

VITA T2, St Johns

Piling Risk Assessment

Curtins Ref: T2-CUR-JC10-TS-XX-002

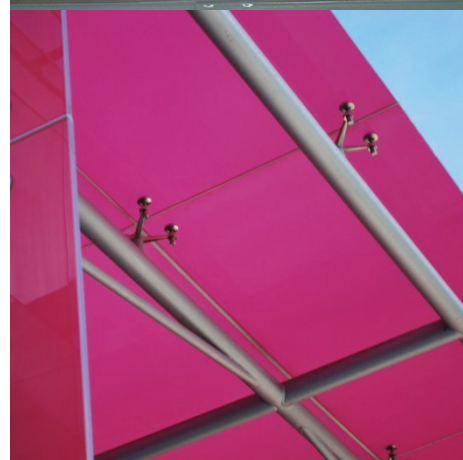
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Client Name: Select Property

Client Address: The Box, Horseshoe Lane, Alderley Edge, Cheshire, SK9 7QP

Site Address: Land off Water Street, Manchester, M3 4JQ



Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester, M1 5WG
Tel: 0161 236 2394
www.curtins.com

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Piling Risk Assessment

Rev	Description	Issued by	Checked	Date

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Author	Signature	Date
R Allen BSc (Hons) MSc FGS MCIWEM C.WEM CEng Principal Engineer		20 December 2021

Reviewed	Signature	Date
N Farnworth BSc (Hons) MCIWEM Senior Geo-Environmental Engineer		20 December 2021

Reviewed & Authorised	Signature	Date
R Allen BSc (Hons) MSc FGS MCIWEM C.WEM CEng Principal Engineer		20 December 2021

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1.0 Introduction

Piled foundations are proposed for the development at the VITA T2 site located off Water Street, Manchester, M3 4JQ.

The proposed development on site comprises 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. The proposed development plans are included within *Appendix A* of this report.

The geology underlying the site comprises Superficial Secondary A Aquifer over Principal Aquifer, and as such a piling risk assessment (PRA) has been produced in order to identify the risks associated with a piled foundation solution.

Given the sensitivity of the groundwater underlying the site a piling risk assessment has been produced, in order to identify the risks associated with a piled foundation solution.

As detailed below, the assessment of risk presented by piled foundation solution has been identified as a specific condition to the overall development of the site (Planning Application no. 126648/FO/2020).

Condition 20: Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the Local Planning Authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details.

This report has been written to address this planning condition.

1.1 Scope

This piling risk assessment provides an overview of the site's ground and groundwater conditions and considers the potential risks associated with the adoption of Continuous Flight Auger (CFA) piles to groundwater.

The report identifies appropriate risk management and monitoring protocols that can be adopted to ensure any residual risk is brought within adequate and practicable limits.

1.2 References

In preparation of this report reference has been made to the following key guidance document:

- Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention National Groundwater & Contaminated Land Centre report NC/99/73 (EA Report 2001) (Ref. 1).

Reference is also made to the following geo-environmental reports undertaken for the site:

- Curtins (2021) Phase 1 Preliminary Risk Assessment, ref. B061559.010-JJ-6925 dated July 2016. (Ref. 2).
- Curtins (2021) Phase 2 Ground Investigation, ref. T2-CUR-JC10-TS-XX-001, dated November 2021. (Ref. 3).

It is assumed that the client is in receipt of these reports and that they will also be submitted to and accepted by Manchester City Council to discharge relevant planning conditions.

2.0 The Site

This section of the report summarises the site setting, history, geology, hydrogeology, hydrology and environmental conditions at the site with reference to the geo-environmental reports referenced previously. It is not the intention of this report to duplicate these reports, with the information below providing the background information to support the piling risk assessment and recommendations. For further background information the full reports should be consulted.

2.1 The Site 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 Site History

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 Hydrogeology and Hydrology

The site, corresponding with the underlying solid geology, is underlain by a Principal Aquifer within the bedrock (Chester Pebble Beds Formation, Sandstone) described as:

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 a 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 cooling 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.

2.4 Ground Model

The following sections present a summary of the ground conditions identified during the Curtins 2018 & 2021 ground investigations. The exploratory hole logs are presented in *Appendix B*.

2.4.1 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.

2.4.2 Natural Deposits

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.

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.

Bedrock (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.

2.4.3 Groundwater

Table 2.4.3a 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 2.4.3a – 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)

Investigation Date	Exploratory Hole Ref.	Strike Depth (m bgl)	Rose to Depth (m bgl)	Strike Level (m AOD)	Strata
	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 2.4.3b*.

Table 2.4.3b – 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.

2.5 Contamination Risk Assessments and Remediation

A programme of environmental chemistry testing was undertaken on soil samples obtained of the Made Ground (6 no.) and natural soils (2 no.) and one sample of ground water.

Samples were tested for a broad suite of contamination as identified in the Phase 2 report. With the Made Ground samples also tested for the presence of asbestos. Contamination risk assessments and recommendations undertaken by Curtins are summarised below.

2.5.1 Soils

The environmental chemistry results were compared with Generic Assessment Criteria for soils with respect to human health for a '*Commercial*' end use for a conservative 1% SOM for Made Ground and natural soils. No exceedances were identified.

No asbestos containing materials (ACMs) were identified during the investigation works or during laboratory analysis.

A **Low** risk rating is identified to construction workers, from soils and dust from inhalation and ingestion at this stage.

2.5.2 Groundwater (Principal Aquifer & Secondary A Aquifers)

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 & Secondary A Aquifers was considered to be **Low** requiring no further action.

2.5.3 Surface Water (River Irwell)

Marginally elevated concentrations of copper and Benzo(a)pyrene were recorded in the groundwater sample obtained from site 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 was assessed as **Very Low** requiring no further action.

2.5.4 Ground Gas

During the 2018 investigation, two gas monitoring visits were undertaken on 14th and 22nd November 2018 with a further four monitoring visits undertaken between 18th August and 7th October 2021.

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.

The 'borehole' Q_{hg} for the development site was derived, which recorded 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 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.

This corresponds with a Characteristic Situation 1 (CS-1) ground gas regime. Subsequently gas protection measures are not required.

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.

2.5.5 Aggressive Ground Conditions

The site has been classified in accordance with BRE Special Digest 1. 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.

3.0 Piling Risk Assessment

At the current design stage, the adoption of CFA piles socketed into sandstone bedrock is considered to be the preferred piling solution. This method has been selected with consideration of minimal ground vibration, as well as groundwater protection aspects.

