

VITA T2, St Johns

Phase 2 Ground Investigation

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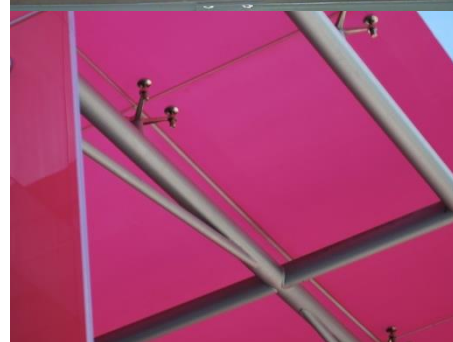
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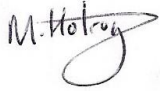
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Executive Summary

Appointment	In June 2021 Curtins were instructed by Select Property to undertake an additional ground investigation of land off Water Street in Manchester, M3 4JQ. An initial investigation was undertaken in 2018 providing a geo-environmental overview of the site, accounting for a previous iteration of the development layout. The additional investigation accounts for an updated development layout, to provide additional geotechnical information to aid foundation design. Development proposals include the construction of a 36 storey building with single storey basement beneath the tower footprint. A single storey wrap is proposed at the west of the proposed structure.
Current Site Status	The relatively flat site (26.51m – 25.97m AOD) is currently occupied by a car park with tarmac or concrete surface cover. The site is bound by hoarding and/or fencing, with Water Street immediately south/east, from which the site can be accessed.
Summary of Phase 1 and Previous Investigations	The earliest mapping (1848) indicates the site was occupied by New Botany Wharf, comprising multiple warehouses with associated small plant and machinery. A pub was located in the southern corner of the site. By the mid 20th century, there had been major reconstruction of the on-site structures, covering the majority of the site area. In the mid-1970s there was partial demolition of the on-site structures, allowing formation of a car park, before all site structures were demolished in 1986 when the whole site became a car park. The surrounding area was historically made up of high-density residential dwellings, before significant industrial and urban development in the late 1800s/early 1900s. The Mason Canal and Brunswick Basins were infilled in the mid 1950s, as well as the construction of engineering workshops in the surrounding area. Significant redevelopment of the surrounding area has commenced in recent years, including the construction of various mixed-use developments within the St. Johns masterplan area. BGS records indicate the site is underlain by superficial soils of alluvium (Secondary A Aquifer) and bedrock of the Chester Formation (Principal Aquifer). The site is not located within a source protection zone. The nearest surface water feature is the River Irwell, adjacent north/west of the site, with a River Quality Grade E.
Fieldworks Undertaken	Four rotary boreholes were undertaken in 2018 to depths of between 8.50m and 40.50m bgl. RBH20, RBH21 and RBH22 and RBH23 were advanced and included collection of rock core samples. In 2021, three cable percussion boreholes (CP01 – CP03) were undertaken, including one with rotary cored follow on to 41.00m bgl (CP01). Boreholes were undertaken in positions reflecting the proposed location of new structures and hardstanding to undertake soil sampling, ground gas monitoring, groundwater level monitoring and rock core sampling for geotechnical testing. Ground gas monitoring standpipes were installed within RBH21, RBH22 and CP01 – CP03. Selected soil and rock samples were subjected to laboratory analysis. One groundwater sample was obtained from the installation within CP01. Two gas and groundwater level monitoring visits were undertaken in 2018, with four further visits in 2021.
Encountered Ground Conditions	Made ground soils comprise a surface cover of tarmacadam or concrete, underlain by a reinforced concrete, or limestone, granite and concrete granular sub-base. This is underlain by generally granular material, with fragments of brick, slag, glass and concrete to maximum recorded depths of 1.70m to 3.20m bgl. Cohesive alluvium was recorded in RBH20, RBH21 and RBH23, comprising brown clay with varying proportions of sand and gravel, from 1.70m to 2.00m bgl. The base of the materials was recorded at 3.40m to 6.40m bgl. Granular alluvium was recorded in RBH22, RBH23, CP01, CP02 and CP03, comprising medium dense becoming dense orangish and yellowish brown gravelly fine to coarse sand and medium dense light brown and brown sandy gravel. Soils were encountered from 1.80m to 6.40m bgl. The base of the materials ranged between 4.20m to 7.70m bgl. Dense to very dense red sand and gravel, or reddish brown fine and medium sand were encountered in RBH20, RBH21, CP01, CP02 and CP03, underlying alluvium. These soils are indicative of weathered bedrock of the Chester Formation. The solid bedrock comprises extremely weak becoming very weak, weak or medium strong, thinly laminated to thinly bedded, reddish brown fine and medium grained sandstone. Groundwater strikes during the investigation were recorded at depths of between 3.70m and 5.00m bgl (22.88m to 20.97m AOD), rising by up to 0.30m. The water was recorded at the base of the alluvium soils or top of the Chester Formation (weathered bedrock). The hydrostatic head level of the groundwater encountered within the alluvium and Chester Formation is in the region of 4.12m to 3.62m bgl, or 22.61m to 21.85m AOD. It is likely that groundwater will be encountered during excavations for the construction of the basement level. Proposals indicate that the basement floor level will be constructed below this level.
Environmental Laboratory Testing	With respect to the proposed end-use of the site, soil testing results were compared against 'Commercial' GACs. No elevated concentrations of any of the contaminants tested were recorded above the relevant GAC thresholds. No suspected asbestos containing materials (ACMs) were identified within any of the exploratory hole logs, and no asbestos was detected in any of the soil samples analysed. The risk to site end users from soils is Low. The risk to construction and maintenance workers from soils is Low.

	Marginally elevated concentrations of copper and benzo(a)pyrene (B(a)P) were recorded in the water sample obtained from CP01 (3.82m bgl)), with respect to UK Drinking Water Standards. Marginally elevated concentrations of B(a)P were also recorded with respect to Water Framework Directive Environmental Quality Standards (WFD EQS). These results are considered to be indicative of background conditions within the aquifer, rather than sourced from shallow made ground soils. The risk to the underlying Principal Aquifer and adjacent River Irwell is Low and Very Low respectively.
Ground Gas Assessment	During the ground gas monitoring programme, methane (CH₄) was recorded below the instrument's detection limit within all the monitoring wells throughout the monitoring period. Maximum carbon dioxide (CO₂) concentrations ranging between <0.1% v/v and 4.8% v/v were recorded. Peak air flow rates ranged between -1.2 (0.7) l/hr and <0.1 l/hr, with maximum steady state air flow rates of between -1.2 (0.6) l/hr and <0.1 l/hr. The Gas Screening Value for the site is taken as 0.023 l/hr for carbon dioxide, indicative of a Characteristic Situation 1 (CS1) gas regime. No gas protection measures are required to mitigate the risk presented by methane or carbon dioxide. As the new development incorporates a single storey basement the advice of a specialist radon assessor must be obtained.
Geotechnical Assessment and Recommendations	The Made Ground or the underlying superficial deposits are not considered to be suitable founding stratum and it is therefore considered that a monolithic raft, piled raft or piled foundation solution could be adopted. In relation to the monolithic and or piled raft further geotechnical finite element modelling will be required to confirm suitability. For a piled solution specialist piling contractors should be contacted to see whether continuous flight auger or rotary bored piles would be more suitable for a piled raft or piled solution. It is recommended that the basement is constructed using permanent secant and or contiguous piled wall with dewatering to allow dry construction. The effects of dewatering will need to be considered on adjacent buildings and infrastructure due to changes in effective stress and possible foundation and or ground movements.
Recommendations	Based on the findings of the ground investigation, the following recommendations are made: 1) It is recommended that construction workers are provided with appropriate PPE and sanitary facilities, with reference to the environmental testing results. 2) Should unexpected contamination be observed during groundworks, advice should be obtained from a Geo-environmental Engineer. 3) As the new development incorporates a single storey basement the advice of a specialist radon assessor must be obtained 4) During development works, a UXO Risk Management Plan and Emergency Response Plan should be implemented. 5) Foundation options should be considered by further geotechnical modelling for a raft or piled raft. 6) A pumping test is required to finalise dewatering design for the basement and advise further the type of piled basement wall. 7) Before any dewatering occurs a predictive ground model should be undertaken to allow a monitoring regime to be put in place for buildings and infrastructure considered to be at risk from resulting ground movement.

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1.0 Introduction

1.1 Project Background

In June 2021, Curtins were instructed by Select Property to undertake a Phase 2 Ground Investigation of land at Water Street, St Johns, Manchester, M3 4JQ.

Four exploratory boreholes have previously been undertaken at the site, as part of a Curtins 2018 investigation of the wider St. Johns development site. Since the initial investigation was undertaken the proposed building footprint has been relocated. Additional boreholes have been undertaken to account for the new iteration of the design layout, and additional geotechnical information required for foundation design.

Development proposals include the construction of a 36 storey building with single storey basement beneath the tower footprint. A single storey wrap is proposed at the west of the proposed structure, as detailed in *Figure 1.1*.



Figure 1.1 – Summary of Development Proposal

Detailed development proposals are included within *Appendix A* for review.

This report considers the geo-environmental risks associated with the site, including soil and groundwater contamination and ground gas risk, and recommendations for basement design, foundation options, basement floor slab construction and considerations for excavations at this site.

1.2 Scope of Services

A scope for the intrusive ground investigation was developed with the following aims:

- i) Support the associated planning application (ref. 126648/FO/2020), and support discharge of relevant pre-commencement contaminated land planning conditions

Specifically, the Phase 2 Ground Investigation Report is intended to:

- a) Determine the risk of the proposed end-user being adversely impacted by potential contamination in shallow site soils that may be present on the site due to its known current, recent and historical use;
- b) Determine if there is a risk to the end-user from soil gases including methane, carbon dioxide, carbon monoxide and hydrogen sulphide;
- c) Characterise site wide natural soils and solid geology;
- d) Recommendations for the design of foundations and ground floor slabs; and
- e) Recommendations for the specification of sub-structure concrete.

Detailed flood risk assessment, ecology, archaeological studies and waste classification for off-site disposal are outside of the scope of this report.

The investigation is supplementary to works undertaken by Curtins in 2018/2019. Reporting will include reference to boreholes RBH20, RBH21, RBH22 and RBH23, as well as associated chemical and geotechnical analysis results, and ground gas and groundwater level monitoring data.

2.0 Phase 1 Preliminary Site Assessment Summary

A Phase 1 Desk Study was undertaken for the site by Curtins in July 2016, on behalf of Allied London. (Ref.1). A summary of the detailed findings of this Desk Study, comprising current site setting, history, geology and hydrogeology/hydrology is presented within this Section with reference to additional information sources.

2.1 Current Setting

The relatively flat site is currently occupied by a car park with tarmac surface cover. The site is bound by hoarding and/or fencing, with Water Street immediately south, from which the site can be accessed.

The site location and boundary are illustrated in *Figure 2.1*.



Figure 2.1 – Site Location Plan (site boundary shown in pink. 250m buffer in purple).
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2.2 Previous Site Use

The earliest mapping (1848) indicates the site was occupied by New Botany Wharf, comprising multiple warehouses with associated small plant and machinery. A pub was located in the southern corner of the site. By the mid 20th century, there had been major reconstruction of the on-site structures, covering the majority of the site area. In the mid-1970s there was partial demolition of the on-site structures, allowing formation of a car park, before all site structures were demolished in 1986 when the whole site became a car park.

The surrounding area was historically made up of high-density residential dwellings, before significant industrial and urban development in the late 1800s/early 1900s. The Mason Canal and Brunswick Basins were infilled in the mid 1950s, as well as the construction of engineering workshops in the surrounding area. Significant redevelopment of the surrounding area has commenced in recent years, including the construction of various mixed-use developments within the St. Johns masterplan area.

2.3 Published Geology

A study of the Envirocheck within the Phase 1 Preliminary Risk Assessment (Ref. 1) report and the British Geological Survey (BGS) 1:50,000 mapping records (Solid and Drift) for Manchester (Sheet 085) dated 2011 (Ref. 2) indicates the following geological and hydrogeological succession underlying the site:

- **Superficial Deposits:** Alluvium
- **Solid Geology:** Chester Formation, Sandstone

2.3.1 Made Ground Deposits

BGS mapping records do not indicate Made Ground on site, however given historic development on site, and demolition of residential dwellings and warehouses made ground is anticipated to be present.

2.3.2 Superficial Deposits

Superficial deposits are recorded as alluvium, anticipated to comprise sand with varying proportions of clay and gravel.

2.3.3 Bedrock Deposits

The site is underlain by the Chester Formation. This typically comprises fine to coarse grained sandstone, commonly pebbly, with conglomerates and sporadic siltstone.

2.3.4 BGS Recorded Borehole Logs

Several BGS recorded borehole logs are located in the area surrounding the site. The majority are confidential and cannot be accessed. A summary of available boreholes in the surrounding area is presented in *Table 2.3.4*.

Table 2.3.4 – Historical Borehole Record from Surrounding Area

Borehole Ref.	Location (Easting, Northing)	Details (Depth to top of strata/lithology/strata thickness)
SJ89NW1496	40m northeast (383070, 398090)	0.00m bgl Bitumous surface onto setts (0.30m)
		0.30m bgl Made ground: ash, cinder, silt, clay, sand and gravel (0.30m)
		0.60m bgl Firm/stiff sandy very silty clay with sand lenses (0.90m)
		1.50m bgl Medium dense silty slightly gravelly fine to medium sand with clay lenses (1.10m)
		2.60m bgl Very dense brown fine to coarse sand and gravel (0.50m)
		3.10m bgl Very dense red-brown fine to medium sand with clay lenses (weathered sandstone) (1.60m)
		4.70m bgl borehole termination

BGS borehole reference SJ89NW85, located approximately 180m north-east of the site, generally records moderate depths of made ground (c.2.10m bgl), heterogeneous in nature, comprised of gravels, sands and fill materials. This was underlain by varying sands and loam comprising sands and gravels further underlain by sandstone at an approximate depth of 5.00m bgl.

2.3.5 Mining

The Coal Authority's online interactive mapping (Ref. 3) confirm the site is located within a coal mining reporting area; however, it is not within a development high risk area and is not underlain by coal bearing strata.

The Envirocheck report within the Phase 1 Preliminary Risk Assessment (Ref.1) confirms there are no recorded BGS mineral sites within 250m of the site. No evidence of mining was noted within the historical mapping within or immediately surrounding the site.

The risk to the development from coal mine workings is considered **Low**.

2.3.6 Radon

There are no BGS recorded landfills within 500m of the site.

The site is located within a Lower Probability Radon Area (less than 1% of homes are estimated to be at or above the Action Level).

The proposed development includes a single storey basement level, and therefore the advice of a radon specialist should be obtained.

2.4 Hydrogeology and Hydrology

The Envirocheck Report within the Phase 1 Preliminary Risk Assessment (Ref. 1) indicates that the geological sequence underlying the site has the following hydrogeological characteristics:

Table 2.4 – Hydrogeology and Hydrology Summary

Geology	Associated Hydrogeological Classification
Alluvium	Secondary A Aquifer ¹
Chester Pebble Beds Formation	Principal Aquifer ²

Notes:

1. 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.
2. 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 aquifer.

The site is not located within a designated Source Protection Zone (SPZ).

The nearest groundwater abstractions are located 404m north-east of the site, at Gartside St. Manchester, operated by Bovis Lend Lease Ltd and Her Majesty's Court Service, for non-evaporative colling purposes.

It is understood that groundwater abstractions are also utilised by the Museum of Science and Industry to the south.

The nearest surface water feature is the River Irwell, adjacent north of the site, with a River Quality Grade E.

The nearest surface water abstraction is located 724m southwest of the site, at Cds Computer Design Systems Ltd. The water is abstracted from the River Irwell, at Irwell Works, Ordsall Lane, Salford, for industrial/commercial/public services: general cooling (low loss).

There are seven discharge consents recorded within 250m of the site all relating to storm water/storm sewage overflows into the river Irwell to the west, north-west and south-west of the site.

2.5 Unexploded Ordnance (UXO) Risk Assessment

The likelihood of UXO being encountered on a development site is influenced by several factors including; the proximity to strategic targets, the nature of the development works being undertaken and evidence of local damage in the post-war periods amongst others. To determine the likelihood of UXO being present on a site, a step-wise risk assessment process is followed. This process is outlined within CIRIA C681 Unexploded Ordnance: A Guide for the Construction Industry (Ref. 4).

Risk Mapping for UXO's (Ref. 5) has placed the site in areas of medium and high risk. Moderate risk areas are those that show a bomb density of 15 - 49 bombs per 1000 acres and may contain WWII

targets. High risk targets are those that show a bomb density of >50 bombs per 1000 acres and contain WWII targets.

Analysis of historical bomb mapping from the University of Manchester (Ref. 6) (*Figure 2.5*) shows that a high explosive bomb hit occurred approximately 50m southwest of the site, with damage to the railway line. A second high-explosive strike was recorded approximately 200m east, with further bomb damage and demolished buildings recorded in the vicinity.



Figure 2.5: Site boundary shown in light blue. Blue circles represent high-explosive bomb hits. Pink shading for demolished buildings, lines mark bomb damage during the Blitz.

A Detailed UXO Risk Assessment was undertaken by Landmark Information Group Ltd and 6 Alpha Associates in March 2018. For the purposes of intrusive investigation, the report identified a **High** risk from items of German aerial delivered UXO, and a residual threat from allied UXO across the site.

The report recommended the following is implemented to support the intrusive works:

- UXO Risk Management Plan and Emergency Response Plan;
- Site specific UXO awareness briefings to all personnel conducting intrusive works;
- EOD Banksman support to monitor all 'open' works (eg trial pits etc.); and
- Down hole magnetometry to maximum bomb penetration depth for all boreholes.

2.6 Landfill

There are no BGS Recorded landfill sites, historic landfill sites or currently operational landfill sites within 250m of the site.

Historic mapping and the Envirocheck Report within the Phase 1 Preliminary Risk Assessment (Ref. 1) identify the infilling of the canal basins to the west of the site.

2.7 Summary of Phase 1 PCSM

A summary of potential pollutant linkages at the development site as identified in the Phase 1 Report (Ref. 1) are presented in *Table 2.7*. These potential pollutant linkages were identified as requiring further investigation to enable the safe redevelopment of the site and are detailed in *Table 2.7* on the following page.

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

Table 2.7 – Preliminary Conceptual Site Model

Source	Pathway	Receptor	Risk Rating	Action
On-site sources of potential contamination: - Made Ground from unknown sources associated with historic development of the site. - Leaks/ spills from plant/engineering identified on historical plans of site. - Localised spillages associated with dockyard processes. - Potential use of asbestos materials on site - Leachable contamination associated with off-site historic railway tracks, substations, engineering works and wider industrial settling.	Direct contact, ingestion, inhalation (dust and vapours)	End-user of site (Commercial and Residential) & Construction Workers	Moderate	Undertake soil testing of shallow soils across the site and undertake GQRA as part of ground investigation.
	Vertical migration through the superficial deposits (soils) May occur due to existing service corridors and physical processes including; capillary action and downwards flow into the natural deposits through infiltration.	Controlled Waters (Groundwater) Bedrock hosts Principal Aquifer Superficial deposits host Secondary A Aquifer. No potable groundwater abstractions within 500m of the site. Basement level anticipated to be constructed, removing potential sources of contamination within made ground soils.	Low	Undertake groundwater testing and GQRA as part of ground investigation.
	Horizontal migration over and through the superficial deposits (soils)	Controlled Waters (Surface Water) The nearest surface water feature is the River Irwell, adjacent north of the site, which has a water quality rating of "E". Basement level anticipated to be constructed, removing potential sources of contamination within made ground soils.	Low	
On and off-site soils with the potential to generate ground gases: - Potential ground gas generation from Made Ground containing organic/putrescible content on site. - Migration of ground gas from infilled canal basins in the vicinity of the site, and other infilled (water) features near the site.	Vertical and horizontal migration through underlying superficial deposits into buildings and air spaces	Site End Users (Basement level, Commercial ground floor, residential apartments above)	Moderate	Undertake ground gas monitoring as part of ground investigation.

3.0 Ground Investigation Scope of Works

Two phases of investigation have been undertaken by Ian Farmer Associates (IFA) on behalf of Curtins, beneath the footprint of the proposed VITA T2 building. The first phase of intrusive works was undertaken between 25th October to 19th November 2018, with two subsequent gas and groundwater monitoring visits. The second phase of intrusive investigation was undertaken between 3rd and 28th August 2021, with four subsequent gas and groundwater monitoring.

The scope of the ground investigation was designed in general accordance with current UK guidance including:

- LCRM (Ref. 7);
- British Standard (BS) 10175:2011+A2:2017 (Ref. 8);
- BS5930:2015+2020 (Ref. 9); and
- BS EN1997: Part 2:2007 Eurocode 7 (Ref. 10).

The scope and rationale are summarised in *Table 3.0*.

Table 3.0 – Scope and Rationale of Fieldwork Undertaken

Investigation Ref.	Exploratory Hole Type	Exploratory Hole Ref.	Ground level (m AOD)	Exploratory Hole Depth (m bgl)	Rationale
2018	Rotary Boreholes	RBH20	26.58	40.50	Confirm the shallow and deeper ground and groundwater conditions; Collect soil samples for chemical analysis; Collect soil samples for geotechnical soil testing Collect rock core samples for geotechnical testing; Ground gas and groundwater level monitoring; and Collect groundwater samples for chemical analysis.
		RBH21	26.23	36.00	
		RBH22	25.97	40.50	
		RBH23	25.36	8.50	
2021	Cable Percussive Boreholes	CP02 CP03	26.33 26.51	6.14 6.13	Confirm the shallow ground and groundwater conditions; Collect soil samples for chemical analysis; Collect soil samples for geotechnical soil testing Ground gas and groundwater level monitoring; and Collect groundwater samples for chemical analysis.
	Cable Percussive with Rotary Cored Follow on Boreholes	CP/RC01*	25.97	41.00*	Confirm the shallow and deeper ground and groundwater conditions; Collect soil samples for chemical analysis; Collect soil samples for geotechnical soil testing

Investigation Ref.	Exploratory Hole Type	Exploratory Hole Ref.	Ground level (m AOD)	Exploratory Hole Depth (m bgl)	Rationale
					Collect rock core samples for geotechnical testing; Ground gas and groundwater level monitoring; and Collect groundwater samples for chemical analysis.

* CP01 with rotary cored follow on from rockhead.

Co-ordinate locations and ground level was surveyed at each exploratory hole location by Ian Farmer Associates.

The location and ground level at each position are presented on the exploratory hole logs which can be referred to in *Appendix B*.

For the location of the exploratory holes refer to Curtins drawing ref: 075424-CUR-00-XX-DR-GE-002-V01 included in *Appendix A*.

3.1 Soil and Rock Logging and Sampling

Exploratory hole arisings were logged onsite by an Ian Farmer Associates Engineer in accordance with the requirements of BS5930 (Ref. 9). Rock core obtained in the rotary boreholes was logged at Ian Farmer Associates Laboratory in accordance with the requirements of BS5930 (Ref. 9). Exploratory hole logs can be referred to *Appendix B*.

No observed visual and olfactory indications of contamination were recorded.

Soil samples for chemical and geotechnical analysis were obtained and placed within containers, specified by the receiving laboratory, and stored in cool boxes on site.

Selected rock core samples were obtained for geotechnical analysis. Samples were stored in core boxes on site.

3.2 Monitoring Well Installations

Ground gas and groundwater monitoring 50mm diameter slotted pipes, with silt sock surround, were installed within CP/RC01, CP02, CP03, RBH21 and RBH22. A bentonite seal was placed at the top and bottom of each of the exploratory holes, surrounding the screened sections of the pipe. A gravel surround was installed in the annulus between the sides of the borehole and the slotted sections of the pipe.

The monitoring wells were designed to assess the potential for ground gas and monitor groundwater levels. The screened sections therefore focused on made ground, shallow granular superficial soils, and the underlying bedrock.

The deeper wells were installed to determine groundwater levels at proposed basement depth and obtained groundwater samples to determine the risk of site contamination to the underlying Principal Aquifer.

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

Table 3.2 – Monitoring Well Response Zones

Investigation Ref.	Borehole Ref.	Response Zone m bgl (m AOD)	Strata Description(s)
2018	RBH21	No installation details	No installation details. Base of installation in sandstone.
	RBH22	2.50 – 7.20 (23.47 – 18.77)	Sand and sandstone
2021	CP/RC01	3.00 – 7.00 (22.97 – 18.97)	Sand and sandstone
	CP02	2.00 – 6.00 (24.33 – 20.33)	Made ground and sand
	CP03	0.50 – 3.00 (26.01 – 23.51)	Made ground

A copy of the borehole logs can be referred to in *Appendix B* of this report.

3.3 Post-Investigation Monitoring

Ground gas and groundwater level monitoring visits were undertaken on 14th and 22nd November 2018 for RBH22 only. Groundwater samples were not obtained during the first phase of investigation.

Additional ground gas and groundwater level monitoring was undertaken between 18th August 2021 and 7th October 2021 for each of the boreholes recorded in *Table 3.2*. Four monitoring visits have been undertaken. A groundwater sample was obtained from CP/RC01 on 3rd September 2021.

The results of the groundwater level monitoring are detailed in *Section 5.8*.

The results of the ground gas monitoring are detailed in *8.0*.

4.0 Laboratory Analysis

4.1 Geo-environmental and Geotechnical Analysis

Representative soil samples were selected for laboratory chemical and geotechnical analysis, based on field observations and to provide information about the encountered ground conditions. Selected rock core samples were scheduled for geotechnical analysis. Soil sampling positions were generally located in a non-targeted, systematic array, to give adequate and representative coverage of the sites proposed end use and the immediate environmental setting.

Soil and groundwater 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 and geotechnical analysis of soils was Envirolab (UKAS and MCERTS accredited). The geotechnical analysis was subcontracted to Ian Farmer Associates (UKAS Accredited).

The laboratory selected for geotechnical analysis of rock core samples was Ian Farmer Associates, a UKAS accredited laboratory.

4.1.1 Soil Analysis

The source material of contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), polyaromatic hydrocarbons (PAHs), heavy metals, and asbestos.

The extent of the above is captured by the broad environmental testing suites listed in *Table 4.1.1*.

Table 4.1.1 – Environmental Chemistry Analysis Suite: Soils

Suite Ref.	Analyte	LOD
Soils Suite A	Asbestos Screen	-
	pH Value	0.1 pH
	2:1 Water Soluble Sulphate	0.01 g/l
	Soil Organic Matter (SOM)	0.1% w/w
	Arsenic, Chromium, Chromium VI, Copper, Lead, Nickel, Selenium	1 mg/kg
	Zinc	5 mg/kg
	Boron (water soluble)	1 mg/kg
	Cadmium	0.5 mg/kg
	Mercury	0.17 mg/kg
	Cyanide (total)	1 mg/kg

Suite Ref.	Analyte	LOD
	Phenols (screen)	0.2 mg/kg
	PAHs (USEPA 16)	0.1 – 0.8 mg/kg
	TPH (Aro/Ali Split)	0.01 - 1 mg/kg

A total of 8 soil samples were obtained from the boreholes and tested for Suite A. Three made ground soil samples were obtained during the 2018 investigation, and 3 No. made ground and 2 No. natural soils during the 2021 investigation.

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

4.1.2 Groundwater Analysis

One groundwater sample was obtained from the monitoring well installed within CP/RC01. The monitoring well was developed to remove potential contamination associated with the drilling of the borehole and subsequent installation. Three well volumes of water were bailed from CP/RC01 on 18th August 2021 to develop the well, and a further three well volumes were bailed prior to obtaining the water sample on 3rd September 2021.

No groundwater sampling or chemical testing was undertaken during the 2018 investigation.

The sample from CP/RC01 was subject to chemical analysis for a suite of contaminants of concern similar to that described for shallow site soils. The testing suite is summarised in *Table 4.1.2*.

