240,000*	*21,000*	*46,000*
Cadmium	**10**[13] 22	**85**[13] 150	**1.8** 3.9	**230** 410	*120* 220	*560* 880
Chromium III	*910*	*910*	*18,000*	*8,600*	*1,500*	*33,000*
Chromium VI	*6* 21	*6* 21	*1.8* 170	*33* 49	*7.7* 21	*220* 250
Lead	200	310	80	2,300	630	1,300
Mercury *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] [*30*]
Mercury (inorganic)	**170**	**240**	**80**	**3600**	*120*	*240*
Nickel	*130*[10]	*180*[10]	*53*[11]	*980*[10]	*230*	*800*
Vanadium	*410*	*1200*	*91*	*9000*	*2000*	*5000*
Copper	*2400*	*7100*	*520*	*68000*	*12000*	*44000*
Zinc	*3700*	*40000*	*620*	*730000*	*81000*	*170000*
Semi-Metals and non-metals						
Arsenic	**32**[12] 37	**35**[12] 40	**43**[12] 49	**640**[12] 640	*79* 79	*170* 170
Antimony		***550***		***7500***	***1500***	***3300***
Selenium	**350**	**600**	**120**	**13000**	*1100*	*1800*
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_6	*78*	*78*	*1700*	*5900*	*590000*	*130000*
$EC_{>6}$ - EC_8	*230*	*230*	*5600*	*17000*	*610000*	*220000*
$EC_{>8}$ - EC_{10}	*65*	*65*	*770*	*4800*	*13000*	*18000*
EC_{10}-EC_{12}	*330*	*330*	*4400*	*23000*	*13000*	*23000*
EC_{12}-EC_{16}	*2400*	*2400*	*13000*	*82000*	*13000*	*25000*
$EC_{>16}$ - EC_{35}	*92000*	*92000*	*270000*	*1700000*	*250000*	*480000*
$EC>_{35}$ - EC_{44}	*92000*	*92000*	*270000*	*1700000*	*250000*	*480000*
Aromatic risk banded hydrocarbons - TPHCWG method						
$EC>_5$ - EC_7	*140*	*690*	*27*	*46000*	*56000*	*84000*
$EC>_7$ - EC_8	*290*	*1800*	*51*	*110000*	*56000*	*95000*
$EC_{>8}$ - EC_{10}	*83*	*110*	*21*	*8100*	*5000*	*8500*
EC_{10} - EC_{12}	*180*	*590*	*31*	*28000*	*5000*	*9700*
EC_{12} - EC_{16}	*330*	*2300*	*57*	*37000*	*5100*	*10000*
$EC_{>16}$ - EC_{21}	*540*	*1900*	*110*	*28000*	*3800*	*7700*
$EC_{>21}$ - EC_{35}	*1500*	*1900*	*820*	*28000*	*3800*	*7800*
$EC>_{35}$ - EC_{44}	*1500*	*1900*	*820*	*28000*	*3800*	*7800*
Aliph + Arom EC >44-70	*1800*	*1900*	*2100*	*28000*	3800	7800
Aromatic						
Benzene	**0.16**	**0.49**	**0.035**	**50**	*72*	*100*
Ethyl benzene	**150**	**380**	**39**	**1200**[8] [35000]	**1200**[8] [*24000*]	**1200**[8] [*22000*]
Toluene	**270**	**1300**	**51**	**1900**[8] [110000]	**1900**[8] [*56000*]	**1900**[8] [*95000*]
Xylene[9]	**98**	**120**	**70**	**1200**[8] [14000]	**1200**[8] [*42000*]	**1200**[8] [*23000*]
Phenol	**290**	**420**	**140**	**1500**[14] (35000)	**1500**[14] (*10000*)	**1500**[14] (*8300*)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	*5.6*	*5.6*	*10*	*460*	*4900*	*1900*
Acenaphthylene	*420*	*4600*	*69*	*97000*	*15000*	*30000*
Acenaphthene	*510*	*4700*	*85*	*97000*	*15000*	*30000*
Fluorene	*400*	*3800*	*67*	*68000*	*9900*	*20000*
Phenanthrene	*220*	*1500*	*38*	*22000*	*3100*	*6200*
Anthracene	*5400*	*35000*	*950*	*540000*	*74000*	*150000*
Fluoranthene	*560*	*1600*	*130*	*23000*	*3100*	*6300*
Pyrene	*1200*	*3800*	*270*	*54000*	*7400*	*15000*
Benz(a)anthracene	*11*	*14*	*6.5*	*170*	*29*	*56*
Chrysene	*22*	*31*	*9.4*	*350*	*57*	*110*
Benzo(b)fluoranthene	*3.3*	*4.0*	*2.1*	*44*	*7.2*	*15*
Benzo(k)fluoranthene	*93*	*110*	*75*	*1200*	*190*	*410*
Benzo(a)pyrene	*2.7*	*3.2*	*2*	*35*	*5.7*	*12*
Indeno(123cd)pyrene	*36*	*46*	*21*	*510*	*82*	*170*
Dibenzo(ah)anthracene	*0.28*	*0.32*	*0.27*	*3.6*	*0.57*	*1.3*
Benzo(ghi)perylene	*340*	*360*	*470*	*4000*	*640*	*1500*
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	*0.00087*	*0.001*	*0.001*	*0.077*	*3.5*	*5*
Trichloroethene (TCE)	*0.034*	*0.036*	*0.091*	*2.6*	*120*	*91*
1,1,1,2 Tetrachlorethane	*2.8*	*3.5*	*1.9*	*250*	*1400*	*1800*
Tetrachlorethene (PCE)	*0.39*	*0.4*	*1.5*	*42*	*1400*	*1100*
1,1,1 Trichlorethane	*18*	*18*	*110*	*1300*	*140000*	*76000*