CFA piles essentially involve driving a large auger into the ground, with soils within the radius of the auger brought to surface and replaced with concrete on withdrawal of the auger. The displacement of the surrounding ground is governed by the speed of rotation of the auger relative to the speed of vertical penetration. Theoretically, it is possible to adjust the speeds so that the volume of soils displaced laterally and removed as arisings is equal to the volume of concrete placed.

Within the EA Report (2001), the six Source-Pathway-Receptor scenarios are identified as:

- 1. Creation of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer;*
- 2. Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface;*
- 3. Direct contact of site workers and others with contaminated soil arising which have been brought to the surface;*
- 4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration);*
- 5. The driving of solid contaminants down into an aquifer during pile driving; and*
- 6. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.*

This piling risk assessment tabulated overleaf address aspects 1, 4, 5 and 6 above only, in keeping with the objectives of this report (assessing the risk to groundwater). Other aspects should be appropriately dealt with through engineering design and suitable on-site management. The risk assessment methodology follows that presented in *Appendix C*.

TABULATED RISK ASSESSMENT: CFA Piles

Aspect	Potential Consequence	Potential Probability	Potential Risk	Risk Management Options Available	Resultant Risk
1. Creation of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer.	Medium Pollution of sensitive water resources in groundwater. Site overlies a Superficial deposits defined as Secondary A aquifer over a Principal aquifer associated with the Chester Formation.	Unlikely - No evidence of free product or gross contamination identified in shallow soils. - Risk to groundwater considered to be Low. - CFA piling method essentially self-sealing with concrete and therefore no resultant pathway.	Low	Not required.	Low
4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration).		Unlikely Soluble sulphate concentrations in soils generally meet a Design Sulphate class of DS-1 AC-1 for Made Ground soils and for natural soils.	Low	Not required.	Low
5. The driving of solid contaminants down into an aquifer during pile driving.		Low Likelihood Above considerations, plus: Low likelihood as arisings brought to surface in CFA methods, with speed of auger rotation to be matched with downward force to avoid driving soils down.	Moderate / Low	Speed of auger rotation needs to be matched with downward force to avoid driving soils down.	Low
6. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.		Low Likelihood Above considerations but accounting for potential for 'bleeding' of concrete.	Moderate / Low	Cement content of the concrete will need to be closely monitored so that this in itself does not 'bleed' into groundwater.	Low

4.0 Summary and Recommendations

The risk assessment presented herein has concluded that there is a low risk to contamination of groundwater beneath the site from the use of CFA piling, providing that the following risk management measures are put in place:

- *Speed of auger rotation needs to be matched with downward force to avoid driving soils down; and*
- *Cement content of the concrete will need to be closely monitored so that this in itself does not 'bleed' into groundwater.*
- *Suitable sulphate resistant concrete should be used for all substructures to remain in contact with Made Ground soils meeting a DS-1 DS class and AC-1 ACEC class in accordance with BRE Special Digest 1:2005 Concrete in Aggressive Ground guidance.*

The following considerations should also be taken into account:

- *The piling contractor should prepare and submit relevant method statements for approval prior to piling works commencing;*
- *Where arisings are generated, they should be classified, handled and disposed of in compliance with relevant best practice and regulatory requirements;*
- *The piling contractor should make allowance for the provision of appropriate PPE based on chemical analysis results within the Phase 2 Ground Investigation Reports; and*
- *In the event of uncovering any areas of unexpected contamination during the piling works, including odorous or stained soils, works should be ceased with the advice of the appointed environmental consultant sought immediately.*

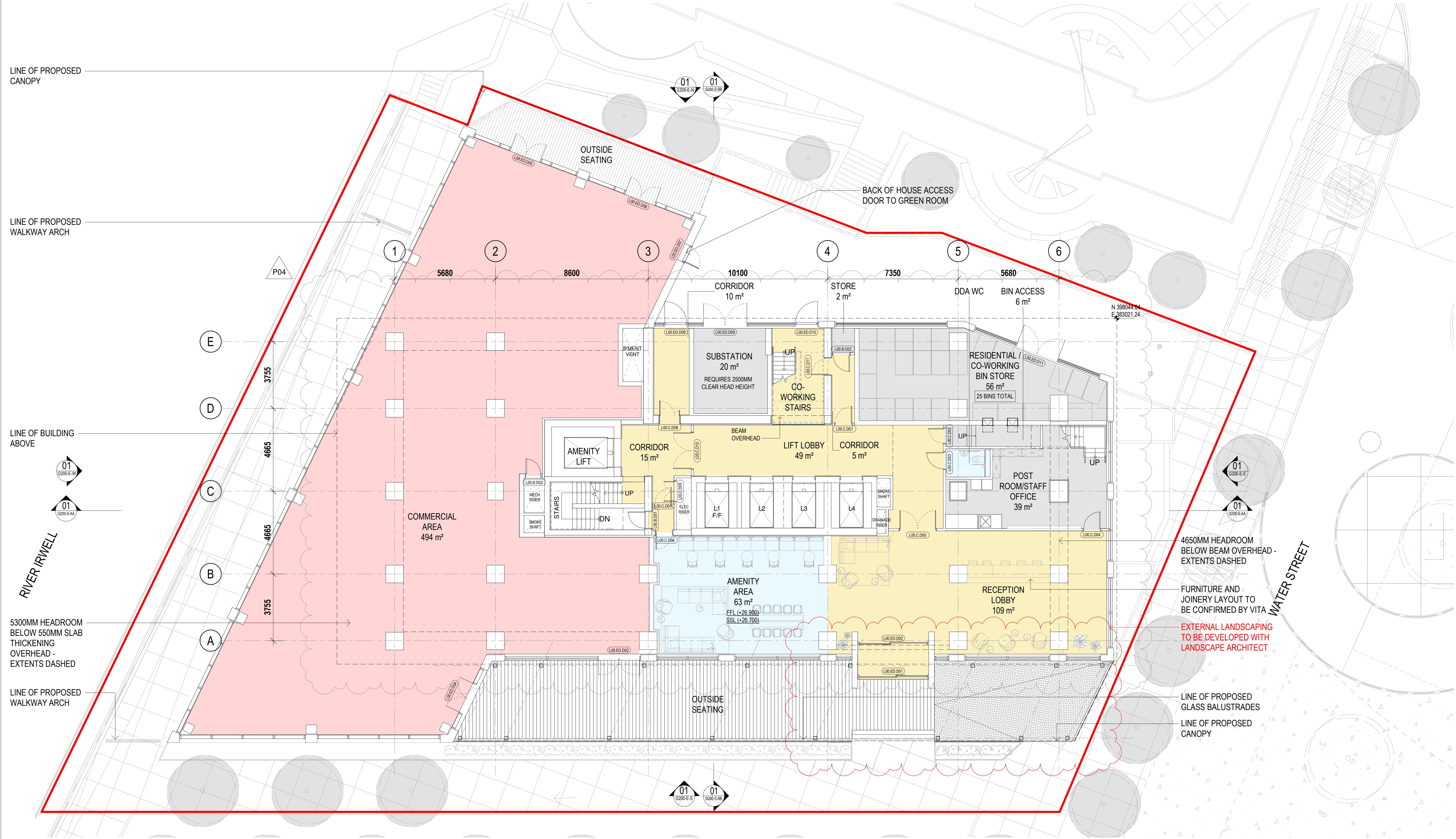
This document should be forwarded to the Planning Authority for discharge of the relevant planning condition before piling works commence to disclose that there is a low risk to groundwater from the proposed use of CFA piling on site where the above risk management measures are adhered to and to detail as to why soil leachability tests are not considered necessary ahead of the development.