Table 4.1.2 – Environmental Chemistry Analysis Suite: Water

Suite Ref.	Analyte	LOD
Soils Suite A	TPH CWG, EPHCWG – Ali/Aro Split	1 – 10 µg/l
	BTEX Compounds	1 µg/l
	Dissolved: arsenic, boron, cadmium, copper, chromium, lead, mercury, nickel selenium, zinc	0.1 – 10 µg/l
	PAH 16MS	0.01 µg/l
	pH	0.01 pH
	Hardness Total	2 mg/l CaCO ₃
	Sulphate, Dissolved calcium	1 mg/l
	Cyanide (total)	0.005 mg/l
	Phenols – Total by HPLC	0.01 mg/l
	Sulphide	0.1 mg/kg
	DOC	0.2 mg/l

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

4.2 Geotechnical Analysis

Rock samples for geotechnical testing were prepared and tested in accordance with ISRM Suggested Methods (Ref.11). Copies of the geotechnical testing certificates are presented in *Appendix D*. The following tests were carried out:

4.2.1 2018 Investigation

- 48 No. Point Load Index Test (PLT) – Axial Plane;
- 43 No. PLT – Diametral Plane;
- 14 No. Uniaxial Compressive Strength (UCS);
- 21 No. Bulk Density;
- 7 No. Dry Density;
- 7 No. Natural Rock Water Content;
- 7 No. Rock Porosity Density;
- 1 No. Brazilian Test;
- 1 No. Sound Velocity Test (P and S Wave);
- 1 No. Hoek Triaxial Compression Test; and
- 1 No. Hoek Shear Box Test.

4.2.2 2021 Investigation

- 30 No. Point Load Index Test (PLT) – Axial Plane;
- 30 No. PLT – Diametral Plane;
- 12 No. Uniaxial Compressive Strength (UCS); and
- 10 No. BRE SD1 Suite D.

5.0 Ground Conditions

The ground conditions across the site, determined during the Curtins ground investigation works, comprised variable made ground, including a surface cover of tarmac and concrete underlain by granular soils, cohesive glacial till, granular glacial till and sandstone of the Chester Formation. The shallow natural soils encountered were generally consistent across the site and will be summarised in the following sections.

5.1 Encountered Ground Conditions

A summary of the ground conditions encountered during the 2018 and 2021 Curtins site investigation works is presented below, with detailed information presented on the exploratory hole logs which can be referred to in *Appendix B*.

Table 5.1 – Summary of Ground Conditions Encountered in the Curtins Investigations

Stratum	Depth to top of strata, m bgl (m AOD)	Recorded Thickness (m)		Description
		Min	Max	
Made Ground	0.00 (26.58 to 25.36)	1.70	3.20	Concrete or Tarmacadam underlain by reinforced concrete or limestone, granite and concrete granular sub-base Yellowish brown and black sandy gravel. Reddish grey slightly clayey and slightly sandy gravel. Light brown and light grey gravelly fine to coarse sand. Anthropogenic materials include brick, slag, glass and concrete.
Alluvium	1.70 to 3.20 (24.88 to 23.31)	0.80	5.70	Brown gravelly clay. Medium dense orangish brown and yellowish brown gravelly fine to coarse sand. Medium dense brown very silty very sandy gravel.
Residual Soils	3.40 to 4.50 (22.83 to 21.83)	0.80*	2.30*	Dense and very dense red sand and gravel.
Chester Formation	4.20 to 7.70 (21.77 to 17.66)	- **		Extremely weak to medium strong reddish brown fine and medium grained sandstone.

* Where encountered

** Max thickness not recorded.

5.2 Made Ground

The surface covering of the site comprised tarmacadam or concrete, underlain by a sub-base of reinforced concrete or a limestone, granite and concrete granular sub-base.

The underlying material was generally granular, comprising:

- RBH20 – Sandy fine to coarse gravel to 1.70m bgl (24.88m AOD);
- RBH21 – Yellowish brown mottled black sandy gravel with cobbles to 1.70m bgl (24.53m AOD);

- RBH22 – Brown mottled black sandy gravel with cobbles to 1.90m bgl (24.07m AOD);
- RBH23 – Light grey fine to coarse sand and gravel with cobbles to 2.00m bgl (23.36m AOD);
- CP01 – Reddish grey, slightly clayey gravel and slightly sandy slightly clayey gravel to 1.59m bgl (24.47m AOD) , underlain by greyish red gravelly fine to coarse sand to 1.80m bgl (24.17m AOD);
- CP02 – Medium dense, dark reddish brown, very sandy gravel to 3.00m bgl (23.33m AOD); and
- CP03 – Loose and medium dense light brown and light grey gravelly fine to coarse sand (to 2.40m), underlain by medium dense light brown slightly gravelly clayey fine to coarse sand to 3.20m bgl (23.31m AOD)

Anthropogenic materials include brick, slag, glass and concrete.

5.3 Alluvium

Cohesive alluvium was recorded in RBH20, RBH21 and RBH23, comprising brown clay with varying proportions of sand and gravel, from depths of 1.70m to 4.20m bgl, 1.70m to 3.40m bgl and 2.00m to 6.40m bgl (24.88m to 22.38m AOD, 24.53m to 22.83m AOD, and 23.36m to 18.96m AOD) respectively.

Granular alluvium was recorded in RBH22, RBH23, CP01, CP02 and CP03, comprising medium dense becoming dense orangish and yellowish brown gravelly fine to coarse sand and medium dense light brown and brown sandy gravel. Soils were encountered from 1.90m to 4.20m bgl, 6.40m to 7.70m bgl, 1.80m to 4.40m bgl, 3.00m to 4.50m bgl, and 3.20m to 4.00m bgl (24.07m to 21.77m AOD, 18.96m to 17.66m AOD, 24.17m to 21.57m AOD, 23.33m to 21.83m AOD and 31.31 to 22.51m AOD) respectively.

Gravel fragments are fine to coarse subangular to subrounded sandstone, siltstone, mudstone and quartz. Rare rounded cobbles of sandstone were also recorded.

5.4 Weathered Bedrock

Weathered bedrock were encountered beneath alluvium in RBH20, RBH21, CP01, CP02 and CP03 from 4.20 to 5.00m bgl, 3.40m to 4.80m bgl, 4.40m to 6.70m bgl, 4.50m to >6.14m bgl and 4.00m to >6.13m bgl (22.38m to 21.58m AOD, 22.83m to 21.43m AOD, 21.57m to 19.27m AOD, 21.83m to <20.19m AOD and 22.51m to <20.38m AOD) respectively.

Soils comprise very dense red sand and gravel or reddish brown fine and medium sand.

CP01 also recorded sandstone recovered as very dense gravelly fine to coarse sand. Similar soils were recorded in CP03.

Residual soils were not encountered in RBH22 or RBH23.

5.5 Chester Formation

Intact bedrock of the Chester Formation was encountered in RBH20, RBH21, RBH22, RBH23, CP01 and CP03, beneath weathered bedrock, where encountered, or alluvium.

Competent bedrock comprises extremely weak becoming very weak, weak or medium strong, thinly laminated to thinly bedded, reddish brown fine and medium grained sandstone. Where non-intact rock was encountered this was recovered as angular to subangular gravel, locally clayey and sandy.

Discontinuities within the rock are horizontal to sub-horizontal, extremely closely spaced to closely spaced, planar, rough and clean. Rare sub-vertical or vertical fractures and 45-50 degree fractures are recorded, occasionally infilled with calcite. Very closely spaced to medium spaced 30 degree fractures were recorded in CP01 between 15.80m and 23.70m bgl (10.17m and 2.27m AOD), as well as 60 degrees fractures between 23.70m and 25.40m bgl (2.27m and 0.57m AOD).

Localised bands of reddish brown mudstone were also recorded, often interbedded with the sandstone.

5.6 Observed Potential Contamination

No visual or olfactory indicators of contamination were recorded during the investigation or subsequent monitoring.

5.7 Obstructions Encountered

No obstructions were encountered.

5.8 Groundwater

Table 5.8a summarises the groundwater levels recorded during drilling. Full details of the recorded groundwater strikes during the investigation are presented in the borehole logs in Appendix B.

Table 5.8a – Groundwater Noted During Drilling

Investigation Date	Exploratory Hole Ref.	Strike Depth (m bgl)	Rose to Depth (m bgl)	Strike Level (m AOD)	Strata
2018	RBH20	3.70	–	22.88	Clay (Alluvium)
	RBH23	4.00	–	21.36	Clay (Alluvium)
2021	CP01	5.00	4.70	20.97	Sand (Weathered Bedrock)
	CP02	5.00	4.70	21.33	Sand (Weathered Bedrock)
	CP03	4.80	4.50	21.71	Sandstone (Chester Formation)

Due to the use of water flush during the progression of the rotary boreholes in the Chester Formation, it was not possible to determine the groundwater level during the investigation where this methodology was used.

Two rounds of groundwater level monitoring of RBH22 were undertaken during the 2018 investigation, on 14th and 22nd November 2018. Water levels were recorded at 3.91m and 4.00m bgl (22.06m and 21.97m AOD) respectively. The monitoring well was installed within the granular alluvium, weathered bedrock and the top of the Chester Formation.

Four further rounds of groundwater level monitoring were undertaken during the 2021 investigation, the results of which are summarised in *Table 5.8b*.

Table 5.8b – Groundwater Monitoring Results - 2021

Borehole Ref.	Installation Strata	Response Zone m bgl	Depth, m bgl (m AOD)			
			18/08/21	03/09/21	16/09/21	07/10/21
RBH21	No installation details		-	3.62 (22.61)	3.69 (22.54)	-
RBH22	Sand and sandstone	2.50 – 7.20 (23.47 – 18.77)	-	4.12 (21.85)	4.08 (21.89)	3.65 (22.32)
CP/RC01	Sand and sandstone	3.00 – 7.00 (22.97 – 18.97)	3.77 (22.20)	3.82 (22.15)	3.87 (22.10)	-
CP02	Made ground and sand	2.00 – 6.00 (24.33 – 20.33)	4.07 (22.26)	3.89 (22.44)	4.01 (22.32)	-
CP03	Made ground	0.50 – 3.00 (26.01 – 23.51)	Dry	Dry	Dry	Dry

- indicates borehole not monitored

Based upon groundwater elevations and the underlying geology, the following considerations are given to the underlying groundwater regime:

- Groundwater levels beneath the site were recorded at depths of between 3.70m and 5.00m bgl (22.88m to 20.97m AOD), rising by up to 0.30m. The water was recorded at the base of the alluvium soils or top of the Chester Formation (Weathered Bedrock).
- The hydrostatic head level of the groundwater encountered within the alluvium and Chester Formation is in the region of 4.12m to 3.62m bgl, or 22.61m to 21.85m AOD. It is likely that groundwater will be encountered during excavations for the construction of the basement level. Proposals indicate that the basement floor level will be constructed below this level.
- Dewatering will be required to facilitate construction of the basement. Designers should consider the potential influence of the River Irwell on dewatering potential. Consideration should also be given to the impact of dewatering on existing water supplies for the Museum of Science and Industry and the Manchester Courts of Justice.

6.0 Ground Model

The ground model for the site interprets the findings of the exploratory hole logs and geotechnical testing results. A summary of the geotechnical parameters to be used in design are included at the end of this section.

6.1 Made Ground

Made ground was encountered in all exploratory holes from ground level to between 1.27m and 2.20m bgl.

Geotechnical testing including in-situ SPTs and pH and 2:1 water soluble sulphate tests were undertaken on the made ground soils, however these soils are to be removed from site to facilitate the construction of a single storey basement level. As such geotechnical parameters for this layer have not been derived.

Ground aggressivity to concrete has been discussed in *Section 6.6*.

6.2 Cohesive Alluvium

Cohesive alluvium was only recorded in the 2018 rotary open hole boreholes RBH20, RBH21 and RBH23. No in-situ or laboratory tests were undertaken on these soils.

As such, geotechnical parameters for design have not been derived.

6.3 Granular Alluvium

Granular alluvium was recorded in RBH22, RBH23, CP01, CP02 and CP03, comprising medium dense becoming dense orangish and yellowish brown gravelly fine to coarse sand and medium dense light brown and brown sandy gravel. Soils were encountered from 1.90m to 4.20m bgl, 6.40m to 7.70m bgl, 1.80m to 4.40m bgl, 3.00m to 4.50m bgl, and 3.20m to 4.00m bgl (24.07m to 21.77m AOD, 18.96m to 17.66m AOD, 24.17m to 21.57m AOD, 23.33m to 21.83m AOD and 31.31 to 22.51m AOD) respectively.

Gravel fragments are fine to coarse subangular to subrounded sandstone, siltstone, mudstone and quartz. Rare rounded cobbles of sandstone were also recorded.

The geotechnical test results recorded within the granular alluvium deposits are summarised in *Table 6.3*.

Table 6.3 – Summary of granular geotechnical test results

Parameter	No. of tests	Minimum	Maximum
pH	4	8.57	9.22
Water Soluble Sulphate (mg/l)	4	11	24
SPT 'N' Value Granular ⁽¹⁾	6	16	35

Parameter	No. of tests	Minimum	Maximum
PSD%	4	2	56
Cobbles		26	92
Gravel		5	15
Sand		1	7
Silt/Clay			

(1) Only includes SPTs tests in which full penetration was achieved.

Six standard penetration tests (SPTs) were undertaken in the granular alluvium soils, with 'N' values ranging between 16 and 35 indicating medium dense to dense deposits.

A moderately conservative characteristic unit weight of 16-18 kN/m³ above the water table and 18-20 kN/m³ below the water table is determined, with reference to BS8004 (Ref. 12).

Estimates of the Young's Modulus of the granular soils ranged between 15.5 MN/m² and 25 MN/m².

A moderately conservative characteristic Angle of Shearing Resistance (ϕ') of 32° has been derived from correlation with SPT N values (Peck et al, 1967, Ref. 14) and a review of published values.

6.4 Weathered Bedrock

Weathered bedrock) were encountered beneath alluvium in RBH20, RBH21, CP01, CP02 and CP03 from 4.20 to 5.00m bgl, 3.40m to 4.80m bgl, 4.40m to 6.70m bgl, 4.50m to >6.14m bgl and 4.00m to >6.13m bgl (22.38m to 21.58m AOD, 22.83m to 21.43m AOD, 21.57m to 19.27m AOD, 21.83m to <20.19m AOD and 22.51m to <20.38m AOD) respectively.

Deposits comprise dense and very dense red and reddish brown fine and medium sand, and sand and gravel.

Limited in-situ and laboratory geotechnical testing was undertaken in these soils.

Seven in-situ standard penetration tests (SPTs) were undertaken on granular soils. N values >50 were typically recorded, with the exception of one test at 4.00m bgl (22.51m AOD) in CP03 recording a 'N' value of 7.

A moderately conservative characteristic unit weight of 20-22kN/m³ above the water table and 22-24 kN/m³ below the water table is determined, with reference to BS8004 (Ref. 12).

Estimates of the Young's Modulus of the granular soils ranged between 11 MN/m², for the lower density soils described above, and 32.5 MN/m².

A moderately conservative characteristic Angle of Shearing Resistance (ϕ') of 40° has been derived from correlation with SPT N values (Peck et al, 1967, Ref 14) and a review of published values.

6.5 Chester Formation

Intact bedrock of the Chester Formation was recorded in exploratory hole ref. RBH20, RBH21, RBH22, RBH23, CP01 and CP03, beneath weathered bedrock, where encountered, or alluvium, from depths of between 4.20m and 7.70m bgl (21.77m and 17.66m AOD). The deepest bedrock was recorded in RBH23, CP01 and CP02.

Total core recovery (TCR) at the top of the Chester Formation was poor, though generally there is an increase in recovery from the rockhead to c. 15m AOD. A similar trend is noted in the solid core recovery (SCR).

The rock quality designation recorded in the sandstone cored samples was very poor to poor rock mass quality at elevations >15m AOD, improving to generally fair from this level. Notwithstanding, zones of poor, locally very poor, good and excellent rock mass quality were recorded from elevations >15m AOD.

A summary of the Rock Quality Parameters are presented in *Figure 6.5a* and *Figure 6.5b*.

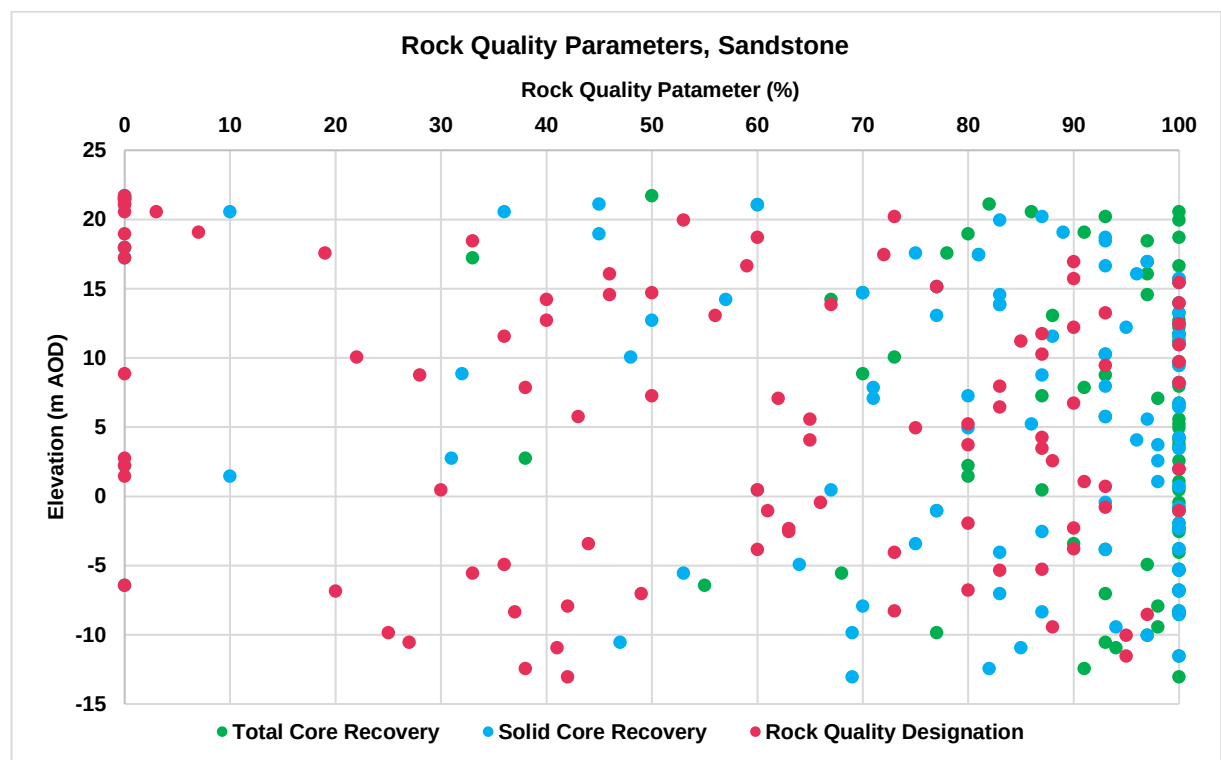


Figure 6.5a – Summary of Rock Quality Parameters vs. Elevation for Sandstone

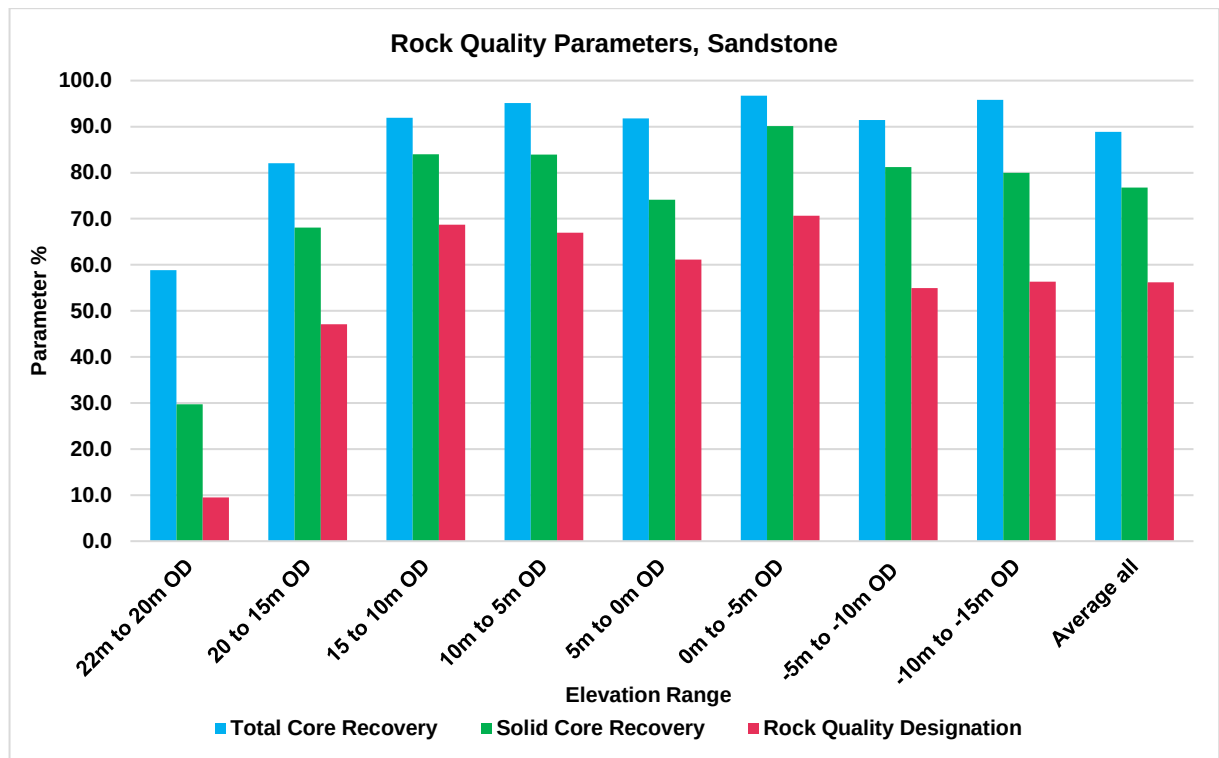


Figure 6.5b – Summary of Rock Quality Parameters vs. Elevation for Sandstone

Table 6.5 summarises the geotechnical testing, both in-situ and laboratory testing, undertaken on the sandstone of the Chester Formation.

Table 6.5 – Summary of Geotechnical Testing (Bedrock)

	Parameter		No. of Tests	Summary of Results	
				Min	Max
Laboratory Test Results	pH		11	8.86	9.15
	Water Soluble Sulphate (mg/l)		11	10	33
	Point Load Indices (Is50) (MPa)	Axial Plane	78	0.01	0.67
		Diametral Plane	73	0.01	0.58
	Unconfined Compressive Strength, UCS (Mpa)		26	0.70	17.40
Derived Parameters	Estimated UCS from Point Load Indices	Axial Plane	78	0.24	16.08
		Diametral Plane	73	0.24	13.92

One SPT 'N' value was recorded within the weathered bedrock. A SPT value >50 was recorded in CP01 at 7.00m bgl (18.97m AOD), described as very weak, thinly bedded reddish brown fine to medium sandstone.

Overall, 78No. Axial and 73No. Diametral Point Load Tests (PLT) were undertaken on selected samples of intact sandstone from rotary cores. Axial plane PLT (Is(50)) results ranged from 0.01MPa and 0.67MPa and Diametral plane PLT (Is(50)) results ranged from 0.01MPa and 0.58MPa.

An approximation of the unconfined compression strength (UCS) of the rock may be derived from the following relationship, described in *Equation 2*:

$$UCS = PLT\ Is(50) \times f_1 \quad \textbf{Equation 2 (Tomlinson)}$$

Where f_1 is derived from the correlation between PLT Is(50) and UCS Results

In consideration of the correlation between Is(50) and UCS values reported from laboratory testing and of published literature (Tomlinson et al), a factor of 24 has been considered suitable.

Based on this relationship, estimated UCS values for sandstone range between 0.24MPa and 16.08MPa for axial tests and 0.24MPa and 13.92MPa for diametral tests, indicating the rock is highly variable with the strength index indicating very weak to weak. The findings generally correlate with field descriptions.

The estimated UCS values were generally consistent with the UCS test results which ranged between 0.70MPa and 17.40MPa. The test termination reasons varied from single shear, multiple shear, axial cleavage and fragmented. The UCS test results indicate the intact rock is generally weak.

At this stage, a conservative assessment of characteristic rock strength of Chester Formation sandstone has been undertaken, summarised in *Figure 6.3c*.

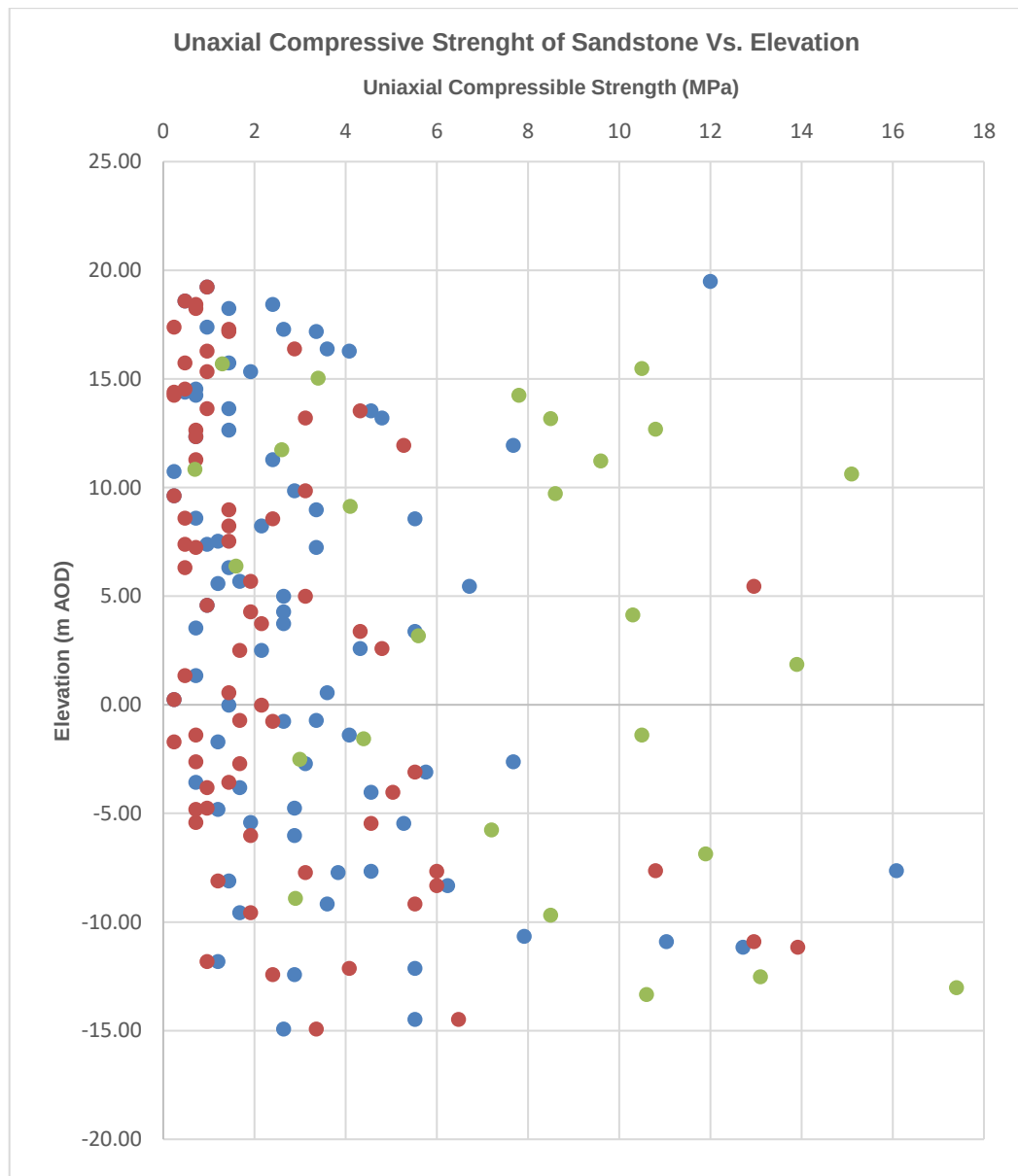


Figure 6.3c – Summary of Rock Strength Geotechnical Testing Results – Chester Formation

6.6 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, 3rd edition of 2005 (Ref. 16). A summary of the results obtained as a part of the ground investigation are summarised in *Table 6.6a* and *Table 6.6b*.