Notes

1. All values above are in mg/kg
2. **Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters**, *numbers in italics are S4ULs*, ***numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters*** and underlined numbers are C4SLs
3. Soil organic matter (SOM) is assumed to be 2.5% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
6. For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
15. NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM

Contaminants	Residential with home grown produce	Residential without home grown produce	Allotments	Commercial	Public open space near residential housing POS_{resi}	Public park POS_{park}
Metals						
Beryllium	*1.7*	*1.7*	*35*	*12*	*2.2*	*63*
Boron	*290*	*11,000*	*45*	*240,000*	*21,000*	*46,000*
Cadmium	**10**[13] 22	**85**[13] 150	**1.8** 3.9	**230** 410	*120* 220	*560* 880
Chromium III	*910*	*910*	*18,000*	*8,600*	*1,500*	*33,000*
Chromium VI	*6* 21	*6* 21	*1.8* 170	*33* 49	*7.7* 21	*220* 250
Lead	200	310	80	2,300	630	1,300
Mercury *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] *[30]*
Mercury (inorganic)	**170**	**240**	**80**	**3600**	*120*	*240*
Nickel	*130*[10]	*180*[10]	*53*[11]	*980*[10]	*230*	*800*
Vanadium	*410*	*1200*	*91*	*9000*	*2000*	*5000*
Copper	*2400*	*7100*	*520*	*68000*	*12000*	*44000*
Zinc	*3700*	*40000*	*620*	*730000*	*81000*	*170000*
Semi-Metals and non-metals						
Arsenic	**32**[12] 37	**35**[12] 40	**43**[12] 49	**640**[12] 640	*79* 79	*170* 170
Antimony		***550***		***7500***	***1500***	***3300***
Selenium	**350**	**600**	**120**	**13000**	*1100*	*1800*
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_6	*42*	*42*	*730*	*3200*	*570000*	*95000*
$EC_{>6}$ - EC_8	*100*	*100*	*2300*	*7800*	*600000*	*150000*
$EC_{>8}$ - EC_{10}	*27*	*27*	*320*	*2000*	*13000*	*14000*
EC_{10}-EC_{12}	*130*	*130*	*2200*	*9700*	*13000*	*21000*
EC_{12}-EC_{16}	*1100*	*1100*	*11000*	*59000*	*13000*	*25000*
$EC_{>16}$ - EC_{35}	*65000*	*65000*	*260000*	*1600000*	*250000*	*450000*
$EC>_{35}$ - EC_{44}	*65000*	*65000*	*260000*	*1600000*	*250000*	*450000*
Aromatic risk banded hydrocarbons - TPHCWG method						
$EC>_5$ - EC_7	*70*	*370*	*13*	*26000*	*56000*	*76000*