5.0 References

1. Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention National Groundwater & Contaminated Land Centre report NC/99/73 (EA Report 2001)
2. Curtins (2021) Phase 1 Preliminary Risk Assessment, ref. B061559.010-JJ-6925, dated July 2016.
3. Curtins (2021) Phase 2 Ground Investigation, ref. T2-CUR-JC10-TS-XX-0001, dated November 2021.

Appendix A – Drawings

- Development Plans
- Curtins Exploratory Hole Location Plan



No.	Date	Drawn	Checked	Appr.	Revision or reason for issue
P01	20210528	JGES	GS	JR	ISSUED FOR STAGE 2 First issue
P02	20210716	ES	GS	JR	ISSUED FOR STAGE 3
P03	20210825	JG	GS	JR	REISSUED FOR STAGE 3 Updated in line with current proposals
P04	20211029	JG	GS	JR	ISSUED FOR STAGE 4

KEY:
INDICATIVE LINE OF MINIMUM PUBLIC REALM AS DIRECTED BY VITA - REFER TO ALLIED LONDON'S S1006A DRAWING

General Notes
Do not scale from drawing. Use marked dimensions.
To be read in conjunction with all other Consultant's drawings.
The Architect to be immediately notified of any discrepancies.
Copyright on this drawing retained by the Architect.

Client
VITA

Select Property Group
The Box, Horseshoe Lane
Alderley Edge, SK9 7QP
Telephone +44 (0) 207 123 4000 Facsimile +44 (0) 161 332 7718
Email info@selectproperty.com

**DENTON
CORKER
MARSHALL**

Architect
Denton Corker Marshall LLP
4th Floor, 6 St Ann's Passage
Old Exchange Buildings, Manchester M2 6BE
Telephone 0161 834 3511
Email mail@dentoncorkermarshall.co.uk

Project Title
T2 VITA LIVING, ST. JOHNS

Scale / North Point
1:100 @ A1 0 1 2 3 5M
1:200 @ A3

Drawing Title
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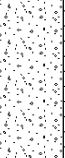
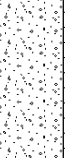
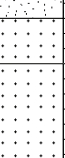
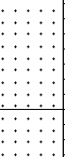
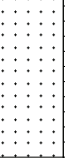
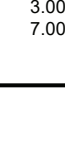
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6555-A-G200-P-00
RENAKER Drawing Number
T2-DCM-G200-PI-Grd-001
Drawing Status
STAGE 4

Revision
P04

Appendix B – Exploratory Hole Logs

- Exploratory Hole Logs

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.		1		
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			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.				
1.20 - 1.65	D5	SPT(S) N=26 (2,4/5,8,6,7)	24.47	1.50	MADE GROUND: Greyish red, gravelly, fine to coarse SAND. Gravel is angular to subangular, fine to coarse including brick and sandstone.		2		
1.20 - 1.70	B4			(0.40)					
1.50	D6		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.				
1.85	D7								
2.00		SPT(S) N=16 (3,4/5,5,3,3)			Below 2.75m: becomes yellowish brown.		3		
2.00 - 2.45	D9								
2.00 - 2.50	B8				Between 3.00m and 3.50m: low cobble content. cobbles are rounded including sandstone.				
2.75	D10								
3.00		SPT(S) N=18 (2,3/1,2,3,12)					4		
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)	21.57	4.40	Very dense, reddish brown, fine and medium SAND.		5		
4.00	D16								
4.00 - 4.45	B15								
4.00 - 4.50	D17								
4.50	D18	SPT(S) 50 (25 for 95mm/50 for 105mm)					6		
4.75									
5.00	D20								
5.00 - 5.45	B19								
5.00 - 5.50		SPT(S) 50 (25 for 95mm/50 for 105mm)					7		
5.75	D21								
6.00									
6.00 - 6.45	D23								
6.00 - 6.50	B22	SPT(S) 50 (25 for 95mm/50 for 105mm)					8		
6.75	D24		19.27	6.70	Red, very weak, weathered SANDSTONE recovered as very dense, gravelly, fine to coarse sand. Gravel is angular, fine to coarse.				
			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.				
7.00 - 8.00	80 45 0	18		(1.50)	Between 7.80m and 8.50m: assumed zone of core loss. Core possibly scrubbed.				
8.00 - 8.50	0 0 0	AZCL					9		
8.50 - 9.30	81 81 72	13	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.				
		AZCL							
							10		

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)
				4.50	150	5.00	4.50		20	4.70		0.00
												3.00
												7.00
												Plain
												50
												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:

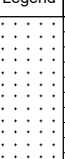
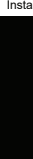
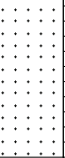
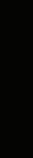
GR/NC

Vertical scale:

1:50

Project ID:

2230571

Coring, Samples & In Situ Testing				Strata Details				Groundwater			
Depth	TCR/SCR/ RQD	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							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								
			15.35m - C35	10.67	15.30 (0.50)					Moderately weak, thinly bedded, reddish brown, fine SANDSTONE.	
15.70 - 17.20	93 93 87	7	16.25m - C36	10.17	15.80					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>	16
		AZCL	17.00m - C37								17
17.20 - 18.70	93 87 28	5	17.42m - C38		(7.90)	18					
			18.45m - C39								
18.70 - 20.20	87 80 50	5				<i>Between 18.60m and 18.90m: assumed zone of core loss. Core possibly scrubbed.</i>					
		AZCL								19	
						Continued next sheet		20			