Table 6.6a –Aggressive Chemical Environment for Concrete (ACEC) Site Classification

Stratum	Test Type	Range
Made Ground	pH	8.79 – 12.40
	Water Soluble Sulphate (mg/l)	30 – 90
Alluvium	pH	8.55 – 8.76
	Water Soluble Sulphate (mg/l)	<10 – 80
Chester Formation	pH	8.86 – 9.15
	Water Soluble Sulphate (mg/l)	10 - 33

Table 6.6b –Aggressive Chemical Environment for Concrete (ACEC) Site Classification

Stratum	Design Sulphate Class	ACEC Class ⁽¹⁾
Made Ground	DS-1	AC-1
Alluvium	DS-1	AC-1
Chester Formation	DS-1	AC-1

In these conditions, it is considered that deterioration of buried concrete due to sulphate or acid attack is unlikely to occur. The preliminary design of buried concrete according to Table C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-1 (AC-1) conditions for concrete within made ground and in natural ground, assuming mobile groundwater.

7.0 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.17).

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 9.0* of this report.

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

7.1 Human Health GQRA

The soil results will be screened against the 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. 18) 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.

7.1.1 Adopted Soil Human Health GACs Screening Methodology

Development proposals include the construction of a 36 storey building with single storey basement level, constructed at c.19.8m AOD. It is understood that the land adjacent to the building is to be covered by hardstanding. The basement level is to be used as bike storage with building maintenance facilities, while the ground floor is to be used generally as commercial office space, with a post-room, refuse store and substation. Private and commercial amenities are to be developed on the first floor, co-working facilities on floors 2 to 4 with co-living apartments on floors 5 to 35.

The proposed end use 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 soils ranged from 0.4% to 8.6%. The greatest organic matter concentrations were recorded in samples of made ground, most notably in CP03 (1.00m) where organic matter concentrations of 8.6% were reported.

With consideration for a calculated geometric average, made ground soils determine a SOM of 1.74%, while natural soils record a lower valuation of 0.59%. As such, a comparison against Generic Assessment Criteria (GAC) thresholds for a conservative SOM of 1.0% for the identified end use thresholds have been adopted for made ground and natural soils.

The adopted GAC's can be referred to in *Appendix F*.

7.1.2 Generic Assessment Criteria Screening of Soil Laboratory Results

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

With respect to 'Commercial' thresholds, no exceedances of contamination GACs were recorded in any of the soil samples tested.

All soil samples were screened for asbestos. No suspected asbestos containing materials (ACMs) were identified within any of the exploratory hole logs, and no asbestos was detected in any of the soil samples analysed.

Made ground soils are anticipated to be removed from beneath the building footprint to facilitate construction of the basement level.

With consideration of the absence of exceedances against the relevant GACs, anticipated removal of made ground soils and presence of hardstanding adjacent to the building, a **Low** risk is presented to site end-users from shallow site soils.

7.2 Controlled Waters GQRA

A model for assessing the potential for pollution of the 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. 19).

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

7.2.1 Adopted Controlled Waters Tier 1 Screening Values and Methodology

The site is underlain by made ground soils, cohesive and granular alluvium, weathered bedrock and intact bedrock of the Chester Formation.

The superficial aquifer is designated as a Secondary A Aquifer, while the underlying bedrock aquifer is designated as a Principal Aquifer.

The nearest surface water feature is the River Irwell adjacent west of the site.

Due to the close proximity of the River Irwell, results of groundwater chemical analysis have been assessed against Water Framework Directive Environmental Quality Standards (WFD EQS) (Ref. 20). Where WFD EQS screening values are not available, World Health Organisation (WHO) guidelines (Ref. 21) have been adopted as screening criteria.

Given the presence of a Principal Aquifer underlying the site, and the potential for piled foundations to be adopted, the results of laboratory analysis of groundwater have been assessed against UK Drinking Water Standards, UK DWS, (Ref. 22). Where these are not available for review, WHO guidelines (Ref. 21) have been adopted as screening thresholds.

This assessment is to be undertaken to determine the risk to surface water and groundwater from historic and future site use.

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

7.2.2 Tier 1 Screening of Groundwater Laboratory Results

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

One groundwater sample was obtained from CP/RC01 (3.82m bgl). The response zone targeted the granular superficial soils beneath made ground, overlying sandstone bedrock.

Groundwater Receptor (Principal Aquifer/Secondary A Aquifer)

Marginally elevated concentrations of benzo(a)pyrene (B(a)P) were recorded in the water sample with respect to UK DWS. The sample identified B(a)P concentrations of 0.03 µg/l, compared with UK DWS of 0.01 µg/l.

The concentrations recorded are likely indicative of natural background concentrations of the groundwater, associated with historic city centre land use. The concentrations recorded are not indicative of significant groundwater contamination sourced from site soils, or substantial on-site source of contamination groundwater. It is likely that any potential source of contamination within made ground will be removed from site to facilitate the construction of the basement level.

Furthermore, there are no potable groundwater abstractions within 250m of the site which would be impacted by the low concentrations of B(a)P recorded in the superficial soils.

On this basis, the risk to the underlying Principal Aquifer is **Low** requiring no further action.

Surface Water Receptor (River Irwell)

Marginally elevated concentrations of copper and B(a)P were recorded in the water sample with respect to WFD EQS.

Copper concentrations of 2 µg/l and B(a)P concentrations of 0.03 µg/l were recorded, compared with WFD EQS of 1 µg/l and 0.01 µg/l respectively.

The concentrations recorded are likely indicative of natural background concentrations of the groundwater, associated with historic city centre land use. The concentrations recorded are not indicative of significant groundwater contamination sourced from site soils, or substantial on-site source of contamination groundwater. It is assumed that any potential site-won sources of contamination within made ground will be removed from site to facilitate the construction of the basement level.

On the basis of the absence of a source of groundwater contamination on site, the risk to the adjacent River Irwell is **Very Low** requiring no further action.

8.0 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. 24), BSI Publication code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings BS8485:2019 (Ref. 25) and other broadly accepted references such as the Ground Gas Handbook 2009 (Ref. 26).

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 Desk Study (Ref. 1) and thereafter validating this conceptual model with the ground gas data, the semi-quantitative risk assessment.

8.1 Ground Gas Monitoring Results

To characterise the site's ground gas regime and validate the qualitative assessment of ground gas risk, standpipe installations were incorporated within RBH21 and RBH22, as part of the 2018 investigation, and CP/RC01, CP02 and CP03 in the 2021 investigation, as detailed in *Section 3.2*.

During the 2018 investigation, two gas monitoring visits were undertaken on 14th and 22nd November 2018. A further four visits over two months were proposed to be undertaken as part of this investigation, all of which have been completed. Monitoring visits were undertaken between 18th August and 7th October 2021.

Barometric pressures were recorded at 1015mb on both visits in 2018, and between 1014mb and 1025mb in 2021. The first and second visits of the 2021 monitoring period were undertaken during periods of falling barometric state, and the first visit of the 2021 monitoring period was undertaken during a period of rainfall.

The results log sheets are contained within *Appendix E* and summarised in *Table 8.1*.

Table 8.1 – Summary of Ground Gas Monitoring Results – 2018 and 2021 Investigations

Exploratory Hole ID	Max. Methane Concentration (%)	Max. Carbon Dioxide Concentration (%)	Min. Steady Oxygen Concentration (%)	Max. Peak Air Flow (l/hr)	Max. Steady State Air Flow (l/hr)
CP/RC01 (sand and sandstone)	<0.1	<0.1	9.7	<0.1	<0.1
CP02 (sand and sandstone)	<0.1	3.0 (2021 v2)	17.8	-0.3 (2021 v3)	<0.1
CP03 (made ground)	<0.1	0.9 (2021 v1/4)	18.4	-1.2/0.1 (2021 v3/2021 v1)	-1.2 (2021 v3)
RBH21	<0.1	3.9 (2021 v2)	<0.1 (2021 v2)	0.7 (2021 v2)	0.6 (2021 v2)
RBH22 (Sand and sandstone)	<0.1	4.8 (2021 v3)	12.9 (2021 v2)	<0.1	<0.1

Methane concentrations were recorded below the limit of detection of the monitoring instrument in all monitoring wells throughout the monitoring periods of the 2018 and 2021 investigations.

Maximum carbon dioxide concentrations ranged between $<0.1\%$ v/v in CP/RC01 to 4.8% in RBH22.

Maximum hydrogen sulphide and carbon monoxide concentrations were recorded at 4ppm and 3ppm respectively.

The greatest peak air flow rate was recorded in CP03 on 16th September 2021, at -1.2 l/hr, which remained at a consistent steady state for 1 minute. The borehole was recorded as dry. Elsewhere, peak air flow rates ranged between -0.3 l/hr and 0.7 l/hr, with steady state air flow rates ranging between <0.1 l/hr to 0.6 l/hr.

8.2 Ground Gas Assessment

The Conceptual Site Model presented in *Section 2.7* highlighted potential Made Ground soils containing organic / putrescible content as a potential source of ground gas generation. It also identified infilled canal basins in the vicinity of the site, and other infilled (water features) as potential ground gas generating sources.

Noxious and asphyxiate gases were attributed to include, but not limited to, carbon dioxide, carbon monoxide, methane and hydrogen sulphide.

The ground investigation revealed a ground model generally consistent with the preliminary conceptual site model. Ground conditions pertaining to the development site comprise made ground (1.70m to 3.20m thickness), overlying cohesive and granular alluvium, weathered and intact bedrock of the Chester Formation.

The hydrostatic head level of groundwater within the granular alluvium, weathered and intact sandstone bedrock is recorded at c. 22.61m to 21.85m AOD.

In accordance with BS8485:2015+A1:2019 (Ref. 25), consideration of the recorded soil gas flow rates, presented below, enables hazardous gas flow rates (Q_{hg}) to be evaluated. Q_{hg} can be derived for both 'borehole' and 'worst case' scenarios and a comparison made in support of an appropriate assessment of ground gas risk. For a 'borehole' scenario (highest hazardous gas flow rate identified a single borehole) steady state flow rates and maximum gas concentrations are adopted, whilst for a 'worst case' scenario (highest Q_{hg} across the entire dataset irrespective of location and discrete monitoring events) peak flows and gas concentrations are adopted.

The dataset obtained is considered to be representative of site conditions beneath the proposed development footprint. Given the quantity of data obtained, and with consideration of the conceptual site model, steady state air flow rates are to be used to determine the Q_{hg} for the site. Where negative

flow rates are recorded, it is assumed that a positive air flow rate of the same value may be possible. Therefore, the absolute values of any negative air flow rates are used in this assessment.

8.2.1 Carbon Dioxide

Evaluation of the 'borehole' scenario (highest hazardous gas flow rate that is realistically possible, i.e. in a single borehole) records a maximum Q_{hg} of 0.0234l/hr for carbon dioxide where maximum steady state air flow rate of 0.6 l/hr was recorded, and maximum gas concentrations of 3.9% v/v on the second monitoring visit of 2021.

Evaluation of the 'worst-case' scenario (highest hazardous gas flow rate at any time) records a maximum Q_{hg} of 0.0288l/hr for carbon dioxide where maximum steady state air flow rate of 0.6 l/hr was recorded on the second monitoring visit of 2021, and maximum gas concentrations of 4.8% v/v on the third visit of 2021.

8.2.2 Methane

Methane concentrations were recorded below the limit of detection of the monitoring instrument throughout the monitoring period. In absence of methane concentrations within the monitoring wells, the Q_{hg} for methane has not been calculated.

8.2.3 Conclusion

The calculated Q_{hg} for both the 'borehole' and 'worst case' scenarios would account for a Gas Screening Value (GSV) indicative of a Characteristic Situation 1 (CS1) gas regime. Therefore, no gas protection measures to mitigate against generation of carbon dioxide or methane will be required for the proposed development.

As the new development includes the construction of a basement, the advice of a specialist radon assessor must be obtained.

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.

9.0 Revised Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) presented *Section 2.7* and discussed in *Section 2.0* of this report has been revised following the GQRA in *Sections 7.0* and *8.0* above. The Revised Conceptual Site Model (CSM) is summarised in the table overleaf.

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. 27) 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 are discussed and assessed in *Section 2.5*.

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. 28) 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. This assumption is factored into the conceptual site model. Reference should be given to the environmental testing results discussed within *Section 7.0* and presented within *Appendix C*.

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 underlying surface covering of tarmac or concrete, associated with: - Historic development of the site; - Leaks/ spills from plant/engineering identified on historical plans of site; - Localised spillages associated with dockyard processes; - Potential use of asbestos materials on site; - Leachable contamination associated with off-site historic railway tracks, substations, engineering works and wider industrial settling.	Direct contact and dermal uptake, soil and dust ingestion, dust and migration inhalation (indoor & outdoor air)	Site End Users	Medium Human Health Risk	Unlikely	Low	No exceedances identified in any of the soil samples tested above 'Commercial' GAC. No suspected asbestos containing materials (ACMs) were identified during the investigation works and no asbestos was detected in any of the soil samples analysed. Made ground soils are anticipated to be removed from beneath the building footprint to facilitate construction of the basement level.	No further action required.
		Construction and maintenance workers		Unlikely	Low		
	Vertical and horizontal migration of soluble phase contamination through groundwater.	Controlled Waters (Surface Water) The nearest surface water feature is the River Irwell, adjacent north of the site, which has a water quality rating of "E". Basement level anticipated to be constructed, removing potential sources of contamination within made ground soils.	Mild	Unlikely	Very Low	Marginally elevated concentrations of copper and benzo(a)pyrene (B(a)P) were recorded in the water sample with respect to WFD EQS. Copper concentrations of 2 µg/l and B(a)P concentrations of 0.03 µg/l were recorded, compared with WFD EQS of 1 µg/l and 0.01 µg/l respectively. The concentrations recorded are likely indicative of natural background concentrations of the groundwater, associated with historic city centre land use. The concentrations recorded are not indicative of significant groundwater contamination sourced from site soils, or substantial on-site source of groundwater contamination.	No further action required.
	Vertical and horizontal migration of soluble phase contamination through superficial deposits and bedrock.	Controlled Waters (Groundwater) Bedrock hosts Principal Aquifer Superficial deposits host Secondary A Aquifer. No potable groundwater abstractions within 500m of the site. Basement level anticipated to be constructed, removing potential sources of contamination within made ground soils.	Medium	Unlikely	Low		
Ground gas generating sources , including: - Made ground, containing organic/putrescible material, alluvium or the sandstone of the Chester Formation - Radon sourced from Chester Formation (<1% homes above action level).	Ground gas & vapour migration and inhalation. Vertical and horizontal migration through existing service corridors and the underlying superficial/bedrock deposits.	Site End Users	Medium Human Health Risk	Unlikely	Low	Carbon Dioxide Evaluation of the 'borehole' scenario (highest hazardous gas flow rate that is realistically possible, i.e. in a single borehole) records a maximum Q_{hg} of 0.0234l/hr for carbon dioxide where maximum steady state air flow rate of 0.6 l/hr was recorded, and maximum gas concentrations of 3.9% v/v on the second monitoring visit of 2021. Evaluation of the 'worst-case' scenario (highest hazardous gas flow rate at any time) records a maximum Q_{hg} of 0.0288l/hr for carbon dioxide where maximum steady state air flow rate of 0.6 l/hr was recorded on the second monitoring visit of 2021, and maximum gas concentrations of 4.8% v/v on the third visit of 2021. Methane Methane concentrations were recorded below the limit of detection of the monitoring instrument throughout the monitoring period. In absence of methane concentrations within the monitoring wells, the Q_{hg} for methane has not been calculated. Conclusion The calculated Q_{hg} for both the 'borehole' and 'worst case' scenarios would account for a Gas Screening Value (GSV) indicative of a Characteristic Situation 1 (CS1) gas regime. Therefore, no gas protection measures to mitigate against generation of carbon dioxide or methane will be required for the proposed development. As the new development includes the construction of a basement, the advice of a specialist radon assessor must be obtained.	Gas protection measures not required to mitigate against carbon dioxide and methane gas. The advice of a specialist radon assessor must be obtained.

9.1 Summary of Significant Pollutant Linkages

A **Low** risk rating is identified to site end-users and construction workers, from soils and dust from inhalation and ingestion at this stage. No exceedances of commercial GACs were recorded in the GQRA. No suspected asbestos containing materials (ACMs) were identified within any of the exploratory hole logs or in any of the samples screened for asbestos in the laboratory.

A **Low** and **Very Low** risk rating is identified to controlled waters (Groundwater and Surface Waters respectively) following the ground investigation.

A **Low** risk rating is identified to site end users from ground gases arising from site soils, migrating into buildings and subsequent inhalation. This corresponds to a Characteristic Gas Situation 1 (CS-1) gas regime for the site, not requiring gas protection measures.

Development proposals indicate the construction of a single storey basement. As such, the advice of a radon specialist must be obtained.

10.0 Geotechnical Assessment and Recommendations

10.1 Introduction

This section will discuss the ground and groundwater conditions encountered across the site and assess their associated risks for the proposed scope of the works. Development proposals include the construction of a 36-storey building with single storey basement level. External areas are to be covered by hardstanding surfaces. The proposed layout is included in *Appendix A*.

10.2 Geotechnical Considerations

The proposed development comprises a thirty-six storey tower with a single level of basement located adjacent to the River Irwell.

The Made Ground or the underlying superficial deposits are not considered to be suitable founding stratum given the anticipated magnitude of structural frame loadings resulting from the high-rise building and it is therefore considered that a monolithic raft, piled raft or piled foundation solution could be adopted. In relation to the monolithic and or piled raft further geotechnical finite element modelling will be required to confirm suitability.

A piled solution would need to bear in the sandstone bedrock. Initial estimates in accordance with Eurocode 7 (Ref. 10) indicate that a bored pile of 750mm diameter and 16m length would provide a total resistance of 11,025kN for combination 1 and 6225 kN for combination 2. For a 900mm diameter bored pile of 16 m length the resistances can be increased to 14,500kN for combination 1 and 8110 kN for combination 2

Specialist piling contractors should be contacted to see whether continuous flight auger or rotary bored piles would be more suitable for a piled raft or piled solution.

In relation to a raft formed on the weathered sandstone at 7.0m below ground level (bgl), Modulus of subgrade reaction values have been estimated to be between 7.0MN/m³ and 12.0MN/m³ with values between 10.0 MN/m³ and 21.0MN/m³ in the partially weathered sandstone at 10.0m bgl.

At this stage it is considered that a raft or piled raft maybe a viable foundation solution but a finite element model should be undertaken to look at the overall stiffness of the ground to assess whether a stiff monolithic raft would be feasible. A piled raft should also be modelled also as part of a substructure options study for either solution.

It is likely that the Environment Agency will require a piling risk assessment due to penetration of the main aquifer for a piled solution.

10.3 Ground Floor Slabs

It is recommended that all ground level slabs outside the footprint of the basement should be designed as suspended construction due to the presence of Made Ground. Basement slabs not part of monolithic and or piled raft construction should be designed to span between piled foundations to resist buoyancy. The potential risk of flotation should be considered in the temporary condition during construction of the basement.

10.4 Chemical Attack on Buried Concrete

The site has been classified in accordance with BRE Special Digest 1 (Ref. 16) and laboratory testing undertaken accordingly in *Section 7.0*. Based on the laboratory test results it is considered that a Design Sulphate Class may be taken as DS-1 with an ACEC class of AC-1 for the made ground, alluvium, and weathered and intact bedrock of the Chester Formation.

10.5 Excavation and Support

The basement will need to be constructed inside a secant or contiguous piled wall. 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 past construction. Groundwater will need to be controlled during the temporary construction of the basement and in the permanent case. A pumping test will need to be conducted to inform the specialist design of any dewatering required if a contiguous wall throughout or a combination of a hybrid secant/contiguous piled wall is proposed by the contractor.

The Environment Agency will need to be consulted and a risk assessment undertaken for pumping the main aquifer as well as the effect on other users with wells in the area.

The pumping test will also need to assess any egress of local water from the River Irwell and redundant canal which may affect the excavations.

Modelling of the results of the pumping test should allow a decision to be made on a wall combination for the basement and whether in the long term the basement construction would increase groundwater levels toward the River Irwell requiring additional underground drainage to be installed between the River Irwell and the Vita T2 tower.

Any dewatering pumping may cause a significant change in the soil effective stress and lead to possible ground movement. Before any dewatering occurs a predictive ground model should be undertaken to allow a monitoring regime to be put in place for buildings and infrastructure considered to be at risk. Consequently this will allow buildings and roads to be monitored to counteract any likely damage during the dewatering.

11.0 Conclusions & Recommendations

11.1 Conclusions

11.1.1 Ground and Groundwater Contamination

The environmental chemistry soil results have been compared with the Generic Assessment Criteria (GAC) for soils with respect to human health against '*Commercial*' thresholds.

No soil concentration exceedances have been noted with respect to the Commercial GAC thresholds.

No suspected asbestos containing materials (ACMs) were identified within any of the exploratory hole logs or soil samples screened at the laboratory

Following the 2018 and 2021 ground investigations, a **Low** risk is identified to site end users, and to construction workers, from soils and dust from inhalation and ingestion.

Marginally elevated concentrations of copper and benzo(a)pyrene (B(a)P) were recorded in the water sample obtained from CP01 (3.82m bgl), with respect to UK Drinking Water Standards. Marginally elevated concentrations of B(a)P were also recorded with respect to Water Framework Directive Environmental Quality Standards (WFD EQS). These results are considered to be indicative of background conditions within the aquifer, rather than sourced from shallow made ground soils. The risk to the underlying Principal Aquifer and adjacent River Irwell is Low and Very Low respectively. A **Low** and **Very Low** risk rating is identified to controlled waters (Groundwater and Surface Waters respectively) following the ground investigation.

11.1.2 Ground Gas Assessment

During the ground gas monitoring programme methane (CH₄) was recorded below the instrument's detection limit within all the monitoring wells throughout the monitoring period.

Maximum carbon dioxide (CO₂) concentrations ranging between <0.1% v/v and 4.8% v/v were recorded. Peak air flow rates ranged between -1.2 (0.7) l/hr and <0.1 l/hr, with maximum steady state air flow rates of between -1.2 (0.6) l/hr and <0.1 l/hr.

The Gas Screening Value for the site is taken as 0.023 l/hr for carbon dioxide, indicative of a Characteristic Situation 1 (CS1) gas regime. No gas protection measures are required to mitigate the risk presented by methane or carbon dioxide.

The site is located within a Lower Probability Radon Area (less than 1% of homes are estimated to be at or above the Action Level).

11.2 Recommendations

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

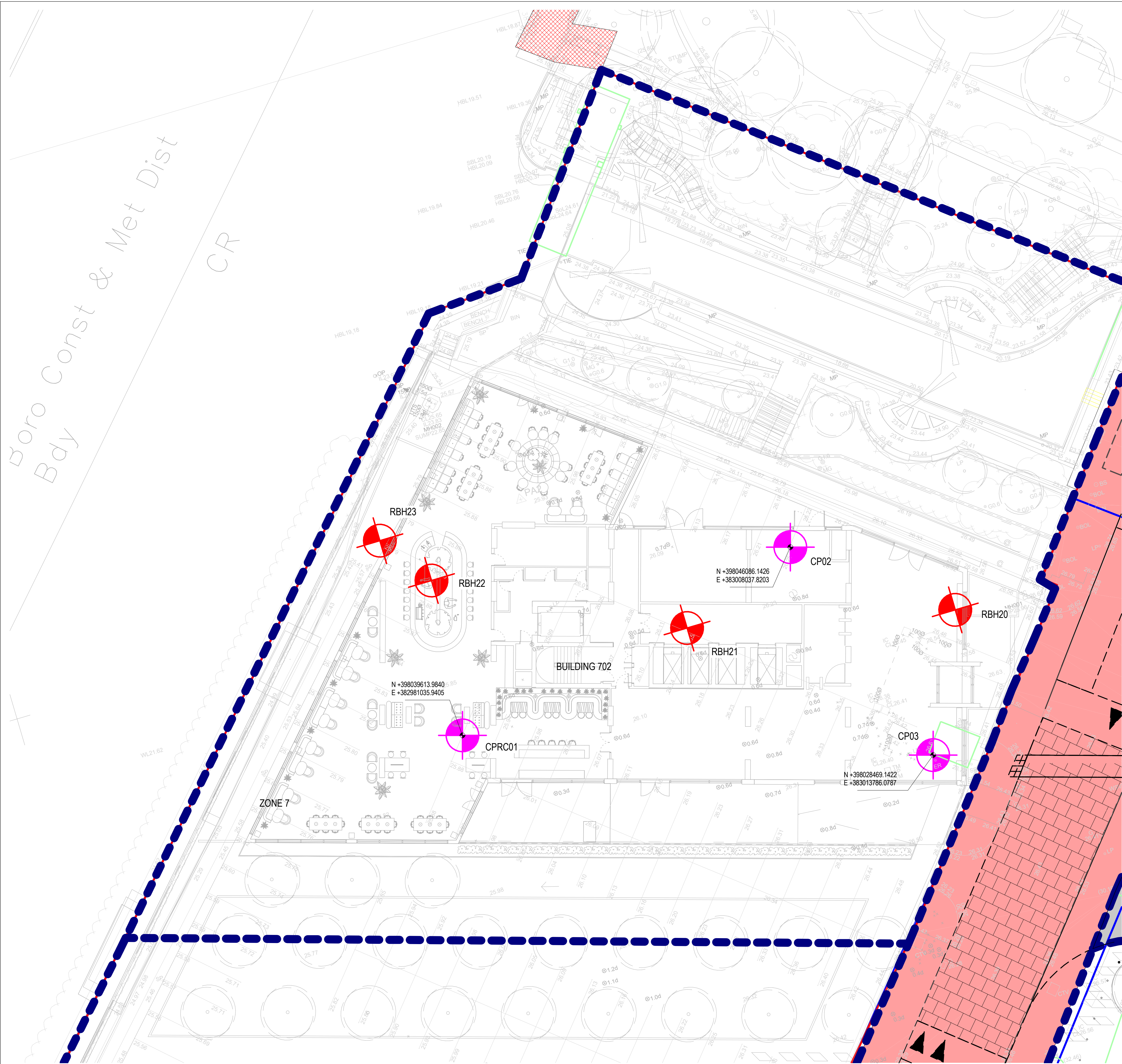
- 1) It is recommended that construction workers are provided with appropriate PPE and sanitary facilities, with reference to the environmental testing results presented herein and within *Appendix C*.
- 2) Should unexpected contamination be observed during construction advice should be obtained from a Geo-environmental Engineer.
- 3) As the new development incorporates a basement level, the advise of a specialist radon assessor must be obtained.
- 4) During development works, a UXO Risk Management Plan and Emergency Response Plan should be implemented.
Foundation options should be considered by further geotechnical modelling for a raft or piled raft.
- 5) A pumping test is required to finalise dewatering design for the basement and advise further the type of piled basement wall.
- 6) Before any dewatering occurs a predictive ground model should be undertaken to allow a monitoring regime to be put in place for buildings and infrastructure considered to be at risk from resulting ground movement.