$EC>_7$ - EC_8	*130*	*860*	*22*	*56000*	*56000*	*87000*
$EC_{>8}$ - EC_{10}	*34*	*47*	*8.6*	*3500*	*5000*	*7200*
EC_{10} - EC_{12}	*74*	*250*	*13*	*16000*	*5000*	*9200*
EC_{12} - EC_{16}	*140*	*1800*	*23*	*36000*	*5100*	*10000*
$EC_{>16}$ - EC_{21}	*260*	*1900*	*46*	*28000*	*3800*	*7600*
$EC_{>21}$ - EC_{35}	*1100*	*1900*	*370*	*28000*	*3800*	*7800*
$EC>_{35}$ - EC_{44}	*1100*	*1900*	*370*	*28000*	*3800*	*7800*
Aliph + Arom EC >44-70	*1600*	*1900*	*1200*	*28000*	3800	7800
Aromatic						
Benzene	**0.08**	**0.3**	**0.017**	**28**	*72*	*90*
Ethyl benzene	**65**	**170**	**16**	**520**[8] [17000]	**520**[8] *[24000]*	**520**[8] *[17000]*
Toluene	**120**	**610**	**22**	**860**[8] [59000]	**860**[8] *[56000]*	**860**[8] *[87000]*
Xylene[9]	**41**	**53**	**28**	**480**[8] [69000]	**480**[8] *[41000]*	**480**[8] *[17000]*
Phenol	**180**	**310**	**66**	**760**[14] (31000)	**760**[14] *(10000)*	**760**[14] *(7600)*
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	*2.3*	*2.3*	*4.1*	*190*	*4900*	*1200*
Acenaphthylene	*170*	*2900*	*28*	*83000*	*15000*	*29000*
Acenaphthene	*210*	*3000*	*34*	*84000*	*15000*	*29000*
Fluorene	*170*	*2800*	*27*	*63000*	*9900*	*20000*
Phenanthrene	*95*	*1300*	*15*	*22000*	*3100*	*6200*
Anthracene	*2400*	*31000*	*380*	*520000*	*74000*	*150000*
Fluoranthene	*280*	*1500*	*52*	*23000*	*3100*	*6300*
Pyrene	*620*	*3700*	*110*	*54000*	*7400*	*15000*
Benz(a)anthracene	*7.2*	*11*	*2.9*	*170*	*29*	*49*
Chrysene	*15*	*30*	*4.1*	*350*	*57*	*93*
Benzo(b)fluoranthene	*2.6*	*3.9*	*0.99*	*44*	*7.1*	*13*
Benzo(k)fluoranthene	*77*	*110*	*37*	*1200*	*190*	*370*
Benzo(a)pyrene	*2.2*	*3.2*	*0.97*	*35*	*5.7*	*11*
Indeno(123cd)pyrene	*27*	*45*	*9.5*	*500*	*82*	*150*
Dibenzo(ah)anthracene	*0.24*	*0.31*	*0.14*	*3.5*	*0.57*	*1.1*
Benzo(ghi)perylene	*320*	*360*	*290*	*3900*	*640*	*1400*
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	*0.00064*	*0.00077*	*0.00055*	*0.059*	*3.5*	*4.8*
Trichloroethene (TCE)	*0.016*	*0.017*	*0.041*	*1.2*	*120*	*70*
1,1,1,2 Tetrachlorethane	*1.2*	*1.5*	*0.79*	*110*	*1400*	*1500*
Tetrachlorethene (PCE)	*0.18*	*0.18*	*0.65*	*19*	*1400*	*810*
1,1,1 Trichlorethane	*8.8*	*9*	*48*	*660*	*140000*	*57000*