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)

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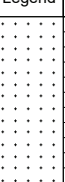
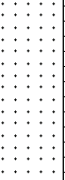
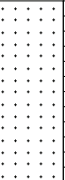
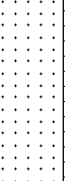
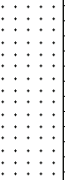
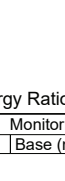
JT

Log status:

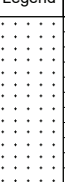
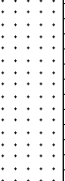
PRELIM

IFA RC

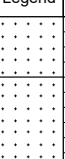
v01.01

 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 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.		21							
20.20 - 21.70	93 93 43		20.98m - C41												
		7	21.70m - C42												
21.70 - 23.20	100 100 87		22.60m - C43 22.80m - C44			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							
23.20 - 24.50	38 31 0	AZCL	23.47m - C45	2.27	23.70										
24.50 - 25.50	80 10 0	8	24.72m - C46		(1.70)	<i>Between 25.50m and 25.70m: assumed zone of core loss. Core possibly scrubbed.</i>		25							
		AZCL													
25.50 - 27.00	87 67 30	8	26.00m - C47	0.57	25.40										
						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.		26							
27.00 - 28.30	77 77 61		27.37m - C48												
		AZCL													
28.30 - 29.80	100 100 63	6	28.60m - C49 29.08m - C50			<i>Between 27.50m and 27.80m: drilling disturbed. Possible joint set.</i>		27							
			30.00m - C51			Continued next sheet		28							
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 4 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						
29.80 - 31.30	93 93 60	10	30.37m - C52		(14.40)	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.		31							
			AZCL												
31.30 - 32.80	100 100 83		31.44m - C53											32	
32.80 - 34.30	100 100 20		32.84m - C54											33	
34.30 - 35.80	100 87 37		33.61m - C55 33.70m - C56											34	
			34.30m - C57												
35.80 - 36.50	77 69 25		35.15m - C58 35.55m - C59											35	
36.50 - 38.30	93 47 27	5	36.88m - C60 37.14m - C61			Between 37.50m and 37.70m: drilling disturbed. Possibly joint set or mudstone clasts.		36							
			38.11m - C62											37	
			AZCL												
			38.49m - C63												
			39.00m - C64												
				-13.83	39.80	Weak, thickly laminated to very thinly bedded, reddish brown,									
						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									
				-14.43	40.40										
		6	40.46m - C65 40.90m - C66	-15.03	41.00										
								41							
								42							
								43							
								44							
								45							
								46							
								47							
								48							
								49							
								50							
Flush Details			Borehole Diameter		Boring Progress			Remarks:							
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time			Depth (m)	Cased (m)	Water (m)			
									SPT Hammer: N/R, Energy Ratio: N/R						
				Casing Diameter		Water Strikes			Monitoring Installations						
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		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			Location ID: CP03
Dates: 04/08/2021 - 05/08/2021	Client: Curtins Consulting			
Location: 383008.39E 398027.15N	Ground level: 26.51mOD	Logged by: GR/TB	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 2230571

Plant used:

Commachio 205

Project:

St John's Masterplan Phase 2

Location ID:

RBH20

Dates:

31/10/2018 - 01/11/2018

Client:

Curtins Consulting

Sheet 1 of 5

Rotary Borehole Log

Location:

383018.36E 398038.25N

Ground level:

26.58mOD

Logged by:

JO

Vertical scale:

1:50

Project ID:

42269

Coring, Samples & In Situ Testing

Depth

TCR/SCR/RQD

FI

Samples & Test Result

Level (mAOD)

Depth (m) (Thickness)

Strata Description

Legend

Groundwater

Water Strike

Backfill/Installation

26.53

0.05

Tarmacadam (driller's description).

26.28

0.30

MADE GROUND: Concrete and rebar (driller's description).

MADE GROUND: Sandy, angular to subangular, fine to coarse GRAVEL of brick (driller's description).

(1.40)

24.88

1.70

Brown, sandy, gravelly CLAY (driller's description).

(2.50)

22.38

4.20

Red SAND and GRAVEL (driller's description).

(0.80)

21.58

5.00

Extremely weak, thinly laminated, reddish brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, planar rough and clean.

5.00 - 5.50

0
0
0

AZCL

5.50 - 6.00

60
60
0

14

6.00 - 7.50

86
36
3

NI

7.50 - 9.00

91
89
7

10

9.00 - 10.50

78
75
19

14

0.50m - ES33

7.10m - C1

8.00m - C2

9.30m - C3

1

2

3

4

5

6

7

8

9

10

Continued next sheet

Flush Details

Top (m)

Base (m)

Flush Type

Flush Return %

Borehole Diameter

Depth (m)

Dia (mm)

Boring Progress

Date

Time

Depth (m)

Cased (m)

Water (m)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

5.50

12.00

Water

90

12.00

36.00

Water

60

36.00

37.50

Water

40

37.50

40.50

Water

20

40.50

146

31/10

16:30

12.00

5.50

1.50

01/11

08:00

12.00

5.50

5.70

01/11

16:30

33.00

5.50

4.80

02/11

08:00

33.00

5.50

5.75

Casing Diameter

Depth (m)

Dia (mm)

Water Strikes

Strike (m)

Cased (m)

Sealed (m)

Time (mins)

Rose to (m)

Monitoring Installations

Top (m)

Base (m)

Pipe Type

Dia (mm)

5.50

200

3.70

20

3.70

Checked by:

HH

Log status:

DRAFT

IFA RC

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	Sheet 2 of 5
Rotary Borehole Log	Location: 383018.36E 398038.25N	Ground level: 26.58mOD
	Logged by: JO	Vertical scale: 1:50
		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
			10.30m - C4			Extremely weak, thinly laminated, reddish brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, planar rough and clean.			
10.50 - 12.00	97 96 46	7	10.90m - C5			Between 10.60m and 11.00m: very weak.		11	
						Between 11.00m and 12.40m: weak.			
		4	12.20m - C6					12	
12.00 - 13.50	97 83 46					Between 12.40m and 13.35m: very weak.			
		7	13.38m - C7			Between 13.35m and 20.10m: weak.		13	
		AZCL							
13.50 - 15.00	80 77 56	19	14.25m - C8			Between 14.70m and 15.18m: 1no 45 degrees, planar rough with calcite infilled discontinuity.		14	
		5	15.30m - C9			At 15.30m: 1no calcite vein.		15	
15.00 - 16.50	100 88 36		15.75m - C10					16	
		13							
		AZCL							
16.50 - 17.70	73 48 22	NI	16.96m - C11			Between 16.99m and 17.13m: 1no 45 degrees, planar rough, calcite infilled discontinuity		17	
		11							
		NI							
17.70 - 18.70	70 32 0	AZCL	18.00m - C12					18	
		NI							
		9							
		AZCL							
18.70 - 19.50	91 71 38	NI	19.20m - C13			Between 18.80m and 18.92m: non intact recovered as sand.		19	
		5							
		NI				Between 19.50m and 19.76m: non intact recovered as sand.			
								20	

Continued next sheet

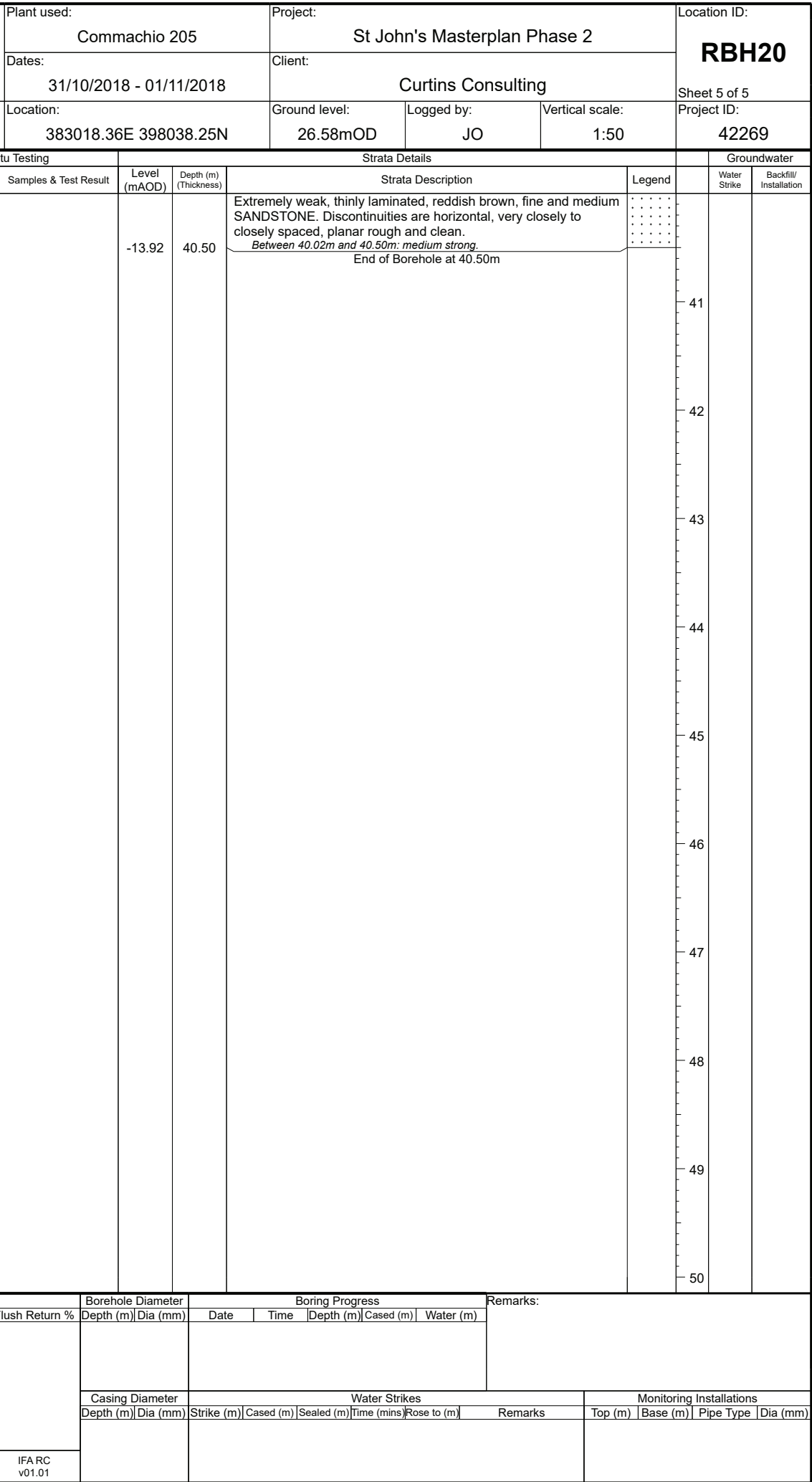
Flush Details				Borehole Diameter		Boring Progress						Remarks:			
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
						02/11	16:30	40.50	5.50	3.90					
				Casing Diameter		Water Strikes						Monitoring Installations			
				Depth (m)	Dia (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													

