



e3p

Phase II Geoenvironmental Site Assessment
Former Boddingtons Site, Cheetham Hill

Reference: 15-175-R2-2
Date: December 2021



PHASE II GEOENVIRONMENTAL SITE ASSESSMENT

Former Boddingtons Site
Great Ducie Street
Manchester
M3 1PT

Prepared for:
Latimer Developments Ltd

Report Ref: 15-175-R2-2
Date Issued: December 2021

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EXECUTIVE SUMMARY

Site Address	Former Boddingtons Site, Cheetham Hill, Manchester, M3 1PT	
Grid Reference	E383786, N399268	
Site Area	0.49 Ha.	
Proposed Development	E3P understands that Latimer Developments Ltd (the client) are involved with a proposed scheme to redevelop the site for residential use. Assael Architects have completed a feasibility study for a car-free development comprising 461 homes and commercial spaces. The development will comprise two main blocks with differing numbers of stories, between 1 story and 26 stories.	
Current Site Use	The site currently comprises land bound by the Travelodge and surface level car parking to the north, the remainder of the surface level car parking and beyond this Dutton Street to the east, the under-construction Manchester College to the south, and Bury New Road to the west in Manchester. The site is itself forms part of a surface level car parking with access gained via Francis Street to the northwest of the site. The site is covered in hardstand with street lighting present along the boundaries of the site (except for the northern boundary which forms part of the wider car park). No structures are present within the site boundary.	
Site History	The subject site comprised buildings associated with print works along with Briddon Street and Nightingale Street in earliest mapping from 1848. By 1850 the site was named Strangeways Calico Print Works with several buildings, boilers and tanks on-site; terraced housing was present in the west of the site. In 1892 the site was named Strangeways Finishing Works with Albion Works present on the north-eastern boundary. Mapping from 1933 identified several industries on the site including boot repairs, rag and cotton warehouse, plumber, dentist, hotel, waterproof clothing factory, cotton goods warehouse, mortar mill, garage, quilt and clothing factory and an oil store. Terrace housing in the west of the site was demolished and replaced with a warehouse circa 1949-1951; by this time the site was part of Strangeways Brewery. Mapping dated 1978-1989 notes that Briddon Street and Nightingale Street were no longer present with large areas of the site cleared or demolished. The site then comprised the brewery and areas of hardstanding up until some point between 2006 and 2009 where the site was demolished and was subsequently utilised as a car park, which is still its current use.	
Environmental Setting	Drift Geology	Till – Diamicton (east of site) No superficial drift deposits recorded by the BGS in the west of the site.
	Bedrock Geology	Chester Formation - SANDSTONE
	Faults	The Ardwick Fault is present across the site trending approximately north-west to south-east with the downthrow side present on the north-east of the fault.
	Hydrogeology	Secondary undifferentiated superficial aquifer in the east overlying a principal bedrock aquifer. The west of the site has been noted as a secondary A aquifer, however, drift deposits have not been recorded.