12.0 References

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Appendix A – Drawings



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- 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/SOOSMITHS
 - EASEMENT TO SHIP CANAL TBC -
 - OBSTRUCTIONS - TUNNEL/CANAL -

- KEY**
- RBH** EXISTING OPEN HOLE ROTARY THROUGH SUPERFICIAL PLUS ROTARY CORED TO BASE THROUGH INTACT ROCK UNDERTAKEN IN 2018
 - CP** PROPOSED CABLE PERCUSSIVE/ROTARY BOREHOLE THROUGH SUPERFICIAL PLUS ROTARY CORED TO BASE THROUGH INTACT ROCK

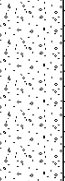
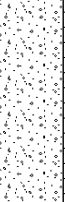
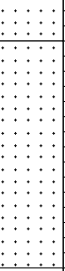
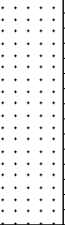
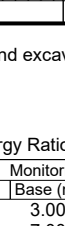
GENERAL NOTES:

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
- 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.
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
- FOR GENERAL NOTES REFER TO DRAWING T1-CUR-G200-TY-XX-20001.

P01	PRELIMINARY ISSUE	28.07.21	AM	AI		
Rev:	Description:	Date:	By:	Chkd:		
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Status:	PRELIMINARY					
Project:	ST JOHNS MASTERPLAN					
Dwg Title:	PROPOSED BOREHOLE LOCATIONS OVERLAY					
Project No:	Size:	Date:	Drawn By:	Designed By:	Checked By:	
065330	A1	JUL 21	AM	AI	AI	
ScaleAs indicated						
ZONE:	Originator:	Uniclass:	Doc Type:	Level:	Category / Number:	Rev:
T2 -	CUR - G200 - PL - GRD - 04100 -					P01

Appendix B – Exploratory Hole Logs

 IAN FARMER ASSOCIATES	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01	
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting				
Cable Percussion and Rotary Boring Log		Location: 382981.32E 398039.71N		Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 1 of 5 Project ID: 2230571

Samples & In Situ Testing			Strata Details				Groundwater		
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation	
0.50	ES1	SPT(S) 50 (25 for 70mm/50 for 0mm)	25.87	0.10	MADE GROUND: CONCRETE.				
0.80 - 1.00	B2		24.87	1.10	MADE GROUND: Reddish grey, slightly clayey GRAVEL. Gravel is angular to subrounded, fine to coarse including sandstone, brick and concrete.				
1.00	D3			(1.00)					
1.20									
1.20 - 1.65	D5	SPT(S) N=26 (2,4/5,8,6,7)	24.47	1.50	MADE GROUND: Very dense, dark reddish grey, slightly sandy, slightly clayey GRAVEL. Gravel is angular to subrounded, fine to coarse including sandstone and brick.				
1.20 - 1.70	B4		0.40						
1.50	D6		1.80						
1.85	D7								
2.00		SPT(S) N=16 (3,4/5,5,3,3)	24.17	1.80	MADE GROUND: Greyish red, gravelly, fine to coarse SAND. Gravel is angular to subangular, fine to coarse including brick and sandstone.				
2.00 - 2.45	D9								
2.00 - 2.50	B8								
2.75	D10								
3.00		SPT(S) N=18 (2,3/1,2,3,12)	21.57	4.40	Below 2.75m: becomes yellowish brown.				
3.00	ES11								
3.00 - 3.45	D13								
3.00 - 3.50	B12								
3.75	D14	SPT(S) 50 (23 for 75mm/50 for 75mm)	19.27	6.70 (0.30)	Between 3.00m and 3.50m: low cobble content. cobbles are rounded including sandstone.				
4.00									
4.00 - 4.45	D16								
4.00 - 4.50	B15								
4.50	D17	SPT(S) 50 (25 for 95mm/50 for 105mm)	18.97	7.00	Very dense, reddish brown, fine and medium SAND.				
4.75	D18								
5.00									
5.00 - 5.45	D20								
5.00 - 5.50	B19	7.00m - SPT(S) 50 (25 for 50mm/50 for 25mm)	17.47	8.50	Between 5.00m and 5.50m: assumed zone of core loss. Core possibly scrubbed.				
5.75	D21								
6.00									
6.00 - 6.45	D23								
6.00 - 6.50	B22	7.55m - C25	18.97	7.00	Red, very weak, weathered SANDSTONE recovered as very dense, gravelly, fine to coarse sand. Gravel is angular, fine to coarse.				
6.75	D24								
7.00 - 8.00	80 45 0				18				
8.00 - 8.50	0 0 0				AZCL				
8.50 - 9.30	81 81 72	13	8.80m - C26		Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with closely to medium spaced, thick laminations to very thin beds of extremely weak reddish brown mudstone. Discontinuities are orientated 1) 0-10 degrees, very close to medium spaced, planar, rough and clean; and 2) 60 degrees, widely spaced, planar, rough and clean.				
		AZCL							
			9.60m - C27						
TCR/SCR/ROD			FI		Continued next sheet				

Chiselling				Borehole Diameter		Boring Progress				Remarks:	
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	Service inspection pit hand excavated from GL to 1.20m.
				7.00	150	03/08	16:30	7.08	4.50	5.10	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
				4.50	150	5.00	4.50		20	4.70	
								Top (m)	Base (m)	Pipe Type	Dia (mm)
								0.00	3.00	Plain	50
								3.00	7.00	Slotted	50
Checked by:		JT		IFA CP							
Log status:		PRELIM		v01.01							



IAN FARMER ASSOCIATES

Plant used:

Dando 2000

Project:

St Johns Additional

Location ID:

CP01

Dates:

03/08/2021 - 28/08/2021

Client:

Curtins Consulting

Sheet 2 of 5

Rotary Boring Log

Location:

382981.32E 398039.71N

Ground level:

25.97mOD

Logged by:

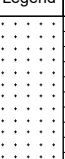
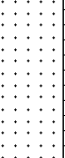
GR/NC

Vertical scale:

1:50

Project ID:

2230571

Coring, Samples & In Situ Testing				Strata Details				Groundwater		
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation	
9.30 - 10.80	100 93 59	7	10.50m - C28			Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with closely to medium spaced, thick laminations to very thin beds of extremely weak reddish brown mudstone. Discontinuities are orientated 1) 0-10 degrees, very close to medium spaced, planar, rough and clean; and 2) 60 degrees, widely spaced, planar, rough and clean. <i>Between 10.80m and 11.10m: assumed zone of core loss. Core possibly scrubbed.</i>				
10.80 - 12.10	77 77 77	AZCL	11.73m - C29							11
12.10 - 12.70	83 83 67	7	12.44m - C30							12
		AZCL	12.80m - C31		(6.80)					13
12.70 - 14.20	100 100 93	4	13.29m - C32							14
14.20 - 15.70	100 100 87		14.03m - C33				15			
		0	14.75m - C34			Moderately weak, thinly bedded, reddish brown, fine SANDSTONE.				
15.70 - 17.20	93 93 87	7	15.35m - C35	10.67	15.30 (0.50)	Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with occasional subangular clasts (<20x30x20mm) of extremely weak, brown, mudstone. Discontinuities are orientated 1) 0-15 degrees, very closely to medium spaced, planar and undulating, rough and clean; 2) 30 degrees, medium spaced, planar, rough and clean; and 3) 90 degrees, undulating rough and clean. <i>Between 15.80m and 15.85m: very thin bed of very weak, brown mudstone.</i>				
		AZCL	16.25m - C36	10.17	15.80					16
17.20 - 18.70	93 87 28	5	17.00m - C37							17
		AZCL	17.42m - C38		(7.90)					18
18.70 - 20.20	87 80 50	5	18.45m - C39							19
		AZCL				<i>Between 18.60m and 18.90m: assumed zone of core loss. Core possibly scrubbed.</i>				
						Continued next sheet				

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
7.08	23.20	Water	100
23.20	25.50	Water	80
25.50	35.80	Water	100
35.80	41.00	Water	0

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)

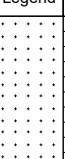
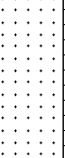
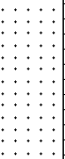
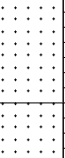
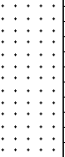
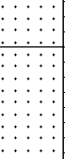
Checked by:

JT

IFA RC v01.01

Log status:

PRELIM

 IAN FARMER ASSOCIATES	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01									
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting												
Rotary Boring Log	Location: 382981.32E 398039.71N		Ground level: 25.97mOD		Logged by: GR/NC	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 2230571								
	Coring, Samples & In Situ Testing		Strata Details					Groundwater							
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation						
20.20 - 21.70	93 93 43	AZCL	20.30m - C40	2.27	23.70	Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with occasional subangular clasts (<20x30x20mm) of extremely weak, brown, mudstone. Discontinuities are orientated 1) 0-15 degrees, very closely to medium spaced, planar and undulating, rough and clean; 2) 30 degrees, medium spaced, planar, rough and clean; and 3) 90 degrees, undulating rough and clean.		21							
			20.98m - C41												
			21.70m - C42												
21.70 - 23.20	100 100 87	7	22.60m - C43 22.80m - C44	0.57	25.40	Very weak, thickly laminated, reddish brown, fine SANDSTONE. Discontinuities are orientated 60 degrees, very closely to closely spaced, planar, rough, open with (2mm) firm, brown clay infill. <i>Between 23.70m and 24.50m: assumed zone of core loss possibly due to joints.</i>		22							
			23.47m - C45												
23.20 - 24.50	38 31 0	AZCL	24.72m - C46		(1.70)	Between 25.50m and 25.70m: assumed zone of core loss. Core possibly scrubbed.		23							
24.50 - 25.50	80 10 0	8				Moderately weak, very thin to thinly bedded, reddish brown locally light blueish grey, fine and medium SANDSTONE with widely spaced very thin bands of very weak, reddish brown mudstone. Discontinuities are orientated 1) 0-10 degrees, very closely to medium spaced, planar, rough and clean; and 2) 70-85 degrees, planar, rough and clean.		24							
25.50 - 27.00	87 67 30	AZCL	26.00m - C47			Between 27.50m and 27.80m: drilling disturbed. Possible joint set.		25							
		8						26							
27.00 - 28.30	77 77 61	AZCL	27.37m - C48			Continued next sheet		27							
								28							
28.30 - 29.80	100 100 63	6	28.60m - C49 29.08m - C50					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:		JT		IFA RC											
Log status:		PRELIM		v01.01											

Plant used: Dando 2000	Project: St Johns Additional			Location ID: CP01
Dates: 03/08/2021 - 28/08/2021	Client: Curtins Consulting			
Location: 382981.32E 398039.71N	Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 2230571

[illegible]

Plant used: Dando 2000	Project: St Johns Additional			Location ID: CP02
Dates: 04/08/2021	Client: Curtins Consulting			
Location: 383007.15E 398045.11N	Ground level: 26.33mOD	Logged by: GR	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 2230571



IAN FARMER ASSOCIATES

Plant used:

Dando 2000

Project:

St Johns Additional

Location ID:

CP03

Dates:

04/08/2021 - 05/08/2021

Client:

Curtins Consulting

Sheet 1 of 1

Cable Percussion Borehole Log

Location:

383008.39E 398027.15N

Ground level:

26.51mOD

Logged by:

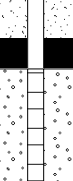
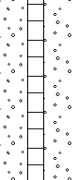
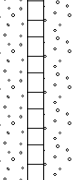
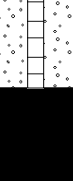
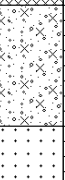
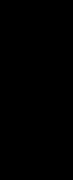
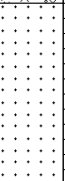
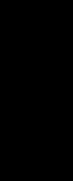
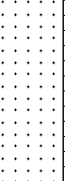
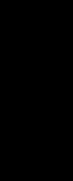
GR/TB

Vertical scale:

1:50

Project ID:

2230571

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
1.00	ES1	SPT(S) N=7 (3,2/3,1,2,1)	26.41	0.10	MADE GROUND: TARMACADAM over concrete.			
1.20 - 1.65	D3		(0.70)	MADE GROUND: Light grey, sandy, angular to subangular, fine to coarse GRAVEL including concrete.				
1.20 - 1.70	B2							
1.85	D4	SPT(S) N=4 (1,2/2,1,1,)	25.71	0.80	MADE GROUND: Light grey, slightly sandy, angular to subangular, fine to coarse GRAVEL including limestone.		1	
2.00	D6		(0.40)					
2.00 - 2.45	B5							
2.50	D7	SPT(S) N=16 (5,5/4,4,4,4)	25.31	1.20	MADE GROUND: Loose, light brown and light grey, gravelly, fine to coarse SAND. Gravel is angular to subrounded, fine to coarse including concrete, brick and sandstone.		2	
2.75	D8		(1.20)					
3.00	D10							
3.00 - 3.45	B9	SPT(S) N=16 (5,5/4,4,4,4)	24.11	2.40	MADE GROUND: Medium dense, light brown, slightly gravelly, clayey, fine to coarse SAND. Gravel is angular to subrounded, fine to coarse including concrete, brick and sandstone.		3	
3.00 - 3.50	B9		(0.80)	Below 2.75m: slightly clayey.				
3.50	ES11							
3.75	D12	SPT(S) N=7 (5,4/4,1,1,1)	23.31	3.20	At 3.00m: pockets of firm brown clay.		4	
4.00	B13		(0.80)	Medium dense, brown, very sandy, very silty, subangular to subrounded fine to coarse GRAVEL including sandstone, siltstone and quartz.				
4.00 - 4.50	B13							
4.75	D14	SPT(S) 50 (6,10/50 for 150mm)	22.51	4.00	Extremely weak, highly weathered, red brown SANDSTONE recovered as slightly silty, fine and medium sand.		5	
5.00	D15		(2.12)					
5.00 - 5.45	B16							
5.75	D17	SPT(S) 50 (25 for 75mm/50 for 50mm)	20.38	6.13	End of Borehole at 6.13m		6	
6.00	D18							
6.00	D18							
							7	
							8	
							9	
							10	

Chiselling

From (m)	To (m)	Time (mins)	Remarks
5.50	6.00	60	

Borehole Diameter

Depth (m)	Dia (mm)
6.00	150

Boring Progress

Date	Time	Depth (m)	Cased (m)	Water (m)
04/08	16:30	4.50	4.00	Dry
05/08	08:00	4.50	4.00	4.50
05/08	16:30	6.13	5.50	Damp

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)
5.50	150

Water Strikes

Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
4.80	4.50	5.50	20	4.50	

Monitoring Installations

Top (m)	Base (m)	Pipe Type	Dia (mm)
0.00	0.50	Plain	50
0.50	3.00	Slotted	50

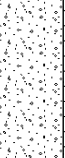
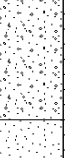
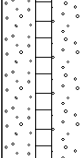
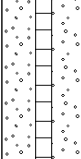
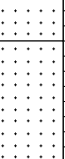
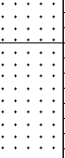
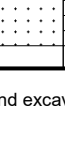
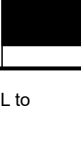
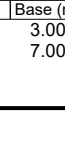
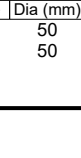
Checked by:

JT

IFA CP v01.01

Log status:

PRELIM

 IAN FARMER ASSOCIATES	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01									
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting												
Cable Percussion and Rotary Boring Log	Location: 382981.32E 398039.71N		Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 1 of 5 Project ID: 2230571									
	Samples & In Situ Testing		Strata Details			Groundwater									
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation							
0.50	ES1	SPT(S) 50 (25 for 70mm/50 for 0mm)	25.87	0.10	MADE GROUND: CONCRETE.		1								
0.80 - 1.00	B2		24.87	1.10	MADE GROUND: Reddish grey, slightly clayey GRAVEL. Gravel is angular to subrounded, fine to coarse including sandstone, brick and concrete.										
1.00	D3								24.47	1.50	MADE GROUND: Very dense, dark reddish grey, slightly sandy, slightly clayey GRAVEL. Gravel is angular to subrounded, fine to coarse including sandstone and brick.				
1.20	D5											24.17	1.80	MADE GROUND: Greyish red, gravelly, fine to coarse SAND. Gravel is angular to subangular, fine to coarse including brick and sandstone.	
1.20 - 1.65	B4														
1.50	D6	SPT(S) N=26 (2,4/5,8,6,7)	24.17	1.80	Medium dense, dark brownish grey, gravelly to very gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone and mudstone.		2								
1.85	D7														
2.00	D9														
2.00 - 2.45	B8														
2.00 - 2.50	B8														
2.75	D10	SPT(S) N=16 (3,4/5,5,3,3)	(2.60)	4.40	Very dense, reddish brown, fine and medium SAND.		3								
3.00	ES11														
3.00 - 3.45	D13														
3.00 - 3.50	B12														
3.75	D14														
4.00	D16	SPT(S) N=18 (2,3/1,2,3,12)	21.57	4.40	Very dense, reddish brown, fine and medium SAND.		4								
4.00 - 4.45	B15														
4.00 - 4.50	B15														
4.50	D17														
4.75	D18														
5.00	D20	SPT(S) 50 (23 for 75mm/50 for 75mm)	(2.30)	6.70	Red, very weak, weathered SANDSTONE recovered as very dense, gravelly, fine to coarse sand. Gravel is angular, fine to coarse.		5								
5.00 - 5.45	B19														
5.00 - 5.50	B19														
5.75	D21														
6.00	D23														
6.00 - 6.45	B22	SPT(S) 50 (25 for 95mm/50 for 105mm)	19.27	6.70	Red, very weak, weathered SANDSTONE recovered as very dense, gravelly, fine to coarse sand. Gravel is angular, fine to coarse.		6								
6.00 - 6.50	B22														
6.75	D24														
7.00 - 8.00	80								7.00m - SPT(S) 50 (25 for 50mm/50 for 25mm)	18.97	7.00	Very weak, very thinly bedded, reddish brown, fine and medium SANDSTONE. Discontinuities are orientated 1) 2-5 degrees, very closely spaced, planar, rough and clean; and 2) 90 degrees, planar rough clean.		7	
7.00 - 8.00	45														
7.00 - 8.00	0														
8.00 - 8.50	0														
8.00 - 8.50	0														
8.50 - 9.30	81	8.80m - C26	17.47	8.50	Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with closely to medium spaced, thick laminations to very thin beds of extremely weak reddish brown mudstone. Discontinuities are orientated 1) 0-10 degrees, very close to medium spaced, planar, rough and clean; and 2) 60 degrees, widely spaced, planar, rough and clean.		8								
8.50 - 9.30	81														
8.50 - 9.30	72														
8.50 - 9.30	72														
8.50 - 9.30	72														
TCR/SCR/ROD		FI	Samples & Tests		Continued next sheet			Groundwater							
Chiselling		Borehole Diameter		Boring Progress		Remarks:									
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	Service inspection pit hand excavated from GL to 1.20m.				
				7.00	150	03/08	16:30	7.08	4.50	5.10	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)				
4.50	150	5.00	4.50		20	4.70		0.00	3.00	Plain	50				
								3.00	7.00	Slotted	50				
Checked by:		JT	IFA CP												
Log status:		PRELIM	v01.01												



IAN FARMER ASSOCIATES

Plant used:

Dando 2000

Project:

St Johns Additional

Location ID:

CP01

Dates:

03/08/2021 - 28/08/2021

Client:

Curtins Consulting

Sheet 2 of 5

Rotary Boring Log

Location:

382981.32E 398039.71N

Ground level:

25.97mOD

Logged by:

GR/NC

Vertical scale:

1:50

Project ID:

2230571

Flush Details

Top (m)	Base (m)	Flush Type	Flush Return %
7.08	23.20	Water	100
23.20	25.50	Water	80
25.50	35.80	Water	100
35.80	41.00	Water	0

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:

JT

IFA RC v01.01

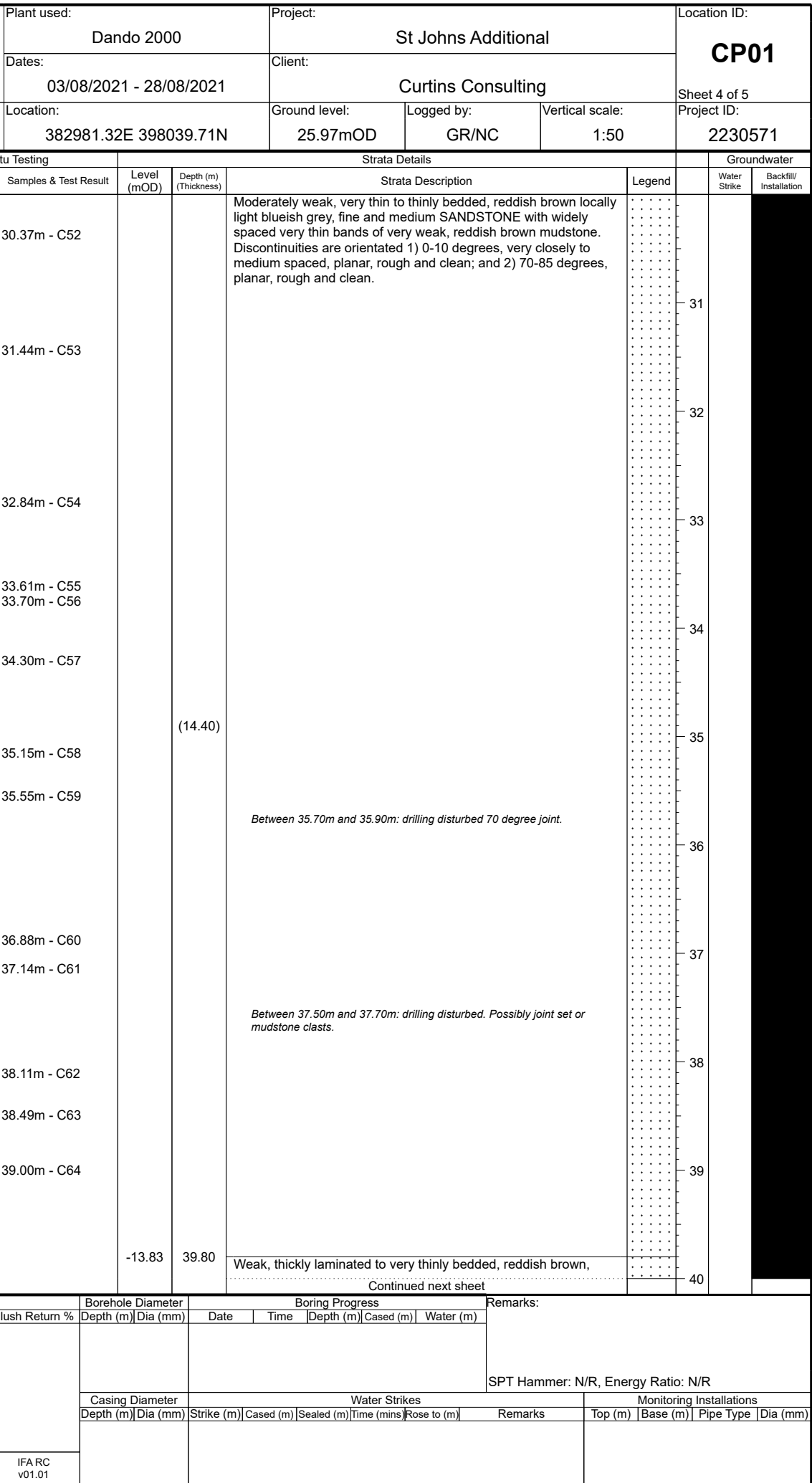
Log status:

PRELIM

	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01	
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting				
Rotary Boring Log	Location: 382981.32E 398039.71N		Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 2230571	

Coring, Samples & In Situ Testing				Strata Details				Groundwater		
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
		AZCL	20.30m - C40			Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with occasional subangular clasts (<20x30x20mm) of extremely weak, brown, mudstone. Discontinuities are orientated 1) 0-15 degrees, very closely to medium spaced, planar and undulating, rough and clean; 2) 30 degrees, medium spaced, planar, rough and clean; and 3) 90 degrees, undulating rough and clean.				
20.20 - 21.70	93 93 43	7	20.98m - C41							
			21.70m - C42							
21.70 - 23.20	100 100 87		22.60m - C43 22.80m - C44							
23.20 - 24.50	38 31 0	AZCL	23.47m - C45	2.27	23.70	Very weak, thickly laminated, reddish brown, fine SANDSTONE. Discontinuities are orientated 60 degrees, very closely to closely spaced, planar, rough, open with (2mm) firm, brown clay infill. <i>Between 23.70m and 24.50m: assumed zone of core loss possibly due to joints.</i>				
24.50 - 25.50	80 10 0	8	24.72m - C46		(1.70)					
		AZCL		0.57	25.40	<i>Between 25.50m and 25.70m: assumed zone of core loss. Core possibly scrubbed.</i>				
25.50 - 27.00	87 67 30	8	26.00m - C47			Moderately weak, very thin to thinly bedded, reddish brown locally light blueish grey, fine and medium SANDSTONE with widely spaced very thin bands of very weak, reddish brown mudstone. Discontinuities are orientated 1) 0-10 degrees, very closely to medium spaced, planar, rough and clean; and 2) 70-85 degrees, planar, rough and clean.				
27.00 - 28.30	77 77 61	AZCL	27.37m - C48			<i>Between 27.50m and 27.80m: drilling disturbed. Possible joint set.</i>				
28.30 - 29.80	100 100 63	6	28.60m - C49 29.08m - C50							
			30.00m - C51			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:		JT		IFA RC											
Log status:		PRELIM		v01.01											



 IAN FARMER ASSOCIATES	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01									
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting												
Rotary Boring Log	Location: 382981.32E 398039.71N		Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 5 of 5 Project ID: 2230571									
	Coring, Samples & In Situ Testing		Strata Details				Groundwater								
Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation						
		15			(0.60)	Weak, thickly laminated to very thinly bedded, reddish brown, conglomeritic, coarse SANDSTONE. Gravel is subrounded, fine and medium of mixed lithologies including quartz and mudstone. Discontinuities are orientated 1) 0-5 degrees, very closely to closely spaced, undulating, rough and clean; 2) 30 degrees, closely spaced, planar, rough and clean; and 3) 50 degrees, planar, rough and clean. Moderately weak, very thinly bedded, reddish brown mottled blueish grey, medium SANDSTONE. Discontinuities are orientated 0-10 degrees, very closely to medium spaced, planar, rough and clean. End of Borehole at 41.00m		41							
		6	40.46m - C65	-14.43	40.40										
			40.90m - C66	-15.03	41.00										
								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:		JT	IFA RC												
Log status:		PRELIM	v01.01												



IAN FARMER ASSOCIATES

Plant used:

Dando 2000

Project:

St Johns Additional

Location ID:

CP01

Dates:

03/08/2021 - 28/08/2021

Client:

Curtins Consulting

Sheet 1 of 5

Cable Percussion and Rotary Boring Log

Location:

382981.32E 398039.71N

Ground level:

25.97mOD

Logged by:

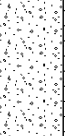
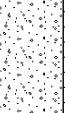
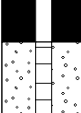
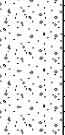
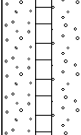
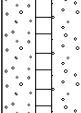
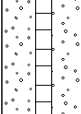
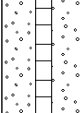
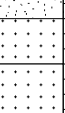
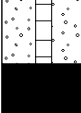
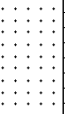
GR/NC

Vertical scale:

1:50

Project ID:

2230571

Samples & In Situ Testing				Strata Details				Groundwater			
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation			
0.50	ES1	SPT(S) 50 (25 for 70mm/50 for 0mm)	25.87	0.10	MADE GROUND: CONCRETE.						
0.80 - 1.00	B2		(1.00)	MADE GROUND: Reddish grey, slightly clayey GRAVEL. Gravel is angular to subrounded, fine to coarse including sandstone, brick and concrete.							
1.00	D3										
1.20											
1.20 - 1.65	D5	SPT(S) N=26 (2,4/5,8,6,7)	24.87	1.10	MADE GROUND: Very dense, dark reddish grey, slightly sandy, slightly clayey GRAVEL. Gravel is angular to subrounded, fine to coarse including sandstone and brick.		1				
1.20 - 1.70	B4		(0.40)	MADE GROUND: Greyish red, gravelly, fine to coarse SAND. Gravel is angular to subangular, fine to coarse including brick and sandstone.							
1.50	D6										
1.85	D7										
2.00		SPT(S) N=16 (3,4/5,5,3,3)	24.47	1.50	Medium dense, dark brownish grey, gravelly to very gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone and mudstone.		2				
2.00 - 2.45	D9		(0.30)								
2.00 - 2.50	B8										
2.75	D10										
3.00		SPT(S) N=18 (2,3/1,2,3,12)	24.17	1.80	Below 2.75m: becomes yellowish brown.		3				
3.00	ES11		(2.60)	Between 3.00m and 3.50m: low cobble content. cobbles are rounded including sandstone.							
3.00 - 3.45	D13										
3.00 - 3.50	B12										
3.75	D14	SPT(S) N=18 (2,3/1,2,3,12)	21.57	4.40	Very dense, reddish brown, fine and medium SAND.		4				
4.00	D16										
4.00 - 4.45	B15										
4.00 - 4.50											
4.50	D17	SPT(S) 50 (23 for 75mm/50 for 75mm)	19.27	6.70	Red, very weak, weathered SANDSTONE recovered as very dense, gravelly, fine to coarse sand. Gravel is angular, fine to coarse.		5				
4.75	D18		(2.30)	Very weak, very thinly thinly bedded, reddish brown, fine and medium SANDSTONE. Discontinuities are orientated 1) 2-5 degrees, very closely spaced, planar, rough and clean; and 2) 90 degrees, planar rough clean.							
5.00											
5.00 - 5.45	D20										
5.00 - 5.50	B19	SPT(S) 50 (25 for 95mm/50 for 105mm)	18.97	7.00	Between 7.80m and 8.50m: assumed zone of core loss. Core possibly scrubbed.		6				
5.75	D21		(1.50)	Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with closely to medium spaced, thick laminations to very thin beds of extremely weak reddish brown mudstone. Discontinuities are orientated 1) 0-10 degrees, very close to medium spaced, planar, rough and clean; and 2) 60 degrees, widely spaced, planar, rough and clean.							
6.00											
6.00 - 6.45	D23										
6.00 - 6.50	B22	7.00m - SPT(S) 50 (25 for 50mm/50 for 25mm)	17.47	8.50			7				
6.75	D24		(1.50)								
7.00 - 8.00	80								AZCL	18	7.00m - SPT(S) 50 (25 for 50mm/50 for 25mm)
	45										
	0										
8.00 - 8.50	0	AZCL			8		9				
	0										
	0										
	0										
8.50 - 9.30	81	AZCL			9		10				
	81										
	72										
TCR/SCR/ROD		FI	Continued next sheet								

Chiselling				Borehole Diameter		Boring Progress				Remarks:	
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
				7.00	150	03/08	16:30	7.08	4.50	5.10	Service inspection pit hand excavated from GL to 1.20m.
											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)
4.50	150	5.00	4.50		20	4.70		0.00	3.00	Plain	50
								3.00	7.00	Slotted	50
Checked by:		JT	IFA CP								
Log status:		PRELIM	v01.01								



IAN FARMER ASSOCIATES

Plant used:

Dando 2000

Project:

St Johns Additional

Location ID:

CP01

Dates:

03/08/2021 - 28/08/2021

Client:

Curtins Consulting

Sheet 2 of 5

Rotary Boring Log

Location:

382981.32E 398039.71N

Ground level:

25.97mOD

Logged by:

GR/NC

Vertical scale:

1:50

Project ID:

2230571

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

Checked by:

JT

Log status:

PRELIM

IFA RC

v01.01

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)

 IAN FARMER ASSOCIATES	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01	
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting				
Rotary Boring Log	Location: 382981.32E 398039.71N		Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 2230571	

Coring, Samples & In Situ Testing				Strata Details				Groundwater			
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation		
		AZCL				Weak, thickly laminated to very thinly bedded, reddish brown, fine and medium SANDSTONE with occasional subangular clasts (<20x30x20mm) of extremely weak, brown, mudstone. Discontinuities are orientated 1) 0-15 degrees, very closely to medium spaced, planar and undulating, rough and clean; 2) 30 degrees, medium spaced, planar, rough and clean; and 3) 90 degrees, undulating rough and clean.					
20.20 - 21.70	93 93 43	7		2.27	23.70						
21.70 - 23.20	100 100 87										
23.20 - 24.50	38 31 0	AZCL					(1.70)	Very weak, thickly laminated, reddish brown, fine SANDSTONE. Discontinuities are orientated 60 degrees, very closely to closely spaced, planar, rough, open with (2mm) firm, brown clay infill. <i>Between 23.70m and 24.50m: assumed zone of core loss possibly due to joints.</i>			
24.50 - 25.50	80 10 0	8									
25.50 - 27.00	87 67 30	AZCL			0.57	25.40					
27.00 - 28.30	77 77 61	8									
28.30 - 29.80	100 100 63	AZCL									
						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)		
										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:		JT		IFA RC							
Log status:		PRELIM		v01.01							

Plant used: Dando 2000	Project: St Johns Additional			Location ID: CP01
Dates: 03/08/2021 - 28/08/2021	Client: Curtins Consulting			
Location: 382981.32E 398039.71N	Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 2230571

 IAN FARMER ASSOCIATES	Plant used: Dando 2000		Project: St Johns Additional			Location ID: CP01									
	Dates: 03/08/2021 - 28/08/2021		Client: Curtins Consulting												
Rotary Boring Log	Location: 382981.32E 398039.71N		Ground level: 25.97mOD	Logged by: GR/NC	Vertical scale: 1:50	Sheet 5 of 5 Project ID: 2230571									
	Coring, Samples & In Situ Testing		Strata Details				Groundwater								
Depth	TCR/SCR/RQD	FI	Samples & Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation						
		15		-14.43	(0.60)	Weak, thickly laminated to very thinly bedded, reddish brown, conglomeritic, coarse SANDSTONE. Gravel is subrounded, fine and medium of mixed lithologies including quartz and mudstone. Discontinuities are orientated 1) 0-5 degrees, very closely to closely spaced, undulating, rough and clean; 2) 30 degrees, closely spaced, planar, rough and clean; and 3) 50 degrees, planar, rough and clean.		41							
		6			40.40					(0.60)					
				-15.03	41.00	Moderately weak, very thinly bedded, reddish brown mottled blueish grey, medium SANDSTONE. Discontinuities are orientated 0-10 degrees, very closely to medium spaced, planar, rough and clean.									
						End of Borehole at 41.00m									
								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:		JT		IFA RC											
Log status:		PRELIM		v01.01											

Plant used: Dando 2000	Project: St Johns Additional			Location ID: CP02
Dates: 04/08/2021	Client: Curtins Consulting			
Location: 383007.15E 398045.11N	Ground level: 26.33mOD	Logged by: GR	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 2230571

Plant used:

Dando 2000

Project:

St Johns Additional

Dates:

04/08/2021 - 05/08/2021

Client:

Curtins Consulting

Location ID:

CP03

Cable Percussion Borehole Log

Location:

383008.39E 398027.15N

Ground level:

26.51mOD

Logged by:

GR/TB

Vertical scale:

1:50

Project ID:

2230571

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
1.00	ES1	SPT(S) N=7 (3,2/3,1,2,1)	26.41	0.10	MADE GROUND: TARMACADAM over concrete.			
1.20 - 1.65	D3		(0.70)	MADE GROUND: Light grey, sandy, angular to subangular, fine to coarse GRAVEL including concrete.				
1.20 - 1.70	B2							
1.85	D4	SPT(S) N=4 (1,2/2,1,1,)	25.71	0.80	MADE GROUND: Light grey, slightly sandy, angular to subangular, fine to coarse GRAVEL including limestone.		1	
2.00	D6		(0.40)					
2.00 - 2.45	B5							
2.50	D7	SPT(S) N=16 (5,5/4,4,4,4)	25.31	1.20	MADE GROUND: Loose, light brown and light grey, gravelly, fine to coarse SAND. Gravel is angular to subrounded, fine to coarse including concrete, brick and sandstone.		2	
2.75	D8		(1.20)					
3.00	D10							
3.00 - 3.45	B9	SPT(S) N=16 (5,5/4,4,4,4)	24.11	2.40	MADE GROUND: Medium dense, light brown, slightly gravelly, clayey, fine to coarse SAND. Gravel is angular to subrounded, fine to coarse including concrete, brick and sandstone.		3	
3.00 - 3.50	B9		(0.80)					
3.50	ES11							
3.75	D12	SPT(S) N=7 (5,4/4,1,1,1)	23.31	3.20	Below 2.75m: slightly clayey. At 3.00m: pockets of firm brown clay.		3	
4.00	B13		(0.80)					
4.00 - 4.50	B13							
4.75	D14	SPT(S) 50 (6,10/50 for 150mm)	22.51	4.00	Medium dense, brown, very sandy, very silty, subangular to subrounded fine to coarse GRAVEL including sandstone, siltstone and quartz.		4	
5.00	D15							
5.00 - 5.45	B16							
5.75	D17	SPT(S) 50 (25 for 75mm/50 for 50mm)	20.38	6.13	Extremely weak, highly weathered, red brown SANDSTONE recovered as slightly silty, fine and medium sand.		5	
6.00	D18		(2.12)					
6.00	D18							
					End of Borehole at 6.13m		6	
							7	
							8	
							9	
							10	

Chiselling				Borehole Diameter		Boring Progress					Remarks: Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
5.50	6.00	60		6.00	150	04/08	16:30	4.50	4.00	Dry	
						05/08	08:00	4.50	4.00	4.50	
						05/08	16:30	6.13	5.50	Damp	

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)
5.50	150	4.80	4.50	5.50	20	4.50		0.00	0.50	Plain	50
								0.50	3.00	Slotted	50

Checked by:

JT

Log status:

PRELIM

IFA CP v01.01

Plant used: Commachio 205	Project: St John's Masterplan Phase 2			Location ID: RBH20
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting			
Location: 383018.36E 398038.25N	Ground level: 26.58mOD	Logged by: JO	Vertical scale: 1:50	Sheet 1 of 5 Project ID: 42269

Plant used: Commachio 205	Project: St John's Masterplan Phase 2			Location ID: RBH20
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting			
Location: 383018.36E 398038.25N	Ground level: 26.58mOD	Logged by: JO	Vertical scale: 1:50	Sheet 2 of 5 Project ID: 42269

Plant used: Commachio 205	Project: St John's Masterplan Phase 2			Location ID: RBH20
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting			
Location: 383018.36E 398038.25N	Ground level: 26.58mOD	Logged by: JO	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 42269

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	98 71 62	6	20.20m - C14			Extremely weak, thinly laminated, reddish brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, planar rough and clean. <i>Between 20.10m and 23.10m: weak</i> <i>Between 20.41m and 20.52m: non intact recovered as sand.</i>			
		NI							
		5	21.00m - C15						
21.00 - 22.50	100 97 65	8	22.00m - C16						
			22.85m - C17						
22.50 - 24.00	100 96 65	4	24.00m - C18		(35.50)	<i>Between 23.10m and 31.05m: medium strong.</i> <i>Between 23.50m and 23.71m: 1no 45 degrees planar and undulating rough with clay and calcite infilled discontinuity.</i>			
24.00 - 25.50	100 98 88		24.73m - C19						
25.50 - 27.00	100 98 91		26.03m - C20						
27.00 - 28.50	100 93 66		27.30m - C21						
			28.30m - C22						
28.50 - 30.00	100 100 80		29.10m - C23						
		1							
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)				

Plant used: Commachio 205	Project: St John's Masterplan Phase 2			Location ID: RBH20
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting			
Location: 383018.36E 398038.25N	Ground level: 26.58mOD	Logged by: JO	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 42269



Plant used: Commachio 205	Project: St John's Masterplan Phase 2		Location ID: RBH20		
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting				
Rotary Borehole Log	Location: 383018.36E 398038.25N	Ground level: 26.58mOD	Logged by: JO	Vertical scale: 1:50	Sheet 5 of 5
	Project ID: 42269				

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
		3		-13.92	40.50	Extremely weak, thinly laminated, reddish brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, planar rough and clean. <i>Between 40.02m and 40.50m: medium strong.</i> End of Borehole at 40.50m			
								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)				
				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													
Log status:	DRAFT	v01.01													

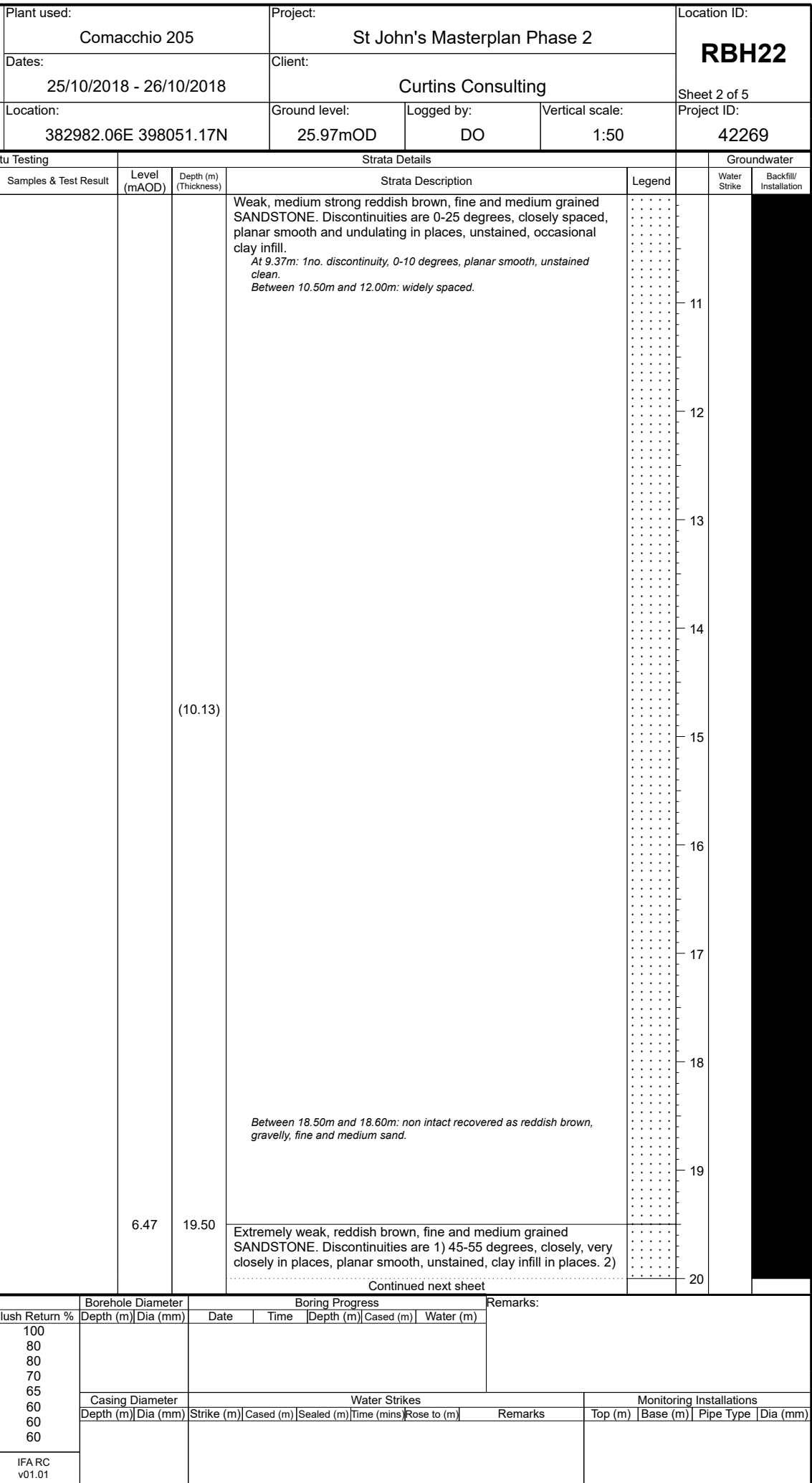
Flush Details				Borehole Diameter		Boring Progress					Remarks:				
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	Service inspection pit hand excavated from GL to 1.20m.				
						19/11	16:30	8.50	7.50	4.20					
				Casing Diameter		Water Strikes						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)
						4.00	3.00			20	4.00				
Checked by:		HH	IFARC v01.01												
Log status:		DRAFT													

Plant used: Comacchio 205	Project: St John's Masterplan Phase 2			Location ID: RBH22
Dates: 25/10/2018 - 26/10/2018	Client: Curtins Consulting			
Location: 382982.06E 398051.17N	Ground level: 25.97mOD	Logged by: DO	Vertical scale: 1:50	Sheet 1 of 5
				Project ID: 42269

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
			0.40m - B1 0.50m - ES2	25.77 25.57	0.20 0.40	MADE GROUND: Tarmacadam. MADE GROUND: Light grey, sandy GRAVEL. Gravel is angular to subangular, fine to coarse including limestone, granite and concrete. MADE GROUND: Brown, mottled black, sandy GRAVEL with medium cobble content. Gravel and cobbles are angular to subrounded, fine to coarse including brick, slag and concrete.			
			1.90m - B3	24.07	1.90	Orange brown speckled black, gravelly, fine to coarse SAND. Gravel is angular to subrounded, fine including sandstone.			
					(1.50)				
				21.77	4.20	Red SANDSTONE (drillers description).			
4.50 - 5.50	0 0 0	AZCL			(1.40)				
5.50 - 6.00	80 20 0	NI		20.37	5.60	Weak, reddish brown, fine and medium grained SANDSTONE. At 5.60m: 1no. discontinuity, 0 degrees, planar smooth, unstained, clean. Between 5.64m and 5.74m: non intact recovered as angular to subangular gravel. Between 5.80m and 6.10m: non intact recovered as angular to subangular gravel.			
6.00 - 7.50	100 83 53	9		19.87	6.10	Weak, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-25 degrees, very closely, planar smooth, unstained, clay infill. Between 6.35m and 6.45m: non intact recovered as angular to subangular gravel. Between 7.35m and 7.55m: non intact recovered as clayey, sandy, angular to subangular cobble.			
		16							
		NI							
7.50 - 9.00	97 93 33	10			(2.95)				
		AZCL		16.92	9.05	Medium strong reddish brown, fine and medium grained SANDSTONE. At 9.15m: 1no. discontinuity 0-10 degrees, planar rough, unstained, clean (possible drilling induced fracture). Extremely weak, reddish brown MUDSTONE. Weak, medium strong reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-25 degrees, closely spaced,			
9.00 - 10.50	97 97 90	5		16.67 16.60	9.30 9.37				

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)	Service inspection pit hand excavated from GL to 1.20m.					
5.50	6.00	Air	95		40.50	146	25/10	16:30	24.00	4.50	2.60						
6.00	7.50	Air	95				26/10	08:00	24.00	4.50	3.70						
7.50	9.00	Air	95				26/10	16:30	40.50	4.50	3.70						
9.00	10.50	Air	95														
10.50	12.00	Air	95														
12.00	13.50	Air	95		Casing Diameter		Water Strikes					Monitoring Installations					
13.50	15.00	Air	100		Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)	
15.00	16.50	Air	100		4.50	200								0.00	2.50	Plain	
														2.50	7.20	Slotted	
Checked by:		HH		IFA RC													
Log status:		DRAFT		v01.01													

Continued next sheet



	Plant used: Comacchio 205		Project: St John's Masterplan Phase 2			Location ID: RBH22	
	Dates: 25/10/2018 - 26/10/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location: 382982.06E 398051.17N		Ground level: 25.97mOD	Logged by: DO	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 42269

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	100 100 83	14				Extremely weak, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 1) 45-55 degrees, closely, very closely in places, planar smooth, unstained, clay infill in places. 2) 0-25 degrees, very closely spaced, planar smooth, unstained, clay infill. <i>Between 19.70m and 21.00: 1no. discontinuity 80-90 degrees, undulating, planar smooth and rough, unstained, clean.</i> <i>At 20.85m: medium strong.</i>			
		7							
21.00 - 22.50	100 80 75	11			(3.30)				
		NI				<i>Between 22.25m and 22.50m: recovered as reddish brown, gravelly, fine and medium sand.</i>			
22.50 - 24.00	100 100 87	1		3.17	22.80	Weak, locally medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 1) 45 degrees, undulating rough, unstained, clean. 2) 0-25 degrees, closely to medium spaced, planar smooth, unstained, clean.			
		10							
24.00 - 25.50	100 100 100	5			(3.00)				
		NI				<i>Between 25.50m and 25.80m: non intact recovered as sand.</i>			
25.50 - 27.00	100 60 60	6		0.17	25.80	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-25 degrees, closely spaced, planar smooth, unstained, clean. <i>Between 26.50m and 26.90m: non intact recovered as gravelly, fine and medium sand.</i>			
		NI							
		8							
27.00 - 28.50	100 100 100	NI			(2.70)	<i>At 27.15m: 1no. discontinuity 0 degrees, undulating rough, unstained, clean (possible drilling induced fracture).</i> <i>Between 27.15m and 28.50m: non intact recovered as sandy, angular to subangular, cobble of weak sandstone.</i>			
		NI							
28.50 - 30.00	100 87 63	10		-2.53	28.50	Weak, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-20 degrees, closely, locally extremely closely spaced, planar smooth, unstained, clean. <i>Between 29.22m and 29.30m: non intact recovered as gravelly, fine and medium sand.</i> <i>Between 29.45m and 30.10m: non intact recovered as angular to subangular cobble.</i>			
		20							
		10							
		14							
		NI							
		7							
		NI							
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)			
30.00	31.50	Air	60												
31.50	33.00	Air	20												
33.00	34.50	Air	20												
36.00	37.50	Air	60												
37.50	39.00	Air	60												
39.00	40.50	Air	60												
				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												
Log status:		DRAFT	v01.01												

Plant used: Comacchio 205	Project: St John's Masterplan Phase 2			Location ID: RBH22
Dates: 25/10/2018 - 26/10/2018	Client: Curtins Consulting			
Location: 382982.06E 398051.17N	Ground level: 25.97mOD	Logged by: DO	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 42269

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)													
				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 RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



Core Photographs RBH20



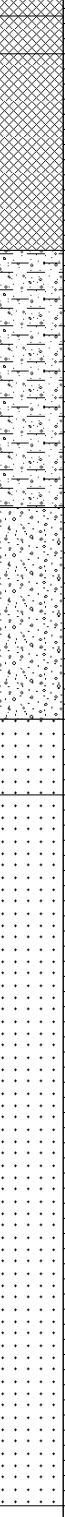
Core Photographs RBH20



Core Photographs RBH20



			Plant used: Comacchio 205/		Project: St John's Masterplan Phase 2			Location ID: RBH21		
			Dates: 26/10/2018 - 31/10/2018		Client: Curtins Consulting					
Rotary Borehole Log			Location: 382999.09E 398042.53N		Ground level: 26.23mOD		Logged by: DO/		Vertical scale: 1:50	
									Sheet 1 of 4 Project ID: 42269	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
			0.15m - ES2	26.08	0.15	MADE GROUND: Tarmacadam.			
			0.40m - ES3	25.83	0.40	MADE GROUND: Light grey, fine to coarse SAND and angular to subangular, fine to coarse GRAVEL including limestone, granite and concrete.			
			0.50m - ES1		(1.30)	MADE GROUND: Yellowish brown, mottled black, sandy GRAVEL with medium cobbles content. Gravel and cobbles are angular to subrounded including brick, slag and concrete. At 0.50m: thin layer of tarmacadam.			
				24.53	1.70	Brown gravelly CLAY (drillers description).			
					(1.70)				
				22.83	3.40	Red SAND and GRAVEL (drillers description).			
					(1.40)				
4.50 - 5.10	50 0 0	AZCL		21.43	4.80	Very weak, reddish brown, fine grained SANDSTONE. Discontinuities are 0-10 degrees, very closely spaced, planar smooth and clean.			
5.10 - 5.65	82 45 0	AZCL NI 32 NI		20.93	5.30	Very weak, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-10 degrees, extremely, locally very closely spaced, planar smooth, unstained clean (possible drilling induced fractures). Between 5.55m and 5.65m: non intact recovered as sand.			
5.65 - 6.00	100/10/0	24 NI AZCL NI 20				Between 6.10m and 6.20m: recovered as angular to subangular, fine and medium gravel of sandstone. Between 6.35m and 6.40m: with interlaminated mudstone.			
6.00 - 7.50	93 87 73	5	7.00m - C4						
7.50 - 9.00	100 93 60	NI 8	8.00m - C5 8.85m - C6			Between 8.10m and 8.60m: recovered as fine and medium sand. Between 8.60m and 8.70m: 1no discontinuity is 45-55 degrees, planar smooth, unstained and clean. Between 9.00m and 9.50m: non intact recovered as fine and medium sand.			
9.00 - 10.50	33 0 0	NI 10							
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)						
4.50	5.10	Water	90	40.50	146	26/10	16:00	1.20			Service inspection pit hand excavated from GL to 1.20m.					
5.10	5.65	Water	90			29/10	08:00	1.20								
5.65	6.00	Water	80			29/10	16:00	24.00	4.50	1.70						
6.00	7.50	Water	80			30/10	08:00	24.00	4.50	3.10						
7.50	9.00	Water	60													
				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)	
				4.50	200											
Checked by:		HH		IFA RC												
Log status:		DRAFT		v01.01												