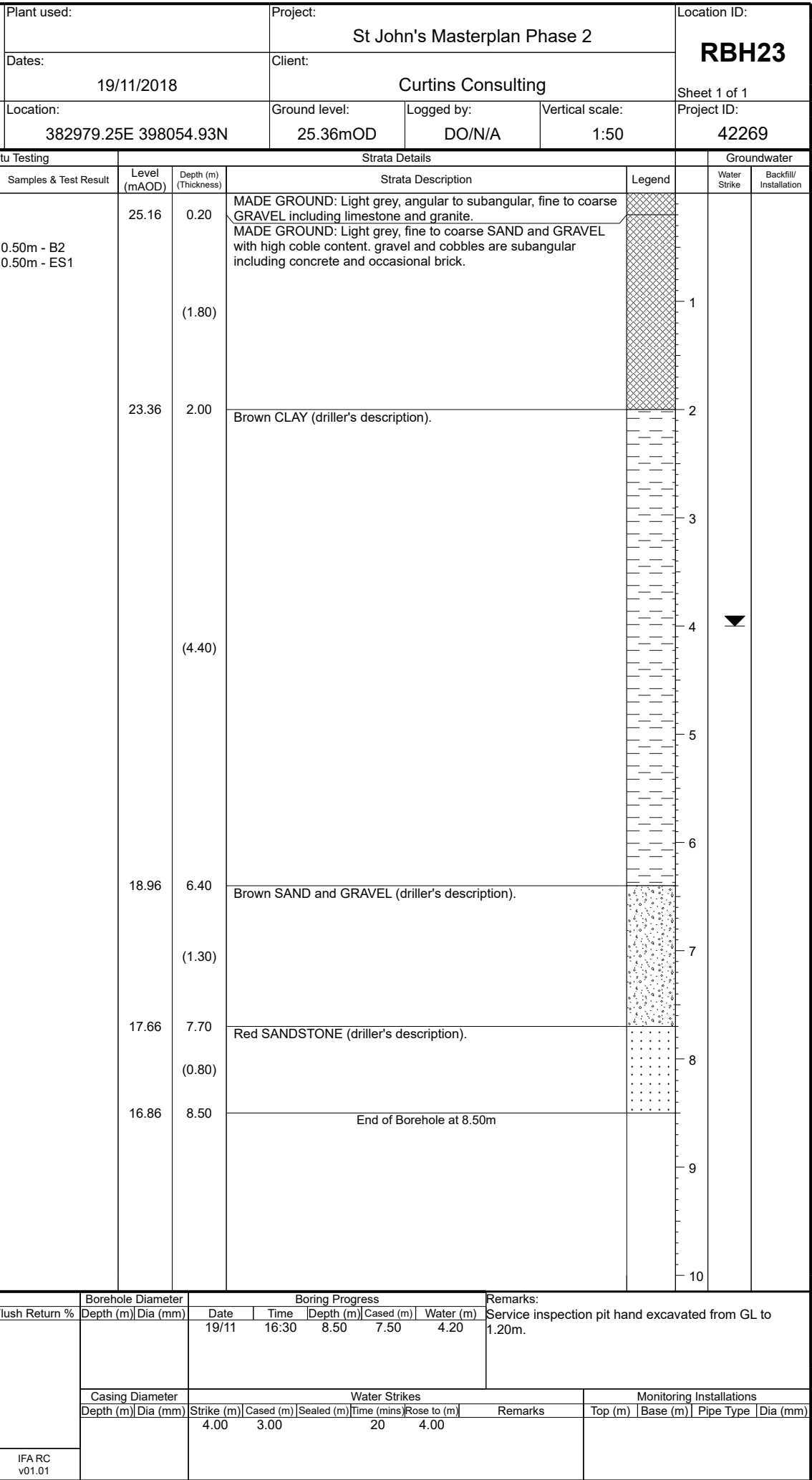
Plant used: Commachio 205	Project: St John's Masterplan Phase 2			Location ID: RBH20
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting			
Location: 383018.36E 398038.25N	Ground level: 26.58mOD	Logged by: JO	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 42269

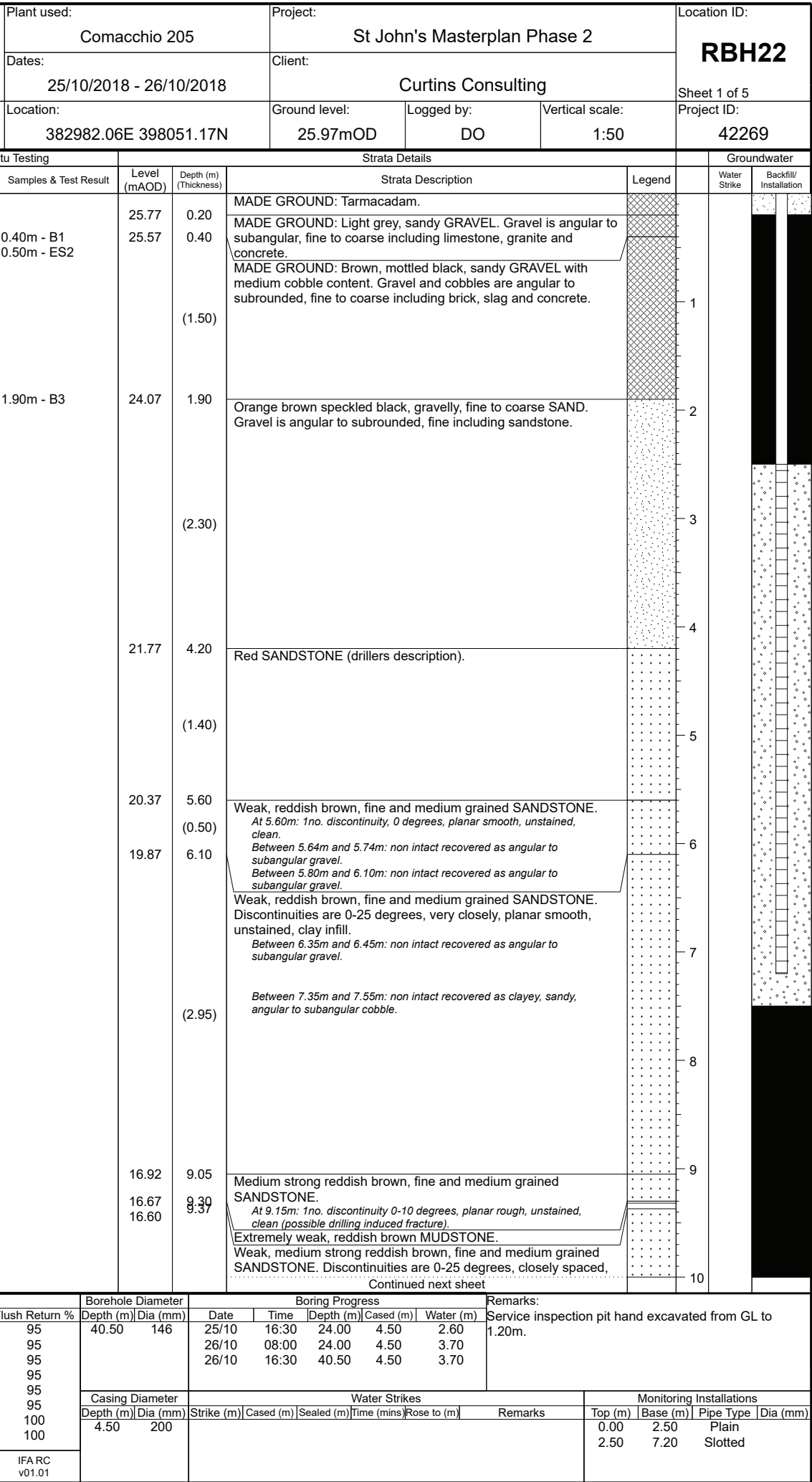
Plant used: Commachio 205	Project: St John's Masterplan Phase 2	Location ID: RBH20
Dates: 31/10/2018 - 01/11/2018	Client: Curtins Consulting	Sheet 4 of 5
Rotary Borehole Log	Location: 383018.36E 398038.25N	Ground level: 26.58mOD
	Logged by: JO	Vertical scale: 1:50
		Project ID: 42269

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
30.00 - 31.50	90 75 44	AZCL	30.40m - C24			Extremely weak, thinly laminated, reddish brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, planar rough and clean.			