	Groundwater Abstraction	There are 18 groundwater abstraction points recorded within 100 m of the site, nine of which are recorded as a potable abstraction (including drinking, cooking, sanitary and washing). These abstraction points are located between 8 m and 51 m from the site and are associated with the former brewery (Strangeways Brewery) located to the south of the site which is no longer present. E3P has not been made aware that these abstraction points have been decommissioned following demolition of the brewery. However as there is now subsequent development where the brewery was located and no new groundwater abstraction licenses recorded for this development, it is anticipated that these are no longer active. The next recorded abstraction points are located 480 m northeast and 486 m north of the site relating to process water for a brewery (Joseph Holt Brewery) and potable water for a dairy (Lancashire Daires Ltd), respectively.
	Groundwater Source Protection	The site is not located within a Groundwater Source Protection Zone.
	Hydrology	No surface water features are present on site. The nearest surface water feature is the River Irwell located 156 m south-west. Based on the local topography and location of nearby surface water features, it is likely that any shallow groundwater if present will flow in a westerly direction towards the River Irwell.
	Flood Risk	The site is located in a Flood Zone 2.
Utility Locations	A formal drainage survey has not been completed; however, a review Survey Systems Utility plan (SSL:2 0838:200:1:1:TOPO:UTIL) and online records held by United Utilities indicate the presence of surface water drains across the site generally running in east-west and north-south trends. A water main is located in the south-west of the site. Electricity infrastructure is present along the northern boundary and in the west and south-west of the site. BT infrastructure is present in the west of the site.	
Landfill Sites and Ground Gases	No landfill sites (current or historic) are located within 250 m of the site. The site has undergone numerous phases of historic development which is likely to have resulted in the deposition of deep and variable Made Ground across the site, which may be a potential source of hazardous ground gases such as methane and carbon dioxide. Potentially infilled land (water and non-water) associated with unknown filled ground has been identified between 23 m and 248 m from the site.	
Radon	Less than 1% of houses above the 'Action Level' – no special precautions required.	



Coal Mining/Land Stability	The site is located within a Coal Mining Reporting Area but not within a development high risk area. There are no mine entries, coal outcrops, past or probable shallow coal mine workings beneath or close to the site. The risk from underground coal workings is therefore considered to be very low and no further works are deemed to be required in relation to coal mining.
Hazardous Installations	No hazardous installations that could potentially prejudice the proposed construction of a moderate sensitive residential apartment complex have been identified within influencing distance of the subject site.
Initial Conceptual Site Model	Contaminant Sources ✚ Made Ground (historical industrial uses) – PAHs, heavy metals, TPHs, ACM, gases ✚ Historical industrial uses (spillages of fuel etc.) – PAHs, TPHs, Metals, SVOCs, VOCs Pathways ✚ Direct contact and ingestion ✚ Volatilisation/indoor explosion ✚ Vapour inhalation ✚ Dust inhalation Receptors ✚ Future site users and construction workers ✚ Buildings ✚ Underlying aquifer (Principal bedrock aquifer)



GROUND INVESTIGATION

Ground Investigation Works	E3P has completed an intrusive ground investigation comprising three mechanically excavated trial pits, 11 window sample boreholes, four cable percussive boreholes with rotary coring follow on and the installation of environmental monitoring wells.
Ground Conditions	MADE GROUND – 0.00 m bgl – 5.10 m bgl Made Ground was encountered within all exploratory hole locations to a maximum proven depth of 5.10 m bgl (WS108), however, typically Made Ground deposits were encountered at depths less than 3.00 m bgl. The majority of locations comprised concrete or asphalt in the upper 0.3 m with the exception of WS101, WS102, WS104 and WS108 which comprised brown sandy gravel or gravelly sandy clay with gravel of brick, mudstone, concrete and sandstone. The underlying Made Ground deposits generally comprised sandy gravel with brick, coal, sandstone, concrete and occasional clinker (TP102 and WS110) and metal (WS110). Reworked silty clay deposits were identified within TP102 (1.40-2.20 m bgl), WS105 (2.00-3.10 m bgl), WS108 (1.00-2.60 m bgl). An organic odour was identified within Made Ground clay deposits in WS106 at 1.60-1.80 m bgl. DRIFT – 0.40 m bgl – 6.70 m bgl Drift deposits were encountered within the majority of exploratory locations with the exception of those where the full depth of Made Ground could not be proven. Drift deposits were not encountered within TP102, TP103, WS101, WS102, WS109 and WS110. Brown silty CLAY was encountered within ten exploratory hole locations between the depths of 0.40 m bgl to a maximum encountered depth of 6.00 m bgl. CLAY deposits were generally firm to stiff, however soft very low strength CLAY was identified within WS105 at circa 5.00 m bgl. The CLAY deposits were typically identified to be underlain by a silty fine to medium SAND within four exploratory locations between depths of 1.80 m bgl to a maximum confirmed depth of 6.70 m bgl. SAND deposits were noted to be loose to medium dense. Loose SAND deposits were noted in BH102 at 2.00 m bgl. and BH104 at 4.00 m bgl. A SAND and GRAVEL and GRAVEL band were noted within WS103 (1.65-1.80 m bgl) and BH103 (3.50-4.60 m bgl.) A stiff to very stiff clayey SILT was identified in WS107 at 3.20-5.45 m bgl. SOLID - >4.60 m bgl Sandstone bedrock was encountered within four exploratory hole locations from 4.60 m bgl - 6.70 m bgl. Deep rotary boreholes confirmed the presence of a weak to moderately strong SANDSTONE bedrock to a maximum depth of 29.00 m bgl.