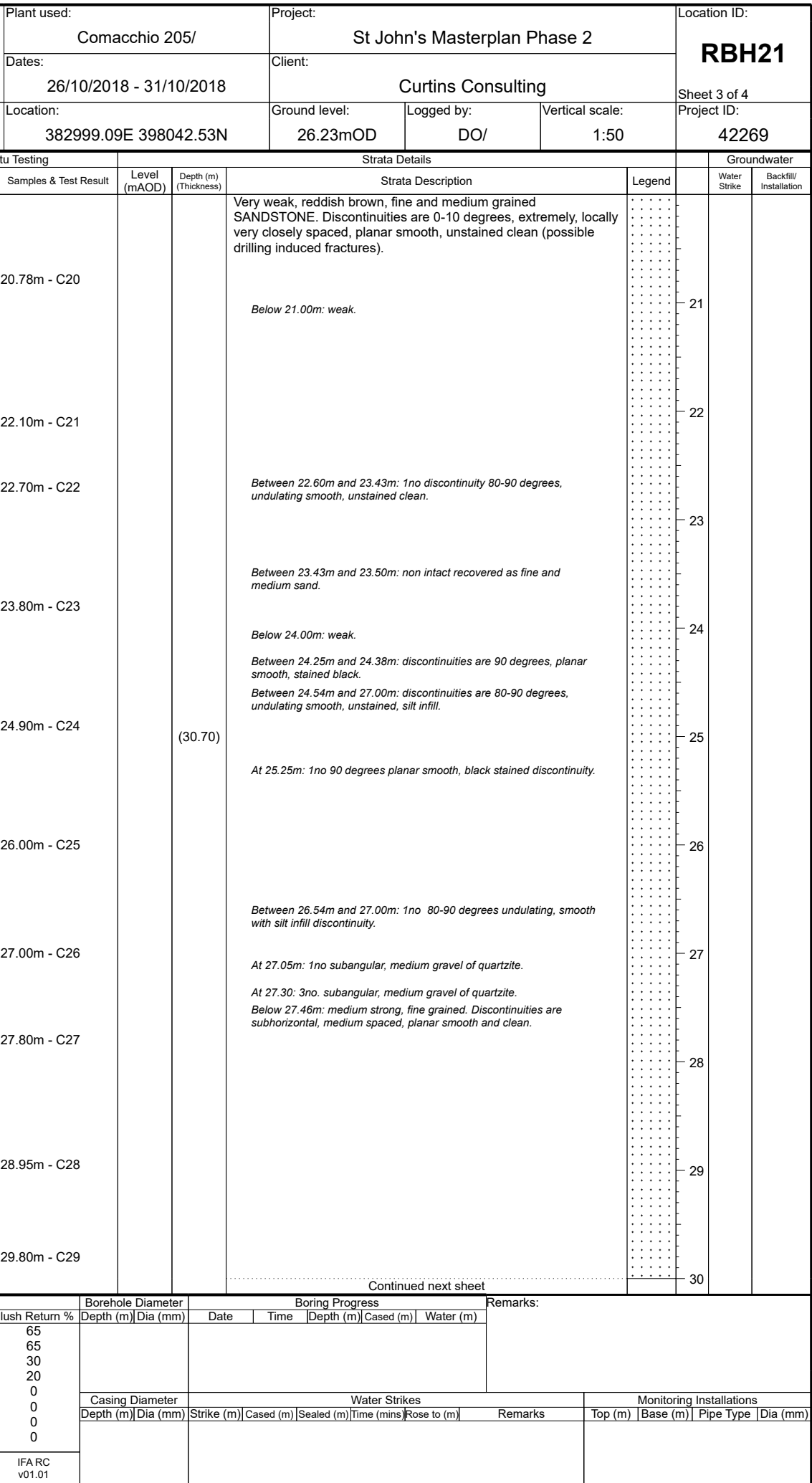
	Plant used: Comacchio 205/		Project: St John's Masterplan Phase 2			Location ID: RBH21	
	Dates: 26/10/2018 - 31/10/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location: 382999.09E 398042.53N		Ground level: 26.23mOD	Logged by: DO/	Vertical scale: 1:50	Sheet 2 of 4 Project ID: 42269

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				Very weak, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-10 degrees, extremely, locally very closely spaced, planar smooth, unstained clean (possible drilling induced fractures). At 11.15m: 1no 30 degrees, planar smooth and clean discontinuity. Between 11.35m and 11.40m: mudstone inter laminated. Below 12.50m: weak and medium grained. At 12.80m: 1no 50-60 degrees, planar smooth and clean discontinuity. At 13.10m: 1no 50-60 degrees, planar smooth and clean discontinuity. Between 13.40m and 13.50m: non intact recovered as fine and medium sand. Between 13.70m and 13.90m: non intact recovered as sand and gravel. Between 14.10m and 14.25m: 1no degrees, planar smooth, unstained, clay infill.			
10.50 - 11.50	100 100 90	7	10.50m - C7 10.90m - C8 11.20m - C9						
11.50 - 12.00	70 70 50		11.70m - C10						
12.00 - 13.50	67 57 40	AZCL 7	12.60m - C11						
13.50 - 14.00	100 50 40	NI 7 NI 10 NI	13.60m - C12						
14.00 - 15.00	100 95 90	3	14.50m - C13						
15.00 - 16.50	100 100 85	30	15.50m - C14 16.39m - C15						
16.50 - 18.00	100 100 100		17.10m - C16 18.00m - C17						
18.00 - 19.50	100 100 100	1	19.00m - C18						
			19.92m - C19						
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)	
12.00	13.50	Water	80			30/10	16:00	36.00	4.50	3.90	
13.50	14.00	Water	80			31/10	08:00	36.00	4.50	11.20	
14.00	15.00	Water	80								
15.00	16.50	Air	80								
16.50	18.00	Air	80								
18.00	19.50	Air	80								
19.50	21.00	Air	80								
21.00	22.50	Air	80								

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
Log status:	DRAFT	v01.01



Plant used: Comacchio 205/	Project: St John's Masterplan Phase 2			Location ID: RBH21
Dates: 26/10/2018 - 31/10/2018	Client: Curtins Consulting			
Location: 382999.09E 398042.53N	Ground level: 26.23mOD	Logged by: DO/	Vertical scale: 1:50	Sheet 4 of 4 Project ID: 42269

Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



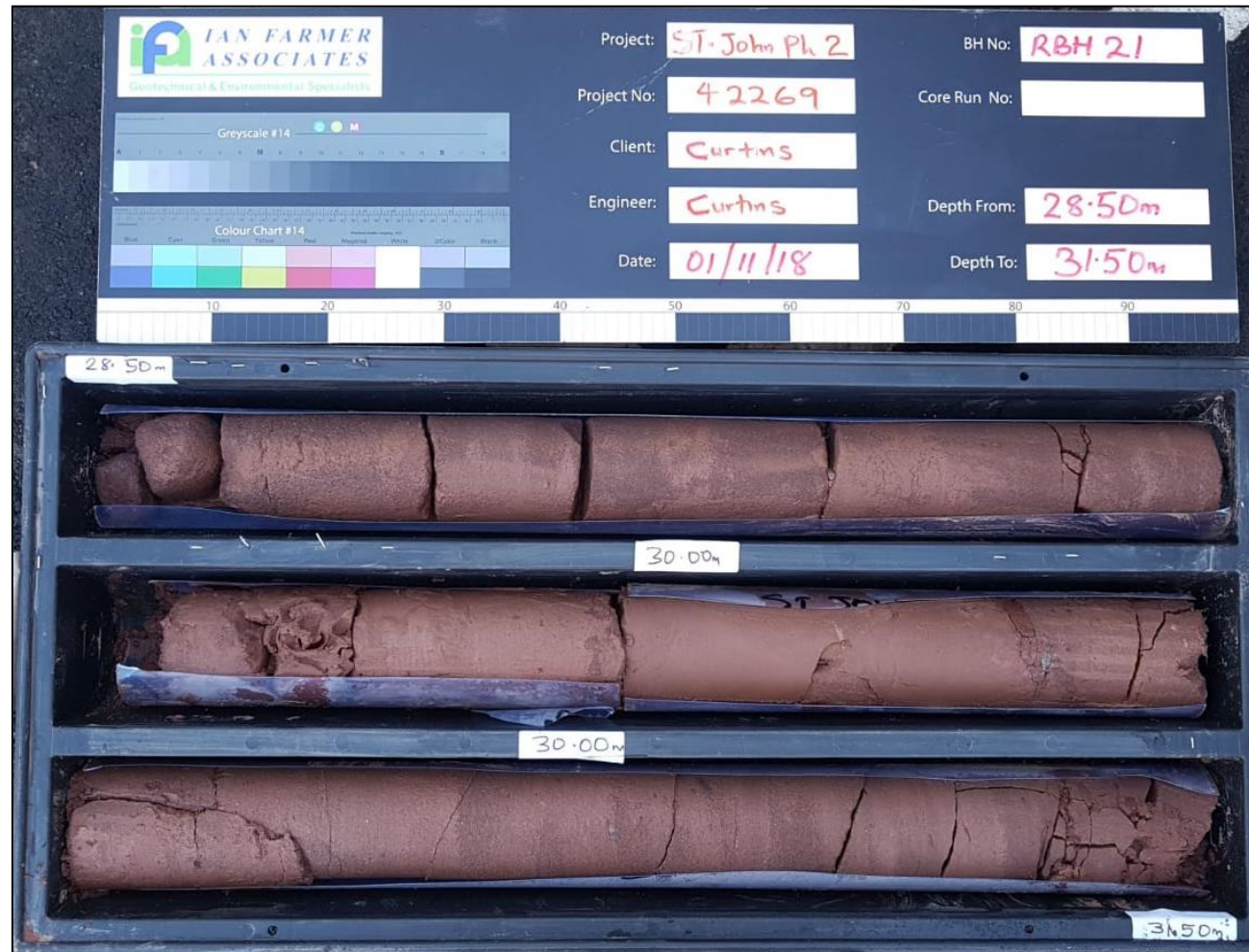
Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH21



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Core Photographs RBH22



Appendix C – Chemical Laboratory Testing Results

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/08568
Issue Number: 1
Date: 16 August, 2021

Client: Curtins Consulting (Manchester)
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: EBMA/Siobhán Hyde
Project Name: St. Johns T2
Project Ref: B078743
Order No: EBMA3010
Date Samples Received: 05/08/21
Date Instructions Received: 06/08/21
Date Analysis Completed: 13/08/21

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 21/08568

Client Project Name: St. Johns T2

Client Project Ref: B078743

Lab Sample ID	21/08568/1	21/08568/2	21/08568/3	21/08568/5	21/08568/6			Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CP01	CP01	CP02	CP03	CP03					
Depth to Top	0.50	3.00	1.50	1.00	3.50					
Depth To Bottom										
Date Sampled	03-Aug-21	03-Aug-21	04-Aug-21	04-Aug-21	04-Aug-21					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	4AB	4A	4AB					
% Stones >10mm _A	16.2	8.8	32.3	5.0	24.0			% w/w	0.1	A-T-044
pH _D ^{M#}	12.40	8.55	9.45	11.53	8.76			pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	0.07	0.08	0.03	0.09	<0.01			g/l	0.01	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1	<1	<1	<1			mg/kg	1	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2	<0.2	<0.2			mg/kg	0.2	A-T-050s
Organic matter _D ^{M#}	3.7	0.7	1.4	8.6	0.5			% w/w	0.1	A-T-032 OM
Arsenic _D ^{M#}	<1	4	8	<1	2			mg/kg	1	A-T-024s
Boron (water soluble) _D	1.3	<1.0	<1.0	<1.0	<1.0			mg/kg	1	A-T-027s
Cadmium _D ^{M#}	<0.5	1.2	0.8	0.7	<0.5			mg/kg	0.5	A-T-024s
Copper _D ^{M#}	13	9	48	7	9			mg/kg	1	A-T-024s
Chromium _D ^{M#}	11	17	15	16	15			mg/kg	1	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1			mg/kg	1	A-T-040s
Lead _D ^{M#}	30	24	446	25	9			mg/kg	1	A-T-024s
Mercury _D	3.02	<0.17	10	4.49	<0.17			mg/kg	0.17	A-T-024s
Nickel _D ^{M#}	7	16	12	8	14			mg/kg	1	A-T-024s
Selenium _D ^{M#}	<1	<1	<1	<1	<1			mg/kg	1	A-T-024s
Zinc _D ^{M#}	39	36	103	49	23			mg/kg	5	A-T-024s

Envirolab Job Number: 21/08568

Client Project Name: St. Johns T2

Client Project Ref: B078743

Lab Sample ID	21/08568/1	21/08568/2	21/08568/3	21/08568/5	21/08568/6			Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CP01	CP01	CP02	CP03	CP03					
Depth to Top	0.50	3.00	1.50	1.00	3.50					
Depth To Bottom										
Date Sampled	03-Aug-21	03-Aug-21	04-Aug-21	04-Aug-21	04-Aug-21					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	4AB	4A	4AB					
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD	NAD	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	N/A	N/A	N/A	N/A	N/A					A-T-045

Envirolab Job Number: 21/08568

Client Project Name: St. Johns T2

Client Project Ref: B078743

Lab Sample ID	21/08568/1	21/08568/2	21/08568/3	21/08568/5	21/08568/6			Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CP01	CP01	CP02	CP03	CP03					
Depth to Top	0.50	3.00	1.50	1.00	3.50					
Depth To Bottom										
Date Sampled	03-Aug-21	03-Aug-21	04-Aug-21	04-Aug-21	04-Aug-21					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	4AB	4A	4AB					
PAH-16MS (MSD order)										
Naphthalene _A ^{M#}	0.13	<0.03	0.62	0.04	<0.03			mg/kg	0.03	A-T-019s
Acenaphthylene _A ^{M#}	0.02	<0.01	0.01	<0.01	<0.01			mg/kg	0.01	A-T-019s
Acenaphthene _A ^{M#}	0.18	<0.01	0.87	0.04	0.02			mg/kg	0.01	A-T-019s
Fluorene _A ^{M#}	0.14	0.02	0.53	0.04	0.02			mg/kg	0.01	A-T-019s
Phenanthrene _A ^{M#}	1.50	0.28	5.49	0.38	0.14			mg/kg	0.03	A-T-019s
Anthracene _A ^{M#}	0.39	0.06	1.33	0.10	0.04			mg/kg	0.02	A-T-019s
Fluoranthene _A ^{M#}	1.58	0.33	6.34	0.42	0.14			mg/kg	0.08	A-T-019s
Pyrene _A ^{M#}	1.41	0.27	5.40	0.38	0.12			mg/kg	0.07	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.63	0.11	2.29	0.19	0.05			mg/kg	0.04	A-T-019s
Chrysene _A ^{M#}	0.70	0.15	2.30	0.19	0.07			mg/kg	0.06	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.65	0.13	2.36	0.16	0.06			mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.24	<0.07	0.93	0.08	<0.07			mg/kg	0.07	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.60	0.13	2.28	0.17	0.06			mg/kg	0.04	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.31	0.07	1.25	0.08	0.04			mg/kg	0.03	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.06	<0.04	0.22	<0.04	<0.04			mg/kg	0.04	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.29	0.06	1.16	0.08	<0.05			mg/kg	0.05	A-T-019s
Total PAH-16MS (MSD order) _A ^{M#}	8.83	1.61	33.4	2.35	0.76			mg/kg	0.03	A-T-019s

Envirolab Job Number: 21/08568

Client Project Name: St. Johns T2

Client Project Ref: B078743

Lab Sample ID	21/08568/1	21/08568/2	21/08568/3	21/08568/5	21/08568/6			Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CP01	CP01	CP02	CP03	CP03					
Depth to Top	0.50	3.00	1.50	1.00	3.50					
Depth To Bottom										
Date Sampled	03-Aug-21	03-Aug-21	04-Aug-21	04-Aug-21	04-Aug-21					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	4AB	4A	4AB					
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
Ali >C8-C10 _A	<1	<1	<1	<1	<1			mg/kg	1	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	<1	<1	<1			mg/kg	1	A-T-055s
Ali >C12-C16 _A ^{M#}	<1	<1	1	<1	<1			mg/kg	1	A-T-055s
Ali >C16-C21 _A ^{M#}	3	<1	2	<1	<1			mg/kg	1	A-T-055s
Ali >C21-C35 _A ^{M#}	27	6	141	10	7			mg/kg	1	A-T-055s
Total Aliphatics _A	30	6	146	10	7			mg/kg	1	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
Aro >C8-C10 _A	17	<1	1	9	<1			mg/kg	1	A-T-055s
Aro >C10-C12 _A	<1	<1	5	<1	<1			mg/kg	1	A-T-055s
Aro >C12-C16 _A	2	<1	13	<1	<1			mg/kg	1	A-T-055s
Aro >C16-C21 _A ^{M#}	12	2	37	4	<1			mg/kg	1	A-T-055s
Aro >C21-C35 _A ^{M#}	30	3	122	9	2			mg/kg	1	A-T-055s
Total Aromatics _A	61	5	178	22	2			mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C35) _A	92	11	324	32	9			mg/kg	1	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	0.01	A-T-022s

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

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, 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.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

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, 9 = INCINERATOR ASH.

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 Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client:	Curtins Consulting (Manchester), Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG	Project No:	21/08568
Project:	St. Johns T2	Date Received:	06/08/2021 (am)
Clients Project No:	B078743	Cool Box Temperatures (°C):	16.2

NO DEVIATIONS IDENTIFIED with respect to sampling dates or containers received.

Note: If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3 (for water samples $5 \pm 3^{\circ}\text{C}$), ISO 18400-120:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Envirolab Analysis Dates

Lab Sample ID	21/08568/1	21/08568/2	21/08568/3	21/08568/5	21/08568/6
Client Sample No					
Client Sample ID/Depth	CP01 0.50m	CP01 3.00m	CP02 1.50m	CP03 1.00m	CP03 3.50m
Date Sampled	03/08/21	03/08/21	04/08/21	04/08/21	04/08/21
A-T-019s	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-022s	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-024s	12/08/2021	12/08/2021	12/08/2021	12/08/2021	12/08/2021
A-T-026s	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-027s	12/08/2021	12/08/2021	12/08/2021	12/08/2021	12/08/2021
A-T-031s	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-032 OM	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-040s	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-042sTCN	12/08/2021	12/08/2021	12/08/2021	12/08/2021	12/08/2021
A-T-044	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
A-T-045	10/08/2021	10/08/2021	10/08/2021	10/08/2021	10/08/2021
A-T-050s	13/08/2021	13/08/2021	13/08/2021	13/08/2021	13/08/2021
A-T-055s	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021

The above dates are the analysis completion dates, please note that these are not necessarily the date that the analysis was weighed/extracted.

End of Report

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/09568
Issue Number: 1

Date: 14 September, 2021

Client: Curtins Consulting (Manchester)
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: EBMA/Rebecca Tidsey/Siobhán Hyde/Tommy Walker
Project Name: St. Johns T2
Project Ref: B065330
Order No: EBMA3043
Date Samples Received: 03/09/21
Date Instructions Received: 03/09/21
Date Analysis Completed: 13/09/21

Prepared by:



Danielle Brierley
Client Manager

Approved by:



Holly Neary-King
Client Services Supervisor

Envirolab Job Number: 21/09568

Client Project Name: St. Johns T2

Client Project Ref: B065330

Lab Sample ID	21/09568/1							Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CPRC 01									
Depth to Top	3.82									
Depth To Bottom	3.83									
Date Sampled	03-Sep-21									
Sample Type	Water - EW									
Sample Matrix Code	N/A									
pH (w) _A [#]	7.51							pH	0.01	A-T-031w
Hardness Total _A [#]	196							mg/l Ca CO ₃	2	A-T-049w
Sulphate (w) _A [#]	129							mg/l	1	A-T-026w
Cyanide (total) (w) _A [#]	<0.005							mg/l	0.005	A-T-042wTCN
Phenols - Total by HPLC (w) _A	<0.01							mg/l	0.01	A-T-050w
Sulphide (w) _A	<0.1							mg/l	0.1	A-T-S2-w
DOC (w) _A [#]	7.1							mg/l	0.2	A-T-032w
Arsenic (dissolved) _A [#]	<1							µg/l	1	A-T-025w
Boron (dissolved) _A [#]	59							µg/l	10	A-T-025w
Cadmium (dissolved) _A [#]	<0.2							µg/l	0.2	A-T-025w
Calcium (dissolved) _A [#]	58							mg/l	1	A-T-049w
Copper (dissolved) _A [#]	2							µg/l	1	A-T-025w
Chromium (dissolved) _A [#]	<1							µg/l	1	A-T-025w
Lead (dissolved) _A [#]	<1							µg/l	1	A-T-025w
Mercury (dissolved) _A [#]	<0.1							µg/l	0.1	A-T-025w
Nickel (dissolved) _A [#]	4							µg/l	1	A-T-025w
Selenium (dissolved) _A [#]	<1							µg/l	1	A-T-025w
Zinc (dissolved) _A [#]	3							µg/l	1	A-T-025w

Envirolab Job Number: 21/09568

Client Project Name: St. Johns T2

Client Project Ref: B065330

Lab Sample ID	21/09568/1							Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CPRC 01									
Depth to Top	3.82									
Depth To Bottom	3.83									
Date Sampled	03-Sep-21									
Sample Type	Water - EW									
Sample Matrix Code	N/A									
PAH 16MS (w)										
Acenaphthene (w) _A [#]	<0.01							µg/l	0.01	A-T-019w
Acenaphthylene (w) _A [#]	<0.01							µg/l	0.01	A-T-019w
Anthracene (w) _A [#]	<0.01							µg/l	0.01	A-T-019w
Benzo(a)anthracene (w) _A [#]	0.03							µg/l	0.01	A-T-019w
Benzo(a)pyrene (w) _A [#]	0.03							µg/l	0.01	A-T-019w
Benzo(b)fluoranthene (w) _A [#]	0.03							µg/l	0.01	A-T-019w
Benzo(ghi)perylene (w) _A [#]	0.01							µg/l	0.01	A-T-019w
Benzo(k)fluoranthene (w) _A [#]	0.01							µg/l	0.01	A-T-019w
Chrysene (w) _A [#]	0.03							µg/l	0.01	A-T-019w
Dibenzo(ah)anthracene (w) _A [#]	<0.01							µg/l	0.01	A-T-019w
Fluoranthene (w) _A [#]	0.08							µg/l	0.01	A-T-019w
Fluorene (w) _A [#]	<0.01							µg/l	0.01	A-T-019w
Indeno(123-cd)pyrene (w) _A [#]	0.02							µg/l	0.01	A-T-019w
Naphthalene (w) _A [#]	<0.01							µg/l	0.01	A-T-019w
Phenanthrene (w) _A [#]	0.06							µg/l	0.01	A-T-019w
Pyrene (w) _A [#]	0.07							µg/l	0.01	A-T-019w
Total PAH 16MS (w) _A [#]	0.34							µg/l	0.01	A-T-019w

Envirolab Job Number: 21/09568

Client Project Name: St. Johns T2

Client Project Ref: B065330

Lab Sample ID	21/09568/1							Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	CPRC 01									
Depth to Top	3.82									
Depth To Bottom	3.83									
Date Sampled	03-Sep-21									
Sample Type	Water - EW									
Sample Matrix Code	N/A									
TPH CWG (w)										
Ali >C5-C6 (w) _A [#]	<1							µg/l	1	A-T-022w
Ali >C6-C8 (w) _A [#]	<1							µg/l	1	A-T-022w
Ali >C8-C10 (w) _A [#]	<5							µg/l	5	A-T-055w
Ali >C10-C12 (w) _A [#]	<5							µg/l	5	A-T-055w
Ali >C12-C16 (w) _A [#]	<5							µg/l	5	A-T-055w
Ali >C16-C21 (w) _A [#]	<5							µg/l	5	A-T-055w
Ali >C21-C35 (w) _A [#]	14							µg/l	5	A-T-055w
Total Aliphatics (w) _A [#]	14							µg/l	5	A-T-055w
Aro >C5-C7 (w) _A [#]	<1							µg/l	1	A-T-022w
Aro >C7-C8 (w) _A [#]	<1							µg/l	1	A-T-022w
Aro >C8-C10 (w) _A	<5							µg/l	5	A-T-055w
Aro >C10-C12 (w) _A [#]	<5							µg/l	5	A-T-055w
Aro >C12-C16 (w) _A [#]	8							µg/l	5	A-T-055w
Aro >C16-C21 (w) _A [#]	<5							µg/l	5	A-T-055w
Aro >C21-C35 (w) _A [#]	<10							µg/l	10	A-T-055w
Total Aromatics (w) _A	<10							µg/l	10	A-T-055w
TPH (Ali & Aro >C5-C35) (w) _A	22							µg/l	10	A-T-055w
BTEX - Benzene (w) _A [#]	<1							µg/l	1	A-T-022w
BTEX - Toluene (w) _A [#]	<1							µg/l	1	A-T-022w
BTEX - Ethyl Benzene (w) _A [#]	<1							µg/l	1	A-T-022w
BTEX - m & p Xylene (w) _A [#]	<1							µg/l	1	A-T-022w
BTEX - o Xylene (w) _A [#]	<1							µg/l	1	A-T-022w
MTBE (w) _A [#]	<1							µg/l	1	A-T-022w

REPORT NOTES

General

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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, 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.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

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, 9 = INCINERATOR ASH.

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 Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client:	Curtins Consulting (Manchester), Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG	Project No:	21/09568
Project:	St. Johns T2	Date Received:	03/09/2021 (am)
Clients Project No:	B065330	Cool Box Temperatures (°C):	16.0

NO DEVIATIONS IDENTIFIED with respect to sampling dates or containers received.

Note: If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3 (for water samples $5 \pm 3^{\circ}\text{C}$), ISO 18400-105:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Envirolab Analysis Dates

Lab Sample ID	21/09568/1
Client Sample No	
Client Sample ID/Depth	CPRC 01 3.82-3.83m
Date Sampled	03/09/21
A-T-019w	09/09/2021
A-T-022w	08/09/2021
A-T-025w	13/09/2021
A-T-026w	09/09/2021
A-T-031w	09/09/2021
A-T-032w	09/09/2021
A-T-042wTCN	09/09/2021
A-T-049w	09/09/2021
A-T-050w	09/09/2021
A-T-055w	08/09/2021
A-T-S2-w	08/09/2021

The above dates are the analysis completion dates, please note that these are not necessarily the date that the analysis was weighed/extracted.

End of Report

Appendix D – Geotechnical Analysis Results

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/11047
Issue Number: 1
Date: 20 October, 2021

Client: Ian Farmer Associates (Newcastle)
Unit 4, Faraday Close
Pattinson North Industrial Estate
Washington
Tyne and Wear
NE38 8QJ

Project Manager: Paul Cathcart; washington@ianfarmer.co.uk
Project Name: St. Johns Additional
Project Ref: 2230571R
Order No: P7529079
Date Samples Received: 12/10/21
Date Instructions Received: 12/10/21
Date Analysis Completed: 20/10/21

Prepared by:


Melanie Marshall
Laboratory Coordinator

Approved by:


Richard Wong
Client Manager

Envirolab Job Number: 21/11047

Client Project Name: St. Johns Additional

Client Project Ref: 2230571R

Lab Sample ID	21/11047/1	21/11047/2	21/11047/3	21/11047/4	21/11047/5	21/11047/6	21/11047/7	Units	Limit of Detection	Method ref
Client Sample No	27	30	33	37	40	45	49			
Client Sample ID	CP01	CP01	CP01	CP01	CP01	CP01	CP01			
Depth to Top	9.60	12.44	14.03	17.00	20.30	23.47	28.60			
Depth To Bottom										
Date Sampled										
Sample Type	Soil - C	Soil - C	Soil - C	Soil - C	Soil - C	Soil - C	Soil - C			
Sample Matrix Code	1A	1A	1A	1A	1A	1A	1A			
% Stones >10mm _A	<0.1	<0.1	<0.1	95.4	<0.1	<0.1	<0.1	% w/w	0.1	A-T-044
pH BRE _D ^{M#}	8.86	9.06	9.03	9.11	9.03	9.14	9.14	pH	0.01	A-T-031s
Chloride BRE, SO4 equiv. (water sol 2:1) _D ^{M#}	8	10	7	<7	<7	<7	<7	mg/l	7	A-T-026s
Nitrate BRE, SO4 equiv. (water sol 2:1) _D	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	mg/l	0.4	A-T-026s
Sulphate BRE (water sol 2:1) _D ^{M#}	13	10	15	<10	<10	<10	10	mg/l	10	A-T-026s
Sulphate BRE (acid sol) _D ^{M#}	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	% w/w	0.02	A-T-028s
Sulphur BRE (total) _D	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	% w/w	0.01	A-T-024s
Magnesium BRE (water sol 2:1) _D	3	3	2	<1	2	2	3	mg/l	1	A-T-SOLMETS

Envirolab Job Number: 21/11047

Client Project Name: St. Johns Additional

Client Project Ref: 2230571R

Lab Sample ID	21/11047/8	21/11047/9						Units	Limit of Detection	Method ref
Client Sample No	55	63								
Client Sample ID	CP01	CP01								
Depth to Top	33.61	38.49								
Depth To Bottom										
Date Sampled										
Sample Type	Soil - C	Soil - C								
Sample Matrix Code	1A	1A								
% Stones >10mm _A	<0.1	<0.1						% w/w	0.1	A-T-044
pH BRE _D ^{M#}	8.90	9.15						pH	0.01	A-T-031s
Chloride BRE, SO4 equiv. (water sol 2:1) _D ^{M#}	<7	<7						mg/l	7	A-T-026s
Nitrate BRE, SO4 equiv. (water sol 2:1) _D	<0.4	<0.4						mg/l	0.4	A-T-026s
Sulphate BRE (water sol 2:1) _D ^{M#}	14	<10						mg/l	10	A-T-026s
Sulphate BRE (acid sol) _D ^{M#}	<0.02	<0.02						% w/w	0.02	A-T-028s
Sulphur BRE (total) _D	<0.01	<0.01						% w/w	0.01	A-T-024s
Magnesium BRE (water sol 2:1) _D	4	3						mg/l	1	A-T-SOLMETS

REPORT NOTES

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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:

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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:

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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 Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Ian Farmer Associates (Newcastle), Unit 4, Faraday Close, Pattinson North
Industrial Estate, Washington, Tyne and Wear, NE38 8QJ

Project No: 21/11047

Date Received: 12/10/2021 (am)

Project: St. Johns Additional

Cool Box Temperatures (°C): 13.4

Clients Project No: 2230571R

Lab Sample ID	21/11047/1	21/11047/2	21/11047/3	21/11047/4	21/11047/5	21/11047/6	21/11047/7	21/11047/8	21/11047/9
Client Sample No	27	30	33	37	40	45	49	55	63
Client Sample ID/Depth	CP01 9.60m	CP01 12.44m	CP01 14.03m	CP01 17.00m	CP01 20.30m	CP01 23.47m	CP01 28.60m	CP01 33.61m	CP01 38.49m
Date Sampled									
Deviation Code									
E (no date)	✓	✓	✓	✓	✓	✓	✓	✓	✓

Key

E (no date) No sampling date provided (all results affected if not provided)

Note: If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3 (for water samples $5 \pm 3^{\circ}\text{C}$), ISO 18400-105:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Envirolab Analysis Dates

Lab Sample ID	21/11047/1	21/11047/2	21/11047/3	21/11047/4	21/11047/5	21/11047/6	21/11047/7	21/11047/8	21/11047/9
Client Sample No	27	30	33	37	40	45	49	55	63
Client Sample ID/Depth	CP01 9.60m	CP01 12.44m	CP01 14.03m	CP01 17.00m	CP01 20.30m	CP01 23.47m	CP01 28.60m	CP01 33.61m	CP01 38.49m
Date Sampled									
A-T-024s	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021
A-T-026s	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021
A-T-028s	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021
A-T-031s	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021	19/10/2021
A-T-044	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021
A-T-SOLMETS	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021	20/10/2021

The above dates are the analysis completion dates, please note that these are not necessarily the date that the analysis was weighed/extracted.