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																			
		DRAFT																					
Log status:																							







	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 2 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
10.50 - 12.00	100 100 100	1				Weak, medium strong reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-25 degrees, closely spaced, planar smooth and undulating in places, unstained, occasional clay infill. <i>At 9.37m: 1no. discontinuity, 0-10 degrees, planar smooth, unstained clean.</i> <i>Between 10.50m and 12.00m: widely spaced.</i>			
12.00 - 13.50	100 100 100								
13.50 - 15.00	100 100 100								
15.00 - 16.50	100 100 100								
16.50 - 18.00	100 100 93								
18.00 - 19.50	100 93 83					<i>Between 18.50m and 18.60m: non intact recovered as reddish brown, gravelly, fine and medium sand.</i>			
				6.47	19.50	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)			

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)	
16.50	18.00	Air	100								
18.00	19.50	Air	80								
19.50	21.00	Air	80								
21.00	22.50	Air	70								
22.50	24.00	Air	65								
24.00	25.50	Air	60								
25.50	27.00	Air	60								
28.50	30.00	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 v01.01
Log status:	DRAFT	

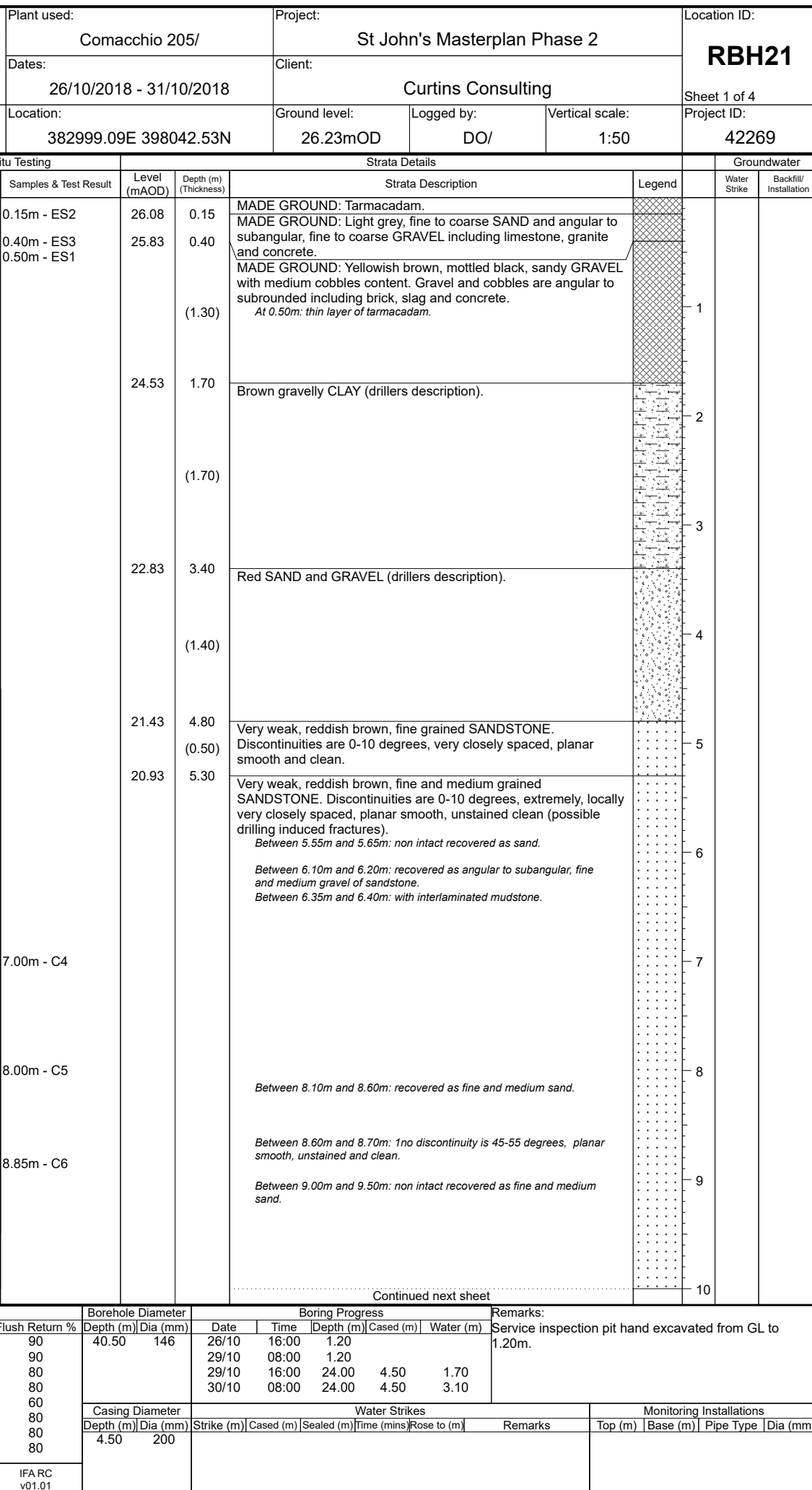
	Plant used: Comacchio 205		Project: St John's Masterplan Phase 2			Location ID: RBH22	
	Dates: 25/10/2018 - 26/10/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location: 382982.06E 398051.17N		Ground level: 25.97mOD	Logged by: DO	Vertical scale: 1:50	Sheet 3 of 5 Project ID: 42269

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

[illegible]