Ground Conditions	GROUNDWATER Groundwater strikes were encountered during the ground investigation at 2.00 m bgl and 3.10 m bgl. Initial monitoring visits indicate groundwater at depths between 0.80 m bgl and 4.80 m bgl however within the majority of locations groundwater is at a depth >2.00 m bgl.
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CONTAMINATED LAND ASSESSMENT

Human Health	The Tier I Human Health Risk Assessment has identified exceedances of naphthalene, non-volatile PAH and TPH C16-C35 when compared to the relevant Tier I thresholds for residential end-use. A conservative assessment has been completed using residential with plant uptake. The identified elevated concentrations have primary exposure pathways related to soil ingestion (TPH), dermal contact and ingestion (PAH), and indoor vapour inhalation (naphthalene). The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed landscaping and public open space to remove any potential for direct exposure to impacted soils. Naphthalene has been identified within one isolated location on site (WS109 at 0.80 m bgl) and presents a risk of vapour inhalation. This material is currently capped by hardstand and therefore does not present a risk to current site users. As the proposed development comprises residential apartments, this material will require delineation and removal in its entirety from the footprint of the buildings to render the site suitable for residential development. The materials would likely be suitable for retention within areas of Public Open Space (POS). TPH C16-C21 and TPH C21-C35 has been identified in one location on site (WS108 at 6.60 m bgl), however the pathway for these compounds is dermal contact and ingestion and given the depth of the identified impact (>5.00 m bgl), it is unlikely that this will pose a future risk to the proposed development in terms of human health. Chemical analysis of the natural drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas with the exception of drift deposits noted to contain hydrocarbon impact; however, further chemical validation samples will be required to confirm this. The use of the natural clay soils will also be dependent on the requirements for site as there is significant depths of Made Ground encountered across the majority of the site therefore the cut/fill works to 'win' the subsoil may be significant. There are no suitable sources of topsoil available on the site.
Controlled Waters	A comparison of leachate samples and groundwater samples has been carried out against Drinking Water Standards (DWS) as both the underlying aquifers have been identified as potential receptors. Elevated concentrations of selenium and TPH Aliphatic C21-C35 have been identified in groundwater within WS108. The determinants are typically considered low mobility.