End of Report

CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



CP01 Core Photographs



Merchant Exchange,
17-19 Whitworth Street West,
Manchester,
M1 5WG

F.A.O.

Final Test Report - 2230571 / 1

Site: St Johns Additional

Job Number: 2230571

Originating Client: Curtins Consulting

Originating Reference: 2230571

Date Sampled: 03/08/2021

Date Scheduled: 20/08/2021

Date Testing Started: 02/09/2021

Date Testing Finished: 09/09/2021

Previous Reports		Amendments	Date Issued

Amendments:

Authorised By:



Tim Robinson
Quality Supervisor

Report Issue Date: 10/09/2021

Page: 2





Site: St Johns Additional

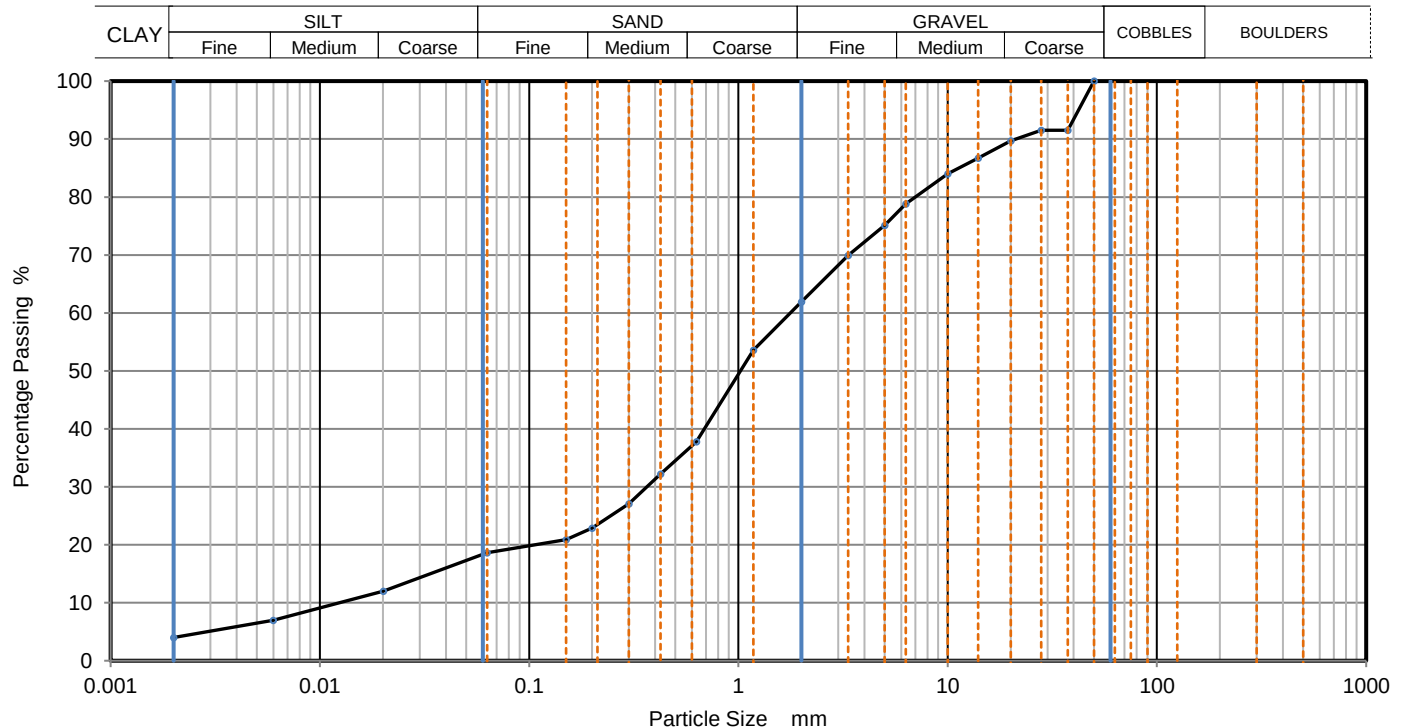
Job Number: 2230571

Client: Curtins Consulting

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
CP01	2.00	B8	Wet Sieve + Pipette	Brown silty, SAND/GRAVEL



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	12
		0.0060	7
		0.0020	4
50	100		
37.5	92		
28	92		
20	90		
14	87		
10	84		
6.3	79		
5	75		
3.35	70		
2	62		
1.18	54	Particle density (assumed) 2.65 Mg/m3	
0.63	38		
0.425	32		
0.3	27		
0.2	23		
0.15	21		
0.063	19		

Dry Mass of sample, g

1461

Sample Proportions	% dry mass
Very coarse	0
Gravel	38
Sand	43
Silt	15
Clay	4

Grading Analysis		
D100	mm	50
D60	mm	1.77
D30	mm	0.366
D10	mm	0.0131
Uniformity Coefficient		140
Curvature Coefficient		5.8

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test
BS EN 17892:Part4:2016, clause 5.4.2 Preparation of samples for pipette test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method
BS EN 17892:Part4:2016, clause 5.4.3 Determination of sedimentation by pipette method

Result reported relates only to the sample tested.





Site: St Johns Additional

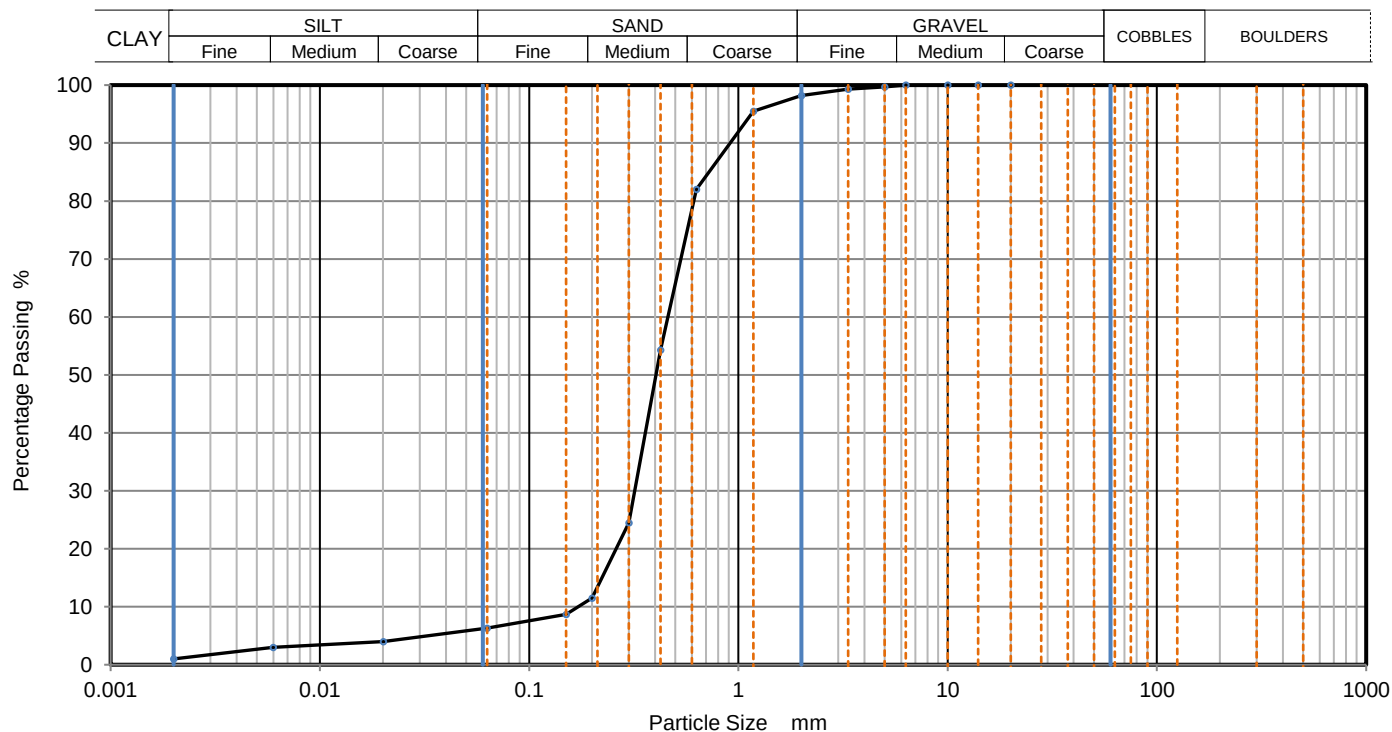
Job Number: 2230571

Client: Curtins Consulting

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
CP01	6.00	B22	Wet Sieve + Pipette	Brown slightly silty SAND (wet)



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	4
		0.0060	3
		0.0020	1
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	99		
2	98		
1.18	96	Particle density (assumed) 2.65 Mg/m3	
0.63	82		
0.425	54		
0.3	25		
0.2	12		
0.15	9		
0.063	6		

Dry Mass of sample, g

637

Sample Proportions	% dry mass
Very coarse	0
Gravel	2
Sand	92
Silt	5
Clay	1

Grading Analysis		
D100	mm	6.3
D60	mm	0.461
D30	mm	0.32
D10	mm	0.171
Uniformity Coefficient		2.7
Curvature Coefficient		1.3

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test
BS EN 17892:Part4:2016, clause 5.4.2 Preparation of samples for pipette test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method
BS EN 17892:Part4:2016, clause 5.4.3 Determination of sedimentation by pipette method

Result reported relates only to the sample tested.



Site: St Johns Additional

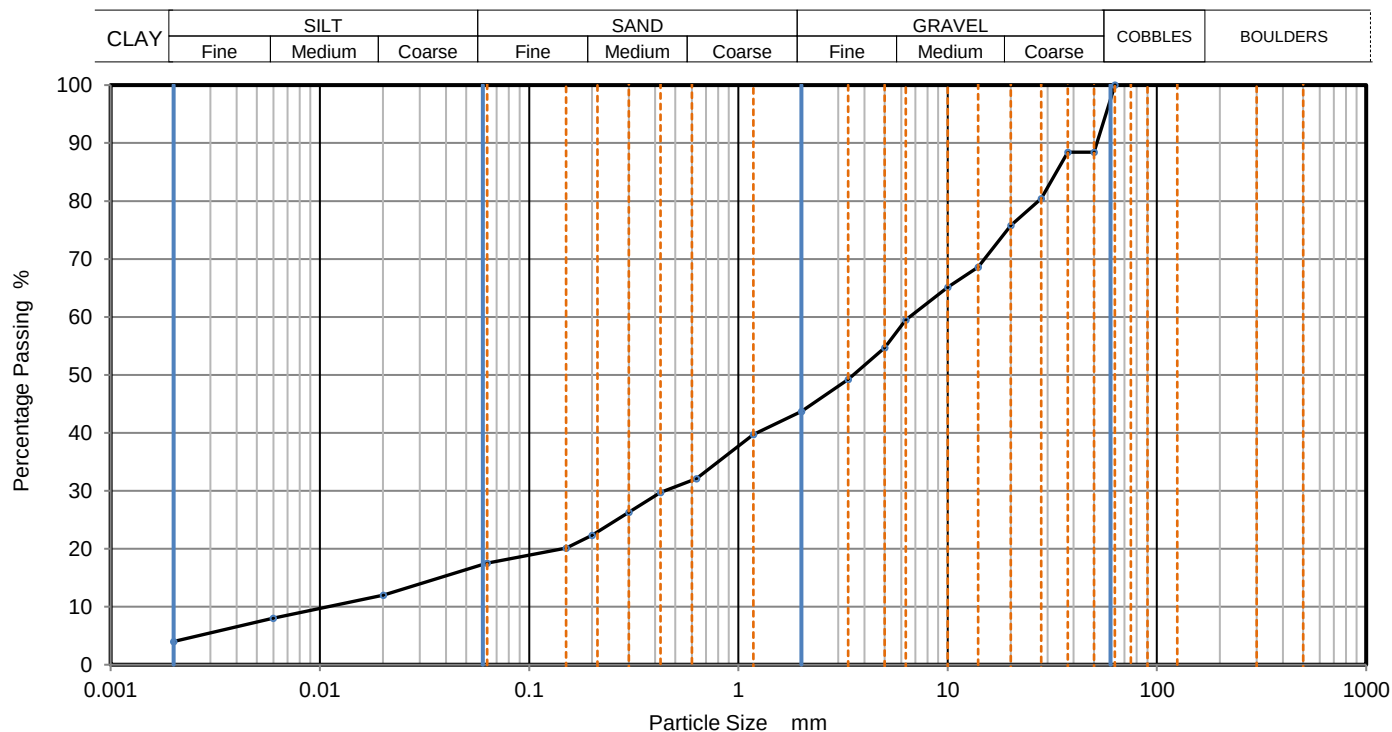
Job Number: 2230571

Client: Curtins Consulting

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
CP02	3.00	B9	Wet Sieve + Pipette	Brown silty, sandy GRAVEL



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	12
		0.0060	8
		0.0020	4
63	100		
50	88		
37.5	88		
28	80		
20	76		
14	69		
10	65		
6.3	60		
5	55		
3.35	49		
2	44		
1.18	40	Particle density (assumed) 2.65 Mg/m3	
0.63	32		
0.425	30		
0.3	26		
0.2	22		
0.15	20		
0.063	18		

Dry Mass of sample, g

2717

Sample Proportions	% dry mass
Very coarse	0
Gravel	56
Sand	26
Silt	13
Clay	4

Grading Analysis		
D100	mm	63
D60	mm	6.59
D30	mm	0.445
D10	mm	0.0107
Uniformity Coefficient		610
Curvature Coefficient		2.8

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test
BS EN 17892:Part4:2016, clause 5.4.2 Preparation of samples for pipette test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method
BS EN 17892:Part4:2016, clause 5.4.3 Determination of sedimentation by pipette method

Result reported relates only to the sample tested.





Site: St Johns Additional

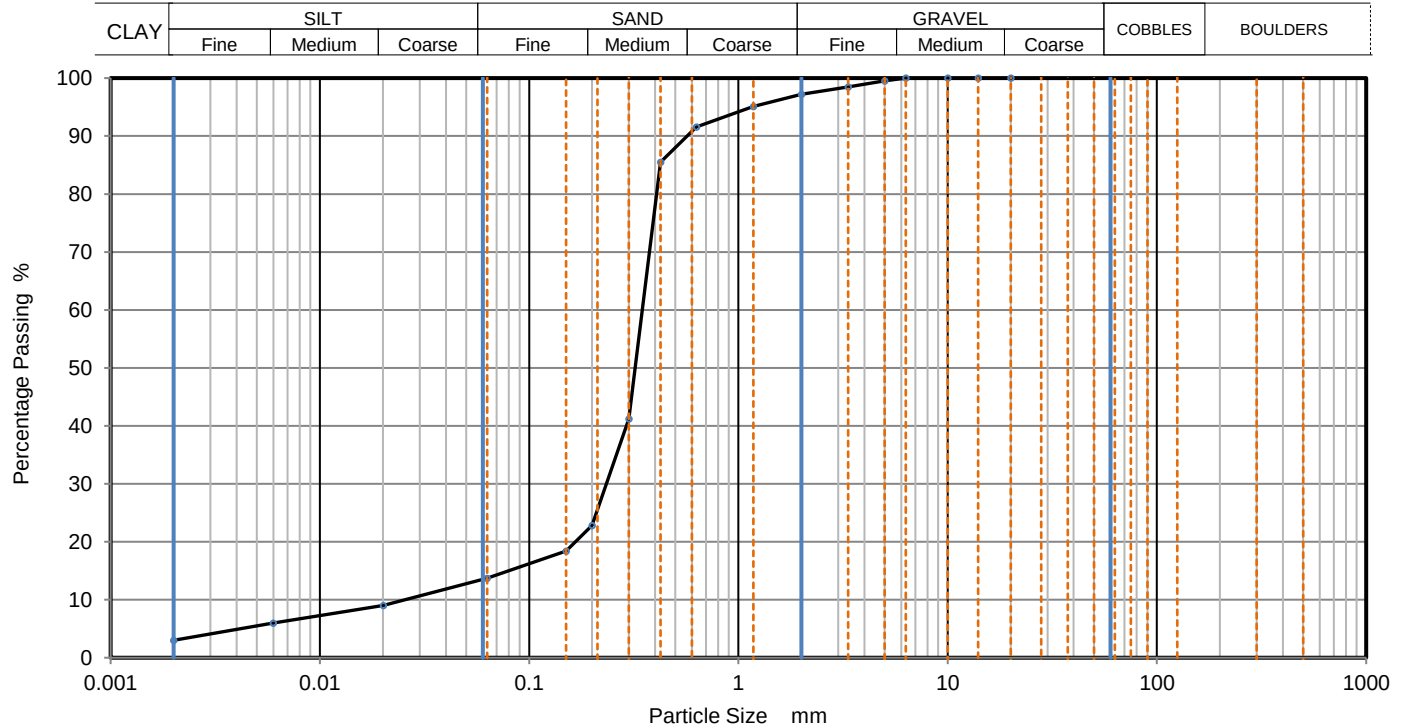
Job Number: 2230571

Client: Curtins Consulting

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
CP02	5.00	B17	Wet Sieve + Pipette	Brown silty SAND (wet)



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	9
		0.0060	6
		0.0020	3
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	99		
2	97		
1.18	95	Particle density (assumed) 2.65 Mg/m3	
0.63	92		
0.425	86		
0.3	41		
0.2	23		
0.15	18		
0.063	14		

Dry Mass of sample, g

710

Sample Proportions	% dry mass
Very coarse	0
Gravel	3
Sand	84
Silt	11
Clay	3

Grading Analysis		
D100	mm	6.3
D60	mm	0.348
D30	mm	0.234
D10	mm	0.0232
Uniformity Coefficient		15
Curvature Coefficient		6.8

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test
BS EN 17892:Part4:2016, clause 5.4.2 Preparation of samples for pipette test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method
BS EN 17892:Part4:2016, clause 5.4.3 Determination of sedimentation by pipette method

Result reported relates only to the sample tested.



Site: St Johns Additional

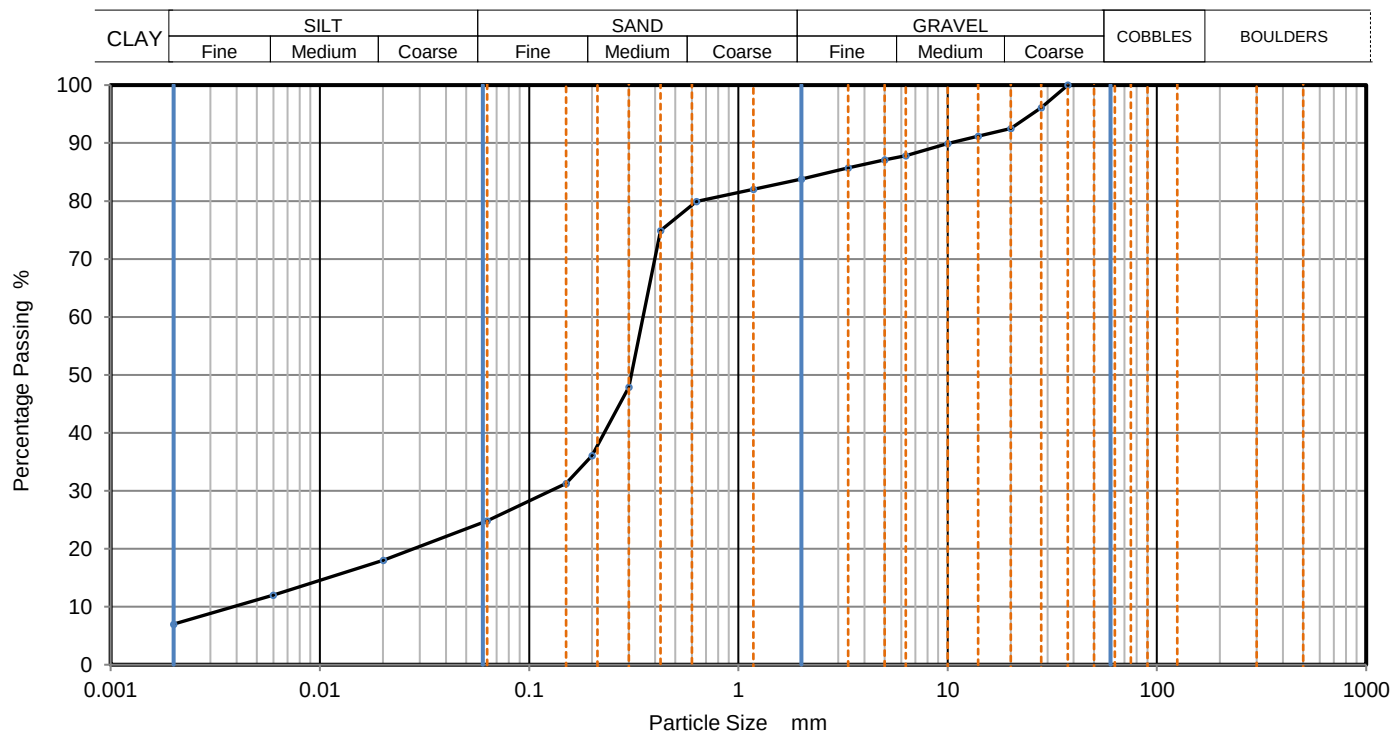
Job Number: 2230571

Client: Curtins Consulting

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
CP03	5.00	B16	Wet Sieve + Pipette	Brown slightly clayey, gravelly, silty SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	18
		0.0060	12
		0.0020	7
37.5	100		
28	96		
20	93		
14	91		
10	90		
6.3	88		
5	87		
3.35	86		
2	84	Particle density (assumed) 2.65 Mg/m3	
1.18	82		
0.63	80		
0.425	75		
0.3	48		
0.2	36		
0.15	31		
0.063	25		

Dry Mass of sample, g

1173

Sample Proportions	% dry mass
Very coarse	0
Gravel	16
Sand	59
Silt	17
Clay	7

Grading Analysis		
D100	mm	37.5
D60	mm	0.351
D30	mm	0.126
D10	mm	0.00358
Uniformity Coefficient		98
Curvature Coefficient		13

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test
BS EN 17892:Part4:2016, clause 5.4.2 Preparation of samples for pipette test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method
BS EN 17892:Part4:2016, clause 5.4.3 Determination of sedimentation by pipette method

Result reported relates only to the sample tested.





Site: St Johns Additional

Job Number: 2230571

Client: Curtins Consulting

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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 %		
CP01	6.75	D24	Brown SANDSTONE	18.7						

Notes 1. ISRM p87 test 1, water content at 105 ± 3 oC, specimen as received at the laboratory 3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper 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 content 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 content of a rock sample

Results reported relate only to the samples tested.



Final Test Report - 2230571 / 1

Site: St Johns Additional

Job Number: 2230571

Originating Client: Curtins Consulting

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

This test report shall not be reproduced, except in full and only with the written permission of Ian Farmer Associates Ltd.

Samples will be retained for 28 days from date of issue of the final test report before being disposed of, unless we receive written instruction to the contrary.

Report Issue Date: 10/09/2021

Merchant Exchange,
17-19 Whitworth Street West,
Manchester,
M1 5WG

F.A.O.