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





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/

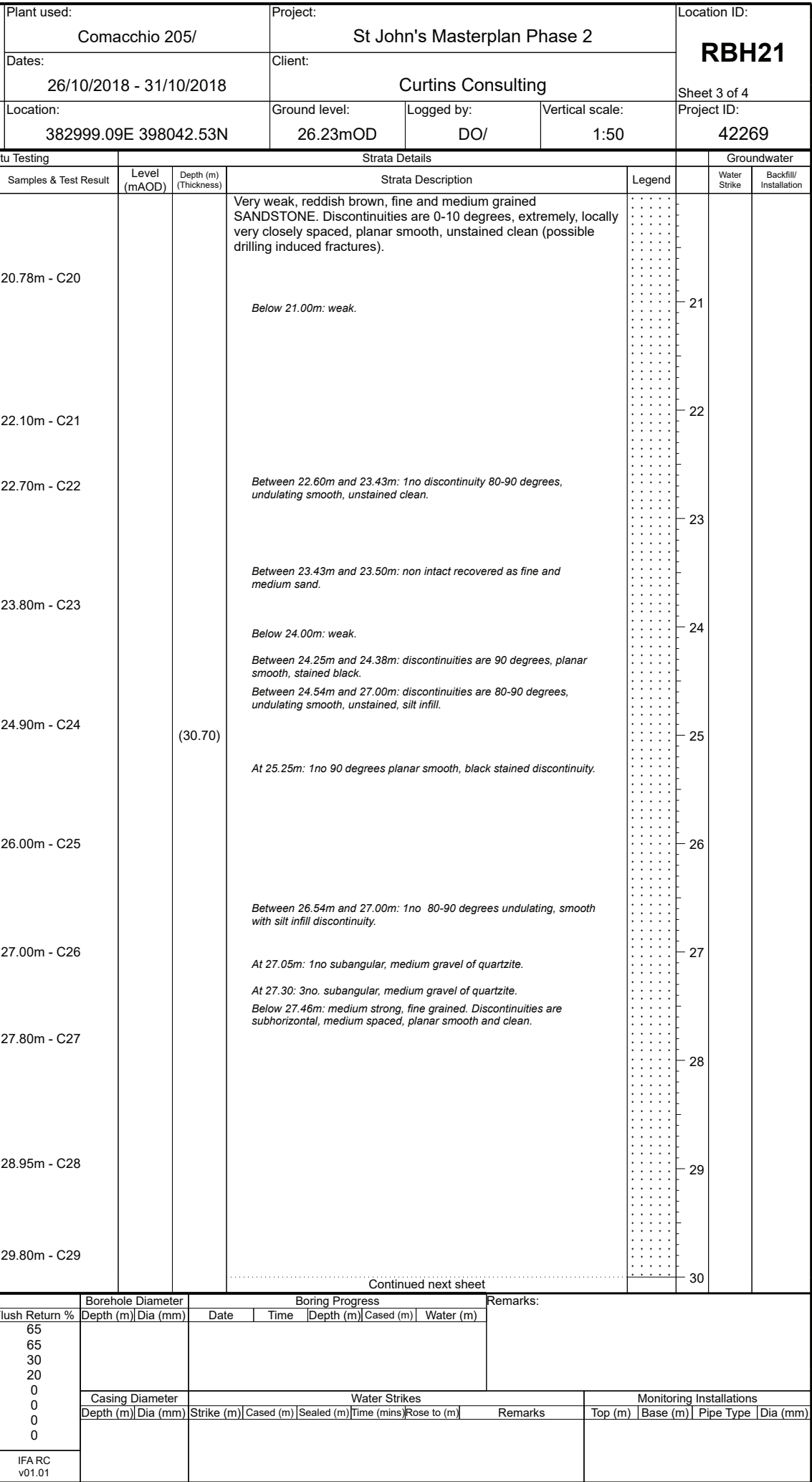
Vertical scale:
1:50

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	
11.50 - 12.00	70 70 50		11.70m - C10					12	
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								20	

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								

Checked by:		HH	IFA RC v01.01
Log status:		DRAFT	
Casing Diameter Depth (m) Dia (mm) Water Strikes Strike (m) Cased (m) Sealed (m) Time (mins) Rose to (m) Monitoring Installations Top (m) Base (m) Pipe Type Dia (mm)			



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

Appendix C – Risk Assessment Rationale

The qualitative risk assessment of environmental harm is designed to establish connecting links between a hazardous source to a potential receptor via an exposure pathway.

The qualitative risk assessment corresponds with the proposed piling operations on site.

Risk assessment is the process of collating known information on a hazard or set of hazards in order 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 hazardous 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 hazard on a site does not necessarily mean there is a risk.

By considering where a viable pathway exists which connects a source with a receptor the risk assessment in Section 3.0 and Table A4.1 identifies where pollutant linkage exists. If there is no pollutant linkage there is no risk and only where a pollutant linkage is established does the risk assessment, consider the level of risk.

The risk assessment considers the likelihood of a particular event taking place (accounting for the presence of the hazard and receptor and the integrity 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 actually 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

In accordance with DoE guidance, the following categorisation of **consequence** has been developed.

Piling Risk Assessment

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 a particular 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 a particular 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.

Piling Risk Assessment

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 or risk management operations.

Our Locations

Birmingham

2 The Wharf
Bridge Street
Birmingham
B1 2JS
T. 0121 643 4694
birmingham@curtins.com

Bristol

Quayside
40-58 Hotwell Road
Bristol
BS8 4UQ
T. 0117 302 7560
bristol@curtins.com

Cambridge

50 Cambridge Place
Cambridge
CB2 1NS
T. 01223 631 799
cambridge@curtins.com

Cardiff

3 Cwrt-y-Parc
Earlswood Road
Cardiff
CF14 5GH
T. 029 2068 0900
cardiff@curtins.com

Douglas

Varley House
29-31 Duke Street
Douglas
Isle of Man
IM1 2AZ
T. 01624 624 585
douglas@curtins.com

Dublin

11 Pembroke Lane
Dublin 2
D02 CX82
T. 00353 1 507 9447
dublin@curtins.com

Edinburgh

1a Belford Road
Edinburgh
EH4 3BL
T. 0131 225 2175
edinburgh@curtins.com

Glasgow

Queens House
29 St Vincent Place
Glasgow
G1 2DT
T. 0141 319 8777
glasgow@curtins.com

Kendal

Units 24-25 Riverside Place
K Village
Kendal
LA9 7FH
T. 01539 724 823
kendal@curtins.com

Leeds

Rose Wharf
Ground Floor
Leeds
L29 8EE
T. 0113 274 8509
leeds@curtins.com

Liverpool

51-51 Tithebarn Street
Liverpool
L2 2SB
T. 0151 726 2000
liverpool@curtins.com

London

40 Compton Street
London
EC1V 0BD
T. 020 7324 2240
london@curtins.com

Manchester

Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG
T. 0161 236 2394
manchester@curtins.com

Nottingham

56 The Ropewalk
Nottingham
NG1 5DW
T. 0115 941 5551
nottingham@curtins.com