Controlled Waters	The site is underlain by a secondary undifferentiated/secondary A drift aquifer and underlying principal bedrock aquifer meaning the site is located within a potentially highly sensitive area with respect to groundwater. However, the closest potable abstraction points, recorded to be between 8 m and 51 m from the site, are associated with a former brewery (Strangeways Brewery) which is no longer present, and the area is being redeveloped. E3P has not been made aware that these abstraction points have been decommissioned following the demolition of the brewery. No new groundwater abstraction licenses are recorded for the development therefore it is anticipated that these are no longer active and as such the risk can be disregarded from this assessment. It should be noted that the boreholes will have previously acted as preferential pathway. The next recorded abstraction points are located 480 m northeast and 486 m north of the site relating to process water for a brewery (Joseph Holt Brewery) and potable water for a dairy (Lancashire Dairies Ltd), respectively. Given the substantial distance from the site, these are not within influencing distance of the site and therefore are not deemed to be at risk from the identified contaminants. The River Irwell is located in excess of 150 m west of the site, therefore, is not considered to be a sensitive receptor. Based on the above assessment, there is considered a low risk to controlled waters from the identified determinants however further groundwater monitoring should be completed to confirm the site poses a low risk.
Ground Gas	Ground gas monitoring (to date) indicates the site falls under Characteristic Situation 1 and protection measures are unlikely to be required should the site be redeveloped. This will need to be confirmed following completion of the ground gas monitoring.
Potable Water Infrastructure	Under the scope of these works, a UU Risk Assessment has been carried out based on the current ground conditions which is presented in Appendix XI. Based on the assessment of current site conditions and the presence of TPH and SVOCs within Made Ground at pipeline depth, it is likely that barrier pipe will be required at the proposed development. Remediation and enabling works will be carried out on-site which may alter the current ground conditions. Post-remediation sampling may be required to re-inform the UKWIR assessment for the final pipe selection.



GEOTECHNICAL ASSESSMENT

Underground Obstructions	No significant underground obstructions have been encountered during the ground investigation, however, due to the numerous phases of previous development on-site, the presence of obstructions cannot be entirely discounted. If encountered, these features may require grubbing out in their entirety to facilitate piled foundations. Concrete and asphalt have been encountered across the entire site to depths of 0.60 m bgl (WS109 and BH102) in the west of the site. All existing concrete slabs and hardstanding will require grubbing out in its entirety and replacing with suitable engineered fill.
Allowable Bearing Pressure	The underlying dense SANDSTONE typically offers an allowable bearing pressure (ABP) of >350 kN/m² at depths in excess of 5.00 m bgl. Geotechnical testing undertaken on selected rock cores at depths of between 9.30 m – 24.90 m bgl indicate a strength of between 3.8 and 13.3 (MPa), equating to 3800–13300 kN/m² from UCS tests. The results of the point load tests indicate that at a depth of between 10.80 m bgl – 16.47 m bgl the bedrock recorded a strength of between 0.04 and 0.27 (MPa) which equates to 40–270 kN/m².
Foundation Options	E3P understands that the structural loads of the proposed apartment building will necessitate the use of piled foundations. The final foundation solution will be dependent on the structural loadings, elevation and should be designed by a suitably qualified structural engineer with detailed designs from a specialist piling contractor.
Building Floor Slabs	A ground bearing slab will be viable; however, it will need to be constructed on a granular sub-base with the thickness designed by a structural engineer to ensure that settlement tolerances are taken into consideration. A suspended floor slab may also be viable but will require specialist design by a structural engineer.
Heave Precautions	Given that the underlying clay is of moderate volume change potential, heave precautions will be required to the internal face of a foundation. As cohesive deposits have been identified over shallow bedrock, with medium volume change potential, a specialist pile design is required in order to prevent pile failure generated from heave. Piles may need to be socketed into the underlying bedrock through CFA method or a sleeve design applied to a pile precast.
Soakaway Drainage	Results of the infiltration tests were generally of a poor soakage potential. The variability in ground conditions across the site with Made Ground to depths of between 0.50 m bgl to 3.50 m bgl, which is typically underlain by clay deposits with localised interbedded SAND and GRAVEL, the potential of identifying a suitable stratum with sufficient soakaway potential is limited. As low permeability CLAY is present on-site, and as the lateral continuity of the Made Ground cannot be assured, it is not recommended that soakaways are utilised for disposal of surface water runoff. The application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – Soakaway Design.
Sulphate Assessment	Concrete classification will be DS1 AC1s.