Final Test Report - 2230571R / 1

Site: St Johns Additional

Job Number: 2230571R

Originating Client: Curtins Consulting

Originating Reference: 2230571

Date Sampled: Not Given

Date Scheduled: 27/09/2021

Date Testing Started: 05/10/2021

Date Testing Finished: 12/10/2021

Previous Reports		Amendments	Date Issued

Amendments:

Authorised By:



Tim Robinson
Quality Supervisor

Report Issue Date: 13/10/2021

**Site:** St Johns Additional**Job Number:** 2230571R**Client:** Curtins Consulting**Page:** 2**UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS**

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions ²			Bulk Density ² Mg/m ³	Water Content ¹ %	Uniaxial Compression ³				Remarks
				Dia. mm	Length mm	H/D			Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
CP01	10.50	C28	Brown SANDSTONE	86.0	249.1	2.9	2.26	11.6	as received	0.4997	S	10.5	
CP01	11.73	C29	Brown SANDSTONE	88.9	115.0	*1.3	2.24	11.8	as received	0.4895	S	7.8	
CP01	12.80	C31	Brown SANDSTONE	85.1	239.3	2.8	2.23	12.1	as received	0.5348	F	8.5	
CP01	13.29	C32	Brown SANDSTONE	88.5	177.2	*2	2.22	11.6	as received	0.4938	F	10.8	
CP01	14.75	C34	Brown SANDSTONE	88.5	241.3	2.7	2.23	12.2	as received	0.4938	F	9.6	
CP01	15.35	C35	Brown SANDSTONE	87.5	254.7	2.9	2.33	10.1	as received	0.5050	F	15.1	
CP01	16.25	C36	Brown SANDSTONE	88.5	253.1	2.9	2.26	10.6	as received	0.4944	S	8.6	
CP01	22.80	C44	Brown SANDSTONE	88.7	228.0	2.6	2.28	11.6	as received	0.4921	MS	5.6	
CP01	30.37	C52	Brown SANDSTONE	86.0	244.8	2.8	2.27	11.3	as received	0.4990	S	10.5	
CP01	32.84	C54	Brown SANDSTONE	88.4	252.2	2.9	2.23	11.4	as received	0.4957	S	11.9	
CP01	38.49	C63	Brown SANDSTONE	86.9	159.7	*1.8	2.29	9.2	as received	0.4884	MS	13.1	
CP01	39.00	C64	Brown SANDSTONE	88.3	255.1	2.9	2.30	10.4	as received	0.4966	S	17.4	

Notes ¹ ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS

*Denotes length diameter ratio outside ISRM specification

² ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

Mode of failure :

³ ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

S - Single shear MS - multiple shear

above notes apply unless annotated otherwise in the remarks

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**Results reported relate only to the samples tested.**

Site: St Johns Additional

Job Number: 2230571R

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
CP01	7.55	C25	Brown SANDSTONE As received	D	U	YES	48.4	87.3	87.3	85.3	0.2	87.3	0.02	0.03	
CP01	7.55	C25	Brown SANDSTONE As received	A	U	YES		84.2	35.8	32.8	0.3	61.9	0.09	0.10	
CP01	8.8	C26	Brown SANDSTONE As received	D	U	YES	76.8	82.2	82.2	80.2	0.3	82.2	0.05	0.06	
CP01	8.8	C26	Brown SANDSTONE As received	A	U	YES		82.7	85.2	79.2	1.0	94.7	0.11	0.14	
CP01	9.6	C27	Brown SANDSTONE As received	D	U	YES	86.7	83.5	83.5	71.5	0.7	83.5	0.10	0.12	
CP01	9.6	C27	Brown SANDSTONE As received	A	U	YES		82.6	102.0	67.0	1.2	103.6	0.11	0.15	
CP01	11.73	C29	Brown SANDSTONE As received	I	U	YES	40.1	87.26 61.67	21.2	20.2	0.0	44.9	0.01	0.01	
CP01	11.73	C29	Brown SANDSTONE As received	I	U	YES	39.0	70.58 44.61	21.8	19.8	0.1	40.0	0.03	0.03	
CP01	12.44	C30	Brown SANDSTONE As received	D	U	YES	86.4	88.9	88.9	88.9	1.1	88.9	0.14	0.18	
CP01	12.44	C30	Brown SANDSTONE As received	A	U	YES		89.2	94.9	89.9	1.5	103.8	0.14	0.19	
CP01	14.03	C33	Brown SNDSTONE As received	D	U	YES	97.6	88.7	88.7	86.7	1.4	88.7	0.17	0.22	
CP01	14.03	C33	Brown SNDSTONE As received	A	U	YES		89.5	98.0	84.0	2.5	105.7	0.23	0.32	
CP01	16.25	C36	Brown SNDSTONE As received	D	U	YES	66.0	91.4	91.4	88.4	3.2	91.4	0.39	0.51	
CP01	16.25	C36	Brown SNDSTONE As received	A	U	YES		89.3	81.8	78.8	2.4	96.4	0.26	0.35	
CP01	17	C37	Brown SNDSTONE As received	D	U	YES	44.0	87.9	87.9	85.9	0.4	87.9	0.05	0.06	
CP01	17	C37	Brown SNDSTONE As received	A	U	YES		87.9	26.3	24.3	0.4	54.2	0.13	0.14	
CP01	17.42	C38	Brown SNDSTONE As received	D	U	YES	60.3	85.8	85.8	84.8	0.6	85.8	0.07	0.10	
CP01	17.42	C38	Brown SNDSTONE As received	A	U	YES		89.8	63.8	58.8	1.3	85.4	0.18	0.23	
CP01	18.45	C39	Brown SNDSTONE As received	D	U	YES	90.5	86.4	86.4	85.4	0.3	86.4	0.04	0.06	
CP01	18.45	C39	Brown SNDSTONE As received	A	U	YES		87.6	93.5	87.5	0.4	102.1	0.04	0.05	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block

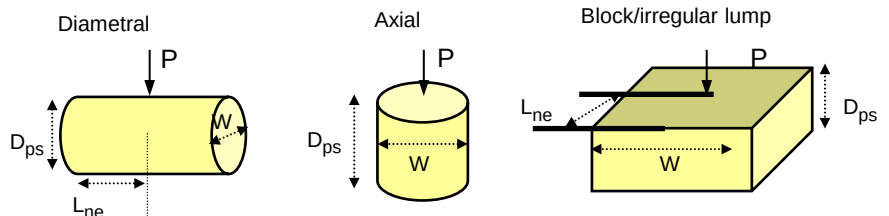
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

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)

Results reported relate only to the samples tested.

Site: St Johns Additional

Job Number: 2230571R

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
CP01	20.3	C40	Brown SANDSTONE As received	D	U	YES	42.9	87.2	87.2	85.2	0.5	87.2	0.06	0.08	
CP01	20.3	C40	Brown SANDSTONE As received	A	U	YES		89.4	46.0	42.0	0.3	72.3	0.06	0.07	
CP01	20.98	C41	Brown SANDSTONE As received	D	U	YES	77.2	86.8	86.8	84.8	0.8	86.8	0.10	0.13	
CP01	20.98	C41	Brown SANDSTONE As received	A	U	YES		87.8	68.3	63.3	0.6	87.4	0.08	0.11	
CP01	21.7	C42	Brown SANDSTONE As received	D	U	YES	55.8	85.1	85.1	84.1	0.5	85.1	0.07	0.08	
CP01	21.7	C42	Brown SANDSTONE As received	A	U	YES		86.9	56.1	51.1	0.5	78.8	0.09	0.11	
CP01	22.6	C43	Brown SANDSTONE As received	D	U	YES	104.8	88.4	88.4	86.4	1.1	88.4	0.14	0.18	
CP01	22.6	C43	Brown SANDSTONE As received	A	U	YES		88.4	109.9	75.9	2.0	111.2	0.16	0.23	
CP01	23.47	C45	Brown SANDSTONE As received	D	U	YES	44.0	83.7	83.7	81.7	0.4	83.7	0.06	0.07	
CP01	23.47	C45	Brown SANDSTONE As received	A	U	YES		83.9	46.8	42.8	0.4	70.7	0.08	0.09	
CP01	24.72	C46	Brown SANDSTONE As received	I	U	YES	49.1	70.02 95.36	74.3	68.3	0.1	88.4	0.02	0.02	
CP01	24.72	C46	Brown SANDSTONE As received	I	U	YES	41.1	78.36 72.62	41.4	37.4	0.1	63.0	0.02	0.02	
CP01	26	C47	Brown SANDSTONE As received	D	U	YES	51.1	87.7	87.7	84.7	0.5	87.7	0.07	0.09	
CP01	26	C47	Brown SANDSTONE As received	A	U	YES		87.5	43.2	39.2	0.2	69.3	0.05	0.06	
CP01	27.37	C48	Brown/Grey SANDSTONE As received	D	U	YES	51.3	87.0	87.0	84.0	0.2	87.0	0.02	0.03	
CP01	27.37	C48	Brown/Grey SANDSTONE As received	A	U	YES		87.2	51.1	39.1	0.8	75.3	0.14	0.17	
CP01	28.6	C49	Brown SANDSTONE As received	D	U	YES	112.8	88.6	88.6	84.6	0.2	88.6	0.02	0.03	
CP01	28.6	C49	Brown SANDSTONE As received	A	U	YES		88.7	123.6	117.6	3.0	118.2	0.21	0.32	
CP01	29.08	C50	Brown SANDSTONE As received	D	U	YES	90.6	87.2	87.2	84.2	1.4	87.2	0.18	0.23	
CP01	29.08	C50	Brown SANDSTONE As received	A	U	YES		88.1	101.2	87.2	2.0	106.5	0.17	0.24	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block

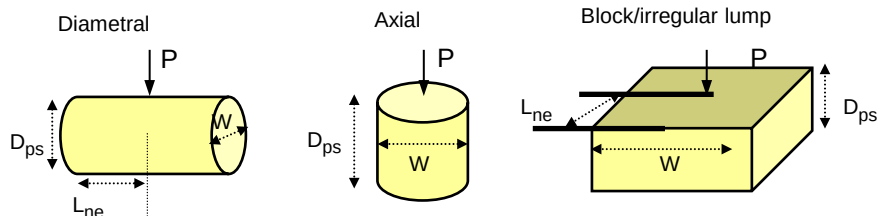
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

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)

Results reported relate only to the samples tested.

Site: St Johns Additional

Job Number: 2230571R

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
CP01	30	C51	Brown SANDSTONE As received	D	U	YES	103.7	84.1	84.1	81.1	1.2	84.1	0.17	0.21	
CP01	30	C51	Brown SANDSTONE As received	A	U	NO		84.9	118.5	107.5	1.7	113.2	0.13	0.19	
CP01	31.44	C53	Brown SANDSTONE As received	D	U	YES	78.8	87.5	87.5	86.5	1.1	87.5	0.15	0.19	
CP01	31.44	C53	Brown SANDSTONE As received	A	U	YES		87.8	85.7	77.7	1.6	97.9	0.16	0.22	
CP01	33.61	C55	Brown SANDSTONE As received	D	U	YES	61.2	86.9	86.9	84.9	2.6	86.9	0.35	0.45	
CP01	33.61	C55	Brown SANDSTONE As received	A	U	YES		88.8	57.1	51.1	3.5	80.3	0.54	0.67	
CP01	33.7	C56	Brown SANDSTONE As received	D	U	YES	76.6	89.2	89.2	87.2	0.8	89.2	0.10	0.13	
CP01	33.7	C56	Brown SANDSTONE As received	A	U	YES		89.1	82.3	78.3	1.1	96.6	0.12	0.16	
CP01	34.3	C57	Brown SANDSTONE As received	D	U	YES	78.2	86.0	86.0	84.0	1.4	86.0	0.19	0.25	
CP01	34.3	C57	Brown SANDSTONE As received	A	U	YES		88.7	79.5	73.5	1.7	94.8	0.19	0.26	
CP01	35.15	C58	Brown SANDSTONE As received	D	U	YES	55.1	86.0	86.0	85.0	1.3	86.0	0.18	0.23	
CP01	35.15	C58	Brown SANDSTONE As received	A	U	YES		84.1	55.4	44.4	0.7	77.0	0.13	0.15	
CP01	35.55	C59	Brown SANDSTONE As received	D	U	YES	53.9	87.2	87.2	84.2	0.5	87.2	0.06	0.08	
CP01	35.55	C59	Brown SANDSTONE As received	A	U	YES		87.8	37.4	35.4	0.2	64.7	0.06	0.07	
CP01	36.88	C60	Brown SANDSTONE As received	D	U	YES	64.0	88.1	88.1	87.1	3.3	88.1	0.42	0.54	
CP01	36.88	C60	Brown SANDSTONE As received	A	U	YES		88.9	72.9	67.9	2.9	90.8	0.35	0.46	
CP01	37.14	C61	Brown SANDSTONE As received	D	U	YES	82.0	88.6	88.6	85.6	3.5	88.6	0.45	0.58	
CP01	37.14	C61	Brown SANDSTONE As received	A	U	YES		89.1	88.2	81.2	3.9	100.0	0.39	0.53	
CP01	38.11	C62	Brown SANDSTONE As received	D	U	YES	55.2	88.1	88.1	85.1	1.1	88.1	0.14	0.17	
CP01	38.11	C62	Brown SANDSTONE As received	A	U	YES		92.4	35.4	31.4	0.9	64.6	0.20	0.23	

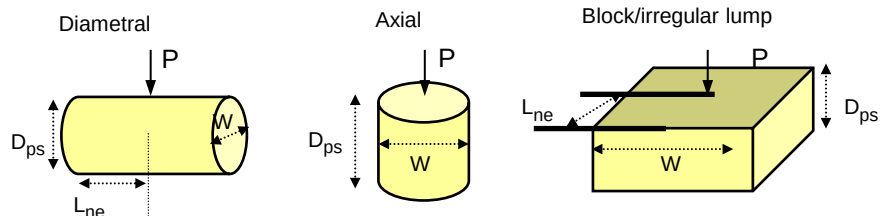
Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block

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)

Results reported relate only to the samples tested.

Site: St Johns Additional

Job Number: 2230571R

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
CP01	40.46	C65	Brown SANDSTONE As received	D	U	YES	76.1	87.0	87.0	85.0	1.6	87.0	0.21	0.27	
CP01	40.46	C65	Brown SANDSTONE As received	A	U	YES		86.5	81.1	74.1	1.5	94.5	0.17	0.23	
CP01	40.9	C66	Brown SANDSTONE As received	D	U	YES	51.4	91.7	91.7	87.8	0.9	91.7	0.11	0.14	
CP01	40.9	C66	Brown SANDSTONE As received	A	U	YES		88.2	47.2	43.2	0.5	72.8	0.10	0.11	

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)

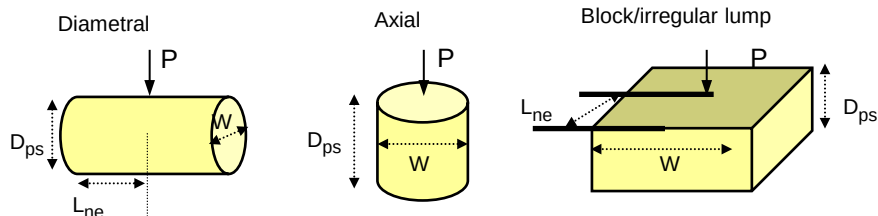
Dps' - at failure (see ISRM note 6)

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)

Results reported relate only to the samples tested.



Final Test Report - 2230571R / 1

Site: St Johns Additional
Job Number: 2230571R
Originating Client: Curtins Consulting

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

This test report shall not be reproduced, except in full and only with the written permission of Ian Farmer Associates Ltd.

Samples will be retained for 28 days from date of issue of the final test report before being disposed of, unless we receive written instruction to the contrary.

Report Issue Date: 13/10/2021

Appendix E – Ground Gas and Groundwater Monitoring Results

Curtins

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	St Johns VITA T2	Date:	18/08/2021
Job Number:	B078743	Visit:	1
Client:	Select Property	Weather:	Rain
Barometric State:	Falling	Ground Conditions:	Wet

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
CPRC01	1014	0.0	0.0	0.0	0.0	0.0	0.0	14.0	2	0	3.77	9.95	3
CP02	1016	0.0	0.0	0.0	0.0	2.2	2.2	18.3	2	0	4.07	5.96	
CP03	1016	0.1	0.0	0.0	0.0	0.9	0.9	19.5	0	1	DRY	3.16	1
RBH21	-	-	-	-	-	-	-	-	-	-	-	-	2

Notes

- 1 Steady state flow fluctuating between 0.1 and 0.0.
- 2 Cannot open install cover.
- 3 Install bailed 37 out of 37.

Logged by

RT

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

GAS MONITORING LOG SHEET

Project:	St Johns VITA T2	Date:	03/09/2021
Job Number:	B078743	Visit:	2
Client:	Select Property	Weather:	Cloudy
Barometric State:	Falling	Ground Conditions:	Dry

Borehole Reference	Barometric Pressure mb	Flow		Methane		Carbon Dioxide		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		l/hr		%		%							
		Max	SS	Max	SS	Max	SS						
CPRC01	1025	0.0	0.0	0.0	0.0	0.2	0.1	9.7	1	1	3.82	9.95	1
CP02	1025	0.0	0.0	0.0	0.0	3.0	3.0	17.8	1	1	3.89	5.96	
CP03	1025	-0.3	0.0	0.0	0.0	0.8	0.8	18.4	1	0	DRY	3.16	2
RBH21	1025	0.0	0.0	0.0	0.0	3.9	3.9	0.0	2	1	3.62	15.31	3
RBH22	1025	0.0	0.0	0.0	0.0	4.4	4.4	12.9	1	4	4.12	7.02	3

Notes

- 1 Water sampled for groundwater testing.
- 2 Steady state flow after 4 seconds.
- 3 Flush cover opened for the second visit.

Logged by

TW

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.

All other gases recorded at 'steady state' unless otherwise stated

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	St Johns VITA T2	Date:	16/09/2021
Job Number:	B078743	Visit:	3
Client:	Select Property	Weather:	Cloudy
Barometric State:	Steady	Ground Conditions:	Dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
CPRC01	1017	0.0	0.0	0.0	0.0	0.2	0.2	8.3	1	0	3.87	9.95	1 2
CP02	1017	-0.3	0.0	0.0	0.0	2.5	2.5	17.7	0	0	4.01	5.96	
CP03	1017	-1.2	-1.2	0.0	0.0	1.0	1.0	17.9	1	0	DRY	3.16	
RBH21	1017	0.7	0.6	0.0	0.0	3.6	3.6	2.4	2	0	3.69	15.31	
RBH22	1017	0.0	0.0	0.0	0.0	4.8	4.8	11.7	2	0	4.08	7.02	

- 1 Steady state air flow rate reached after 15 seconds.
- 2 Steady state air flow rate recorded after 1 minute.

TW

1% gas volume = 10,000 ppm
Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.
All other gases recorded at 'steady state' unless otherwise stated

Curtins

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	St Johns VITA T2	Date:	07/10/2021
Job Number:	B078743	Visit:	4
Client:	Select Property	Weather:	Cloudy
Barometric State:	Rising	Ground Conditions:	Dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
CPRC01	-	-	-	-	-	-	-	-	-	-	-	-	1
CP02	-	-	-	-	-	-	-	-	-	-	-	-	2
CP03	1022	-0.4	-0.4	0.0	0.0	0.9	0.9	19.6	0	0	Dry	3.19	1
RBH21	-	-	-	-	-	-	-	-	-	-	-	-	
RBH22	1022	0.0	0.0	0.0	0.0	4.5	4.5	13.2	0	0	3.65	7.10	

Notes

- 1 Bung stuck in pipework and tap destroyed. Could not monitor
- 2 Could not locate borehole

Logged by

SH

1% gas volume = 10,000 ppm

Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.
All other gases recorded at 'steady state' unless otherwise stated

Appendix F – GAC Screening Thresholds

Adopted Soil Generic Assessment Criteria
Sandy loam with 6% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> 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 (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	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						
<i>Aliphatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅₋₅ - EC ₆	160	160	3900	12000	600000	180000
EC ₅₋₆ - EC ₈	530	530	13000	40000	620000	320000
EC ₅₋₈ - EC ₁₀	150	150	1700	11000	13000	21000
EC ₁₀₋₁₀ - EC ₁₂	760	770	7300	47000	13000	24000
EC ₁₂₋₁₂ - EC ₁₆	4300	4400	13000	90000	13000	26000
EC ₅₋₁₆ - EC ₃₅	110000	110000	270000	1800000	250000	490000
EC ₃₅₋₃₅ - EC ₄₄	110000	110000	270000	1800000	250000	490000
<i>Aromatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅₋₅ - EC ₇	300	1400	57	86000	56000	92000
EC ₅₋₇ - EC ₈	660	3900	120	180000	56000	100000
EC ₅₋₈ - EC ₁₀	190	270	51	17000	5000	9300
EC ₁₀₋₁₀ - EC ₁₂	380	1200	74	34000	5000	10000
EC ₁₂₋₁₂ - EC ₁₆	660	2500	130	38000	5000	10000
EC ₅₋₁₆ - EC ₂₁	930	1900	260	28000	3800	7800
EC ₂₁₋₂₁ - EC ₃₅	1700	1900	1600	28000	3800	7900
EC ₃₅₋₃₅ - 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
Tetrachlorethane (PCE)	0.90	0.92	3.6	95	1400	1500
1,1,1 Trichlorethane	39	40	240	3000	140000	100000

Notes

- All values above are in mg/kg
- 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**
- Soil organic matter (SOM) is assumed to be 6% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- 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
- 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
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- 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)
- NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 2.5% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> 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 <u>21</u>	6 <u>21</u>	1.8 <u>170</u>	33 <u>49</u>	7.7 <u>21</u>	220 <u>250</u>
Lead	<u>200</u>	<u>310</u>	<u>80</u>	<u>2,300</u>	<u>630</u>	<u>1,300</u>
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 <u>79</u>	170 <u>170</u>
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
<i>Aliphatic risk banded hydrocarbons - TPHCWG method</i>						
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
<i>Aromatic risk banded hydrocarbons - TPHCWG method</i>						
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
<i>Aromatic</i>						
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)
<i>Polycyclic Aromatic Hydrocarbons (PAH)</i>						
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
Tetrachlorethane (PCE)	0.39	0.4	1.5	42	1400	1100
1,1,1 Trichlorethane	18	18	110	1300	140000	76000

Notes

- All values above are in mg/kg
- 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
- Soil organic matter (SOM) is assumed to be 2.5% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- 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
- 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
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- 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)
- NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> 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 <u>21</u>	6 <u>21</u>	1.8 <u>170</u>	33 <u>49</u>	7.7 <u>21</u>	220 <u>250</u>
Lead	<u>200</u>	<u>310</u>	80	<u>2,300</u>	630	<u>1,300</u>
Mercury (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	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 <u>79</u>	170 <u>170</u>
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
<i>Aliphatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅₋₅ - EC ₆	42	42	730	3200	570000	95000
EC ₆₋₆ - EC ₈	100	100	2300	7800	600000	150000
EC ₈₋₈ - EC ₁₀	27	27	320	2000	13000	14000
EC ₁₀₋₁₀ - EC ₁₂	130	130	2200	9700	13000	21000
EC ₁₂₋₁₂ - EC ₁₆	1100	1100	11000	59000	13000	25000
EC ₁₆₋₁₆ - EC ₃₅	65000	65000	260000	1600000	250000	450000
EC ₃₅₋₃₅ - EC ₄₄	65000	65000	260000	1600000	250000	450000
<i>Aromatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅₋₅ - EC ₇	70	370	13	26000	56000	76000
EC ₇₋₇ - EC ₈	130	860	22	56000	56000	87000
EC ₈₋₈ - EC ₁₀	34	47	8.6	3500	5000	7200
EC ₁₀₋₁₀ - EC ₁₂	74	250	13	16000	5000	9200
EC ₁₂₋₁₂ - EC ₁₆	140	1800	23	36000	5100	10000
EC ₁₆₋₁₆ - EC ₂₁	260	1900	46	28000	3800	7600
EC ₂₁₋₂₁ - EC ₃₅	1100	1900	370	28000	3800	7800
EC ₃₅₋₃₅ - 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
Tetrachlorethane (PCE)	0.18	0.18	0.65	19	1400	810
1,1,1 Trichlorethane	8.8	9	48	660	140000	57000

Notes

- All values above are in mg/kg
- 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**
- Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- 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
- 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
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- 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)
- NA: Not applicable

Tier 1 Thresholds

Water Contaminants: Initial Assessment of Risk



Introduction

The Generic Assessment Criteria (GAC) employed as Tier 1 Controlled Water Screening criteria are given in Tables 1 and 2. The more conservative available Drinking Water Standards (DWS) and Environmental Quality Standards (EQS) (Freshwater and Saltwater), applicable in England and Wales have been included in the tables.

The list of determinands is non-industry specific and it should be recognised that additional site specific determinands may need to be taken into account. The applicability of these criteria, with regard to the developed Conceptual Site Model, is discussed within the relevant section of the preceding report. Further details on individual GAC can be obtained in the referenced source legislation.

Generic Assessment Criteria

Table 1 – Inorganic Contaminant Controlled Waters Generic Assessment Criteria

Contaminant	Units	Hardness Banding (mg/l CaCO ₃)	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
Arsenic	µg/l	-	50	25	10	10
Boron	µg/l	-	2000	7000	1000	0.3
Cadmium	µg/l	<40	0.08	0.2	5	3
		40- <50	0.08			
		50- <100	0.09			
		100- <200	0.15			
		>200	0.25			
Chromium III	µg/l	-	4.7	-	50	50
Chromium VI	µg/l	-	3.4	0.6		
Copper	µg/l	-	1 bioavailable ⁱ	3.76 Where DOC ⁱⁱ ≤ 1mg	2000	2000
				3.76 + (2.677 x ((DOC/2)- 0.5)) Where DOC ⁱⁱ >1mg/l		
Cyanide (Free)	µg/l	-	1	1		
Cyanide (Total)	µg/l	-	1	1	50	70
Iron	µg/l	-	1000	1000	200	300
Lead	µg/l		1.2	1.3	10	10
Mercury	µg/l	-	0.07 ⁱⁱⁱ	0.07 ⁱⁱⁱ	1	1
Nickel	µg/l	-	4 bioavailable ⁱ	8.6	20	70

Tier 1 Thresholds

Water Contaminants: Initial Assessment of Risk



Contaminant	Units	Hardness Banding (mg/l CaCO ₃)	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
Selenium	µg/l	-	-	-	10	10
Sulphate	mg/l	-	400	-	250	-
Sulphide	µg/l	-	0.25	-	-	-
Zinc	µg/l	-	10.9 bioavailable ⁱⁱ + ABC ^v	6.8 dissolved ^{iv} + ABC	5000	3000

i - fraction likely to have toxic effect as determined using the UKTAG Metal Bioavailability Assessment Tool

ii - concentration of dissolved organic carbon in mg/l of the receiving water (as identified in the Conceptual Site Model)

iii - in absence on Annual Average the Maximum Allowable Concentration Used

iv - total dissolved as reported

v - Average Background Concentration (ABC) as listed in Part 2 Table 2 in Ref. 1.

Table 2 – Organic Contaminant Controlled Waters Generic Assessment Criteria

Contaminant	Units	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
Organics					
Phenol (total)	µg/l	7.7	7.7	0.5	-
MTBE	µg/l	-	-	-	15
Total Petroleum Hydrocarbons (TPH)					
Aliphatic C5-C6	µg/l	-	-	-	15000
Aliphatic C6-C8	µg/l	-	-	-	15000
Aliphatic C8-C10	µg/l	-	-	-	300
Aliphatic C10-C12	µg/l	-	-	-	300
Aliphatic C12-C16	µg/l	-	-	-	300
Aliphatic C16-C21	µg/l	-	-	-	300
Aliphatic C21-C35	µg/l	-	-	-	300
Aromatic C6-C7 (benzene)	µg/l	10	8	1	10
Aromatic C7-C8 (toluene)	µg/l	74	74	-	700
Aromatic C8-C10 (ethylbenzene)	µg/l	20	20	-	300
Aromatic C10-C12	µg/l	-	-	-	100
Aromatic C12-C16	µg/l	-	-	-	100
Aromatic C16-C21	µg/l	-	-	-	90
Aromatic C21-C35	µg/l	-	-	-	90
Total Hydrocarbons (Dissolved / Emulsion)	µg/l	-	-	10 (revoked)	300

Tier 1 Thresholds

Water Contaminants: Initial Assessment of Risk



Contaminant	Units	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
BTEX Compounds					
Benzene	µg/l	10	8	1	10
Toluene	µg/l	74	74	-	700
Ethyl-benzene	µg/l	20	20	-	300
Xylene (o+p+m)	µg/l	30	30	-	-
Polycyclic Aromatic Hydrocarbons (PAH)					
Anthracene	µg/l	0.1	0.1	-	-
Benzo(a)pyrene	µg/l	0.00017	0.00017	0.01	0.01
Napthalene	µg/l	2	2	-	-
PAHs Sum of four-benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene	µg/l	-	-	0.1	-

References

- 1 The Water Framework Directive, (Standards and Classification) Directions (England and Wales) [2015]
- 2 Council Directive 76/464/EEC, Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) [1976]
- 3 Council Directive 98/83/EC on the quality of water intended for human consumption [1998]
- 4 World Health Organisation (WHO), Guidelines for Drinking Water Quality. Third edition [2004]

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

Phase 2 Ground Investigation

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.

Phase 2 Ground Investigation

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 <i>high probability</i> that <i>severe harm</i> could arise to a designated receptor from an identified hazard at the site without appropriate further action.
High Risk	<i>Harm is likely to arise</i> to a designated receptor from an identified hazard at the site without appropriate further action.
Moderate Risk	<i>It is possible</i> that without appropriate further action <i>harm could arise</i> to a designated receptor. It is relatively <i>unlikely</i> that any such harm would be <i>severe</i> , and if any harm were to occur it is <i>more likely</i> that such harm would be <i>relatively mild</i> .
Low Risk	<i>It is possible</i> that <i>harm could arise</i> to a designated receptor from an identified hazard. It is <i>likely</i> that, at worst, if any harm was realised any effects would be <i>mild</i> .
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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