Notes

1. All values above are in mg/kg
2. **Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters**, *numbers in italics are S4ULs*, ***numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters*** and underlined numbers are C4SLs
3. Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
6. For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
15. NA: Not applicable

Appendix G – Risk Assessment Methodology

The site-specific risk assessment, presented in this report, follows the principle of establishing whether there is a viable linkage between a contaminant source to a potential receptor, via an exposure pathway.

The risk assessment corresponds with the total site area and incorporates both descriptive (qualitative) and, where available, numerical (quantitative) lines of evidence.

Risk assessment is the process of collating known information on a hazard or set of hazards to estimate actual or potential risk to receptors. The receptor may be humans, a water resource, a sensitive local ecosystem or future construction materials. Receptors can be connected to the source by one or several exposure pathways such as direct contact for example. Risks are generally managed by isolating the receptor or intercepting the exposure pathway or by isolating or removing the hazard.

Without the three essential components of a source, pathway and receptor there can be no risk. Therefore, the presence of contaminant source on a site does not necessarily mean there is a risk.

The risk assessment considers the likelihood of an event taking place (accounting for the presence of the source and receptor and the viability of the exposure pathway) in conjunction with the severity of the potential consequence (accounting for the potential severity of the hazard and the sensitivity of the receptor).

In the risk assessment, the consequence of the hazard has been classified as severe or medium or mild or minor and the probability (likelihood) of the circumstances occurring classified as high likelihood or likely or low likelihood or unlikely.

The consequences and probabilities are subsequently cross-correlated to give a qualitative estimation of the risk using Department of the Environment risk classifications as detailed in the table below and as referenced in CIRIA C552.

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability (Likelihood)	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

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In accordance with DoE guidance, the following categorisation of **consequence** has been developed.

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in “significant harm” as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to an ecosystem or organisation forming part of such ecosystem.	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health. Pollution of sensitive water resources. A significant change in an ecosystem or organism forming part of such ecosystem.	Concentration of a contaminant from site exceeds the generic or site-specific assessment criteria. Leaching of contaminants from a site to a Principal or Secondary A aquifer. Death of a species within a designated nature reserve. Lesser toxic and asphyxiate effects
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater (inc. Secondary B aquifers). Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

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In accordance with DoE guidance, the following categorisation of **probability** has been developed.

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

In accordance with DoE guidance, the following categorisation of **risk** has been developed.

Classification	Definition
Very High Risk	There is a *high probability* that *severe harm* could arise to a designated receptor from an identified hazard at the site without appropriate further action.
High Risk	*Harm* is *likely to arise* to a designated receptor from an identified hazard at the site without appropriate further action.
Moderate Risk	*It is possible* that without appropriate further action *harm could arise* to a designated receptor. It is relatively *unlikely* that any such harm would be *severe*, and if any harm were to occur it is *more likely* that such harm would be *relatively mild.*
Low Risk	*It is possible* that *harm could arise* to a designated receptor from an identified hazard. It is *likely* that, at worst, if any harm was realised any effects would be *mild.*
Very Low Risk	The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

The term 'risk' in this instance refers to the risk that the source, pathway, receptor linkage for a given source of contamination is complete. It does not refer to immediate risk to individuals or features present on the site from potential contaminants and is intended to be used as a tool to assess the necessity of further investigation.

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