CBR Design %	Granular soils can be re-engineered to ensure 5% within the subgrade during favourable climatic conditions. Natural clay soils will provide a CBR in the order of 3–5% during drier climatic periods. However, if water is allowed to shed onto the formation, the CBR will reduce to < 2%, which will require specialist engineering of the subgrade.
Cut/Fill	Significant cut-and-fill works may not likely be required to prepare the development platform. However, any obstructions will need to be grubbed out in their entirety from within the footprint of the proposed structures.
Civil Engineering Excavations	Rockhead has been encountered at between 4.60 m bgl and 6.70 m bgl. Dependent on development levels and anticipated depths of drainage, it is considered that standard machinery will be suitable for the advancement of civil engineering excavations, however, specialist equipment may be required.
Waste Characterisation	Any material that is to be disposed off-site should undergo assessment using Technical Guidance WM3: <i>Waste Classification – Guidance on the classification and assessment of waste</i>.

RECOMMENDATIONS

Based on the findings of the geoenvironmental site assessment, the following additional works are recommended to be completed in due course:

- ✿ Further investigation of inaccessible areas.
- ✿ Specific foundation schedule (upon receipt of the final development levels).
- ✿ Geotechnical earthworks strategy (infrastructure).
- ✿ Remediation and enabling works strategy.
- ✿ Construction phase Surface Water Management Plan.



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DRAWING LIST

15-175-001 - Site Location Plan
15-175-002 - Proposed Development Plan
15-175-003 - Historical Features Plan
15-175-004 - Site Features Plan
15-175-005 - Exploratory Hole Location Plan
15-175-006 - Depth of Made Ground Plan
15-175-007 - Depth of Bedrock Plan
15-175-010 - Conceptual Site Model
15-175-015 - Development Constraints Plan



1. INTRODUCTION

1.1. BACKGROUND

E3P has been commissioned by Latimer Developments Ltd to undertake a detailed Phase I and II Geoenvironmental Site Assessment for a parcel of land to the east of Great Ducie Street, Manchester, M3 1PT.

This report is required to determine potential contaminated land liabilities, remediation requirements and geotechnical engineering works that will be required as part of the proposed development for a proposed high-rise residential development.

1.2. PROPOSED DEVELOPMENT

E3P understands that Latimer Developments Ltd is involved with a proposed scheme to redevelop the site for residential use. Assael Architects have completed a feasibility study for a car free development comprising 442 homes and commercial spaces. The development will comprise two main blocks with differing number of stories, between 1 story and 27 stories.

The site forms part of the adopted Great Ducie Street Strategic Regeneration Framework Masterplan, bringing forward the redevelopment of the former Boddingtons Brewery demolished circa 10 years ago. The site has been purchased from LTE Group (trading as Manchester College) who are delivering a new college facility on the southern part of the site, this is due for completion by summer 2022.

A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.3. OBJECTIVES

The objectives of the geoenvironmental assessment are as follows:

- ✦ Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available in order to complete a desk study in line with Environment Agency (EA) document *Land Contamination: Risk Management (LCRM) (2019)*.
- ✦ Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified.
- ✦ Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors.
- ✦ Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs.
- ✦ Provide recommendations regarding future works required.

1.4. SCOPE OF WORKS

The scope of work includes the following elements:

- ✦ Detailed review of historic information;
- ✦ Design of suitable intrusive ground investigation;
- ✦ Window sample probeholes with, and construction of, environmental monitoring installations;
- ✦ Deep cable percussive boreholes with groundwater monitoring installations;
- ✦ Mechanically excavated trial pits;
- ✦ In-situ geotechnical testing;
- ✦ Chemical and geotechnical laboratory analysis;
- ✦ Groundwater monitoring and sampling;
- ✦ Ground gas monitoring;
- ✦ Contamination risk assessment and conceptual site model;
- ✦ Geotechnical assessment and interpretation; and
- ✦ Factual and interpretive reporting.

1.5. LIMITATIONS

The limitations of this report are presented in Appendix I.



1.6. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.



2. GROUND INVESTIGATION

2.1. GENERAL OVERVIEW

A ground investigation has been designed based on the findings of the desk study, with exploratory holes advanced to target specific potential contaminant sources identified within the previous site investigations. The required exploratory hole locations were chosen by SGI Consulting Engineers.

The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development.

Exploratory fieldwork was completed between 27th September 2021 and 6th October 2021. The works are summarised in Table 2.1.

2.2. LIMITATIONS OF THE INVESTIGATION

BRE 365 SOAKAWAY TESTING

The scope of works included the advancement of four mechanically excavated trial pits to carry out in-situ BRE365 soakaway testing to confirm the drainage potential of the underlying natural stratum. Ground conditions encountered within three trial pits comprised significant depths of Made Ground to depths in excess of 2.00 m bgl and as such soakaway tests were unable to be completed. As an alternative in order to provide an impression of the drainage potential of the natural ground falling head permeability tests were undertaken within the underlying natural strata within four environmental monitoring wells.

WINDOW SAMPLE PROBEHOLES

The original scope of works included 20 Window Sample Probeholes. Due to the presence of significant depths of concrete across the site and dense Made Ground, the advancement of 20 probeholes was not possible within the timeframes of the site works. Eleven probeholes were advanced during the site works with the installation of seven environmental monitoring wells. It was considered that the boreholes completed would provide sufficient information to inform the design of the proposed development.



2.3. SCOPE OF INVESTIGATION

TABLE 2.1 SUMMARY OF FIELDWORK

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (m bgl)	MONITORING WELLS RESPONSE ZONE (m bgl)
General Ground Conditions Including the Presence/Nature of Obstructions	TP101	Mechanically Excavated Trial Pit	3.10	N/A
	TP102		2.20	N/A
	TP103		2.20	N/A
	WS101	Window Sample Probehole	2.05	N/A
	WS102		1.83	N/A
	WS103		5.45	1.00-4.00
	WS104		5.45	N/A
	WS105		5.45	0.50-2.00
	WS106		5.45	N/A
	WS107		5.45	N/A
	WS108		6.18	1.00-6.00
	WS109		2.84	0.50-2.50
	WS110		0.53	N/A
	WS111		5.45	1.00-4.00
General Ground Conditions Including the Investigation of Deeper Soil Horizons and the Underlying Bedrock	BH101	Cable Percussive Borehole with Rotary Coring Follow-on	29.00	N/A
	BH102		16.50	3.50-5.50
	BH103		19.50	3.50-4.50
	BH104		29.00	N/A

Mechanically excavated trial pits were advanced to investigate ground conditions.

Window sample probeholes were advanced to undertake in-situ detailed geotechnical testing, obtain environmental samples and install groundwater and ground gas monitoring wells.

Cable percussive boreholes were advanced to carry out in-situ geotechnical testing and identify the depth of the underlying bedrock. These boreholes were then continued with rotary open hole (where required) and rotary coring was completed to obtain rock cores for detailed logging and geotechnical analysis. Photographs of the rock cores are presented in Appendix X and the Geotechnical Lab Report is available in Appendix VIII.

The sampling locations are illustrated in Drawing 15-175-005 (Appendix III). The ground conditions encountered are indicated on the logs, which are provided in Appendix V.

Return visits were made to monitor installations for groundwater level and gas concentrations. In addition, selected wells were purged, and samples of groundwater were recovered for chemical analysis.



2.4. IN-SITU STANDARD PENETRATION TESTING (SPT)

In-situ geotechnical testing was conducted using the standard penetration test (SPT) and, where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the probehole logs in Appendix V and presented in Table 3.5 and discussed in Section 5.

2.5. PERMEABILITY TESTS

Mechanically excavated trial holes were advanced to carry out BRE365 Soakaway Tests, however, due to ground conditions and the depths of Made Ground encountered these were not viable.

As an alternative, four falling head permeability tests were undertaken within environmental monitoring wells (WS103, WS111, BH102 and BH103) in order to assess the likely permeability of the underlying strata to determine the potential suitability for soakaway drainage within the proposed development. The results are presented in Table 3.7 and the test certificates are included within Appendix IX.

2.6. LABORATORY ANALYSIS

Selected soil samples were submitted for a range of chemical analysis comprising:

- ✦ Metals.
- ✦ pH, total sulphate, water-soluble sulphate (2:1 extract).
- ✦ Sulphide.
- ✦ Cyanide.
- ✦ Phenols.
- ✦ Total and speciated polycyclic aromatic hydrocarbons (PAHs).
- ✦ Semi Volatile Organic Compounds (SVOC).
- ✦ Volatile Organic Compounds (VOC).
- ✦ Asbestos identification and quantification.
- ✦ Speciated and banded total petroleum hydrocarbon (TPH).

I2 Analytical undertook the analytical work and the testing results are included in Appendix VI and discussed in Section 4.



Selected samples were submitted to PSL Laboratory where the following geotechnical tests were undertaken:

-  Atterberg limits determinations;
-  Moisture Content;
-  Particle Size Distribution;
-  Single-stage triaxial tests;
-  Point Load Tests; and
-  Unconfined Compressive Strength Tests.

Laboratory analysis sheets are included in Appendix VIII and are summarised in Section 5.



3. GROUND AND GROUNDWATER CONDITIONS

3.1. SUMMARY OF GROUND CONDITIONS

The ground investigation generally confirms the published geology and identifies the strata set out in Table 3.1.

TABLE 3.1 SUMMARY OF STRATA

HOLE	DEPTH TO STRATUM (m bgl)					
	MADE GROUND	SILTY CLAY	CLAYEY SILT	GRAVEL	SILTY SAND	BEDROCK
TP101	0.00–3.00	3.00–3.10	–	–	–	–
TP102	0.00–2.20	–	–	–	–	–
TP103	0.00–2.20	–	–	–	–	–
WS101	0.00–2.05	–	–	–	–	–
WS102	0.00–1.83	–	–	–	–	–
WS103	0.00–0.40	0.40–1.65 1.80–5.45	–	1.65–1.80	–	–
WS104	0.00–1.40	1.40–5.45	–	–	–	–
WS105	0.00–3.10	3.10–5.45	–	–	–	–
WS106	0.00–1.80	1.80–5.45	–	–	–	–
WS107	0.00–0.60	0.60–3.20	3.20–5.45	–	–	–
WS108	0.00–5.10	–	–	–	5.10–6.18	–
WS109	0.00–2.84	–	–	–	–	–
WS110	0.00–0.53	–	–	–	–	–
WS111	0.00–2.50	4.10–5.45	–	–	2.50–4.10	–
BH101	0.00–3.50	3.50–6.00	–	–	–	6.00–29.00
BH102	0.00–1.80	3.50–5.60	–	–	1.80–3.50	5.60–16.50
BH103	0.00–3.50	–	–	3.50–4.60 (SAND and GRAVEL)		4.60–19.50
BH104	0.00–1.90	1.90–3.50	–	–	3.50–6.70	6.70–29.00

3.2. MADE GROUND

Made Ground was encountered within all exploratory hole locations to a maximum proven depth of 5.10 m bgl (WS108), however, typically Made Ground deposits were encountered at depths less than 3.00 m bgl.

The majority of locations comprised concrete or asphalt in the upper 0.3 m with the exception of WS101, WS102, WS104 and WS108 which comprised brown sandy gravel or gravelly sandy clay with gravel of brick, mudstone, concrete and sandstone.

The underlying Made Ground deposits generally comprised sandy gravel with brick, coal, sandstone, concrete and occasional clinker (TP102 and WS110) and metal (WS110). Reworked silty clay deposits were identified within TP102 (1.40–2.20 m bgl), WS105 (2.00–3.10 m bgl), WS108 (1.00–2.60 m bgl).



An organic odour was identified within Made Ground clay deposits in WS106 at 1.60-1.80 m bgl.

A Depth of Made Ground Plan is presented as Drawing 15-175-006 in Appendix III.

3.3. DRIFT DEPOSITS

Drift deposits were encountered within the majority of exploratory locations with the exception to those where the full depth of Made Ground could not be proven. Drift deposits were not encountered within TP102, TP103, WS101, WS102, WS109 and WS110.

Brown silty CLAY was encountered within ten exploratory hole locations between the depths of 0.40m bgl to a maximum encountered depth of 6.00 m bgl. CLAY deposits were generally firm to stiff, however soft very low strength CLAY was identified within WS105 at circa 5.00mbgl.

The CLAY deposits were typically identified to be underlain by a silty fine to medium SAND within four exploratory locations between depths of 1.80 m bgl to a maximum confirmed depth of 6.70 m bgl. SAND deposits were noted to be loose to medium dense. Loose SAND deposits were noted in BH102 at 2.00mbgl. and BH104 at 4.00mbgl.

A SAND and GRAVEL and GRAVEL band were noted within WS103 (1.65-1.80mbgl) and BH103 (3.50-4.60 m bgl.)

A stiff to very stiff clayey SILT was identified in WS107 at 3.20-5.45 m bgl.

3.4. SOLID GEOLOGY

Sandstone bedrock was encountered within four exploratory hole locations from 4.60 m bgl - 6.70 m bgl.

Deep rotary boreholes confirmed the presence of a weak to moderately strong SANDSTONE bedrock to a maximum depth of 29.00 m bgl.

A Depth to Bedrock Plan is presented as Drawing 15-175-006.

3.5. GROUNDWATER

Groundwater was encountered as strikes. The depth of the strikes is shown on the exploratory hole records in Appendix V and are summarised in Table 3.2.

TABLE 3.2 SUMMARY GROUNDWATER STRIKES

LOCATION	DEPTH TO STRIKE (m)	NOTES
TP101	3.10	Slow Ingress – land drain
WS105	2.00	Slow Ingress

Initial monitoring visits indicate groundwater at depths between 0.80 m bgl and 4.80 m bgl however within the majority of locations groundwater is at a depth >2.00 m bgl.

3.6. VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

Visual and olfactory evidence of potential contamination has been identified during the site investigation and these are summarised in Table 3.3.



TABLE 3.3 SUMMARY VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

LOCATION	DEPTH (m)	STRATUM	NOTES
TP102	0.20–1.40	Made Ground	Clinker
WS108	5.10 – 6.18	SAND	Hydrocarbon Odour and Sheen
WS110	0.25 – 0.80	Made Ground	Clinker

3.7. SOIL CONSISTENCY

Undrained shear strength values were measured using laboratory undrained triaxial tests. Results of the tests are presented in Table 3.4, which indicate the clay soils to vary between firm and stiff. Strength test data is generally consistent with the field descriptions of the aforementioned soils.

Results of the standard penetration tests, including undrained shear strengths derived from SPTs are included in Table 3.5.

TABLE 3.4 SUMMARY OF UNDRAINED SHEAR STRENGTH TEST RESULTS

LOCATION	SAMPLE DEPTH (m)	LAB DESCRIPTION	UNDRAINED SHEAR STRENGTH (kN/m ²)	CONSISTENCY
BH104	6.50 – 6.95	Stiff brown slightly sandy CLAY	124	Stiff
BH102	4.00 – 4.45	Firm brown slightly gravelly sandy CLAY	47	Firm

3.8. SIDE STABILITY AND EASE OF EXCAVATION

Deep Made Ground was encountered within all three trial pit locations. The presence of gravel and inclusions of brick and concrete cobbles within the Made Ground deposits meant that in certain places, excavation was slow through the Made Ground and in some places, Made Ground could not be fully penetrated. Due to the presence of granular Made Ground to depths in excess of 2.00 m bgl, the trial pits were unstable and localised side wall collapse occurred.



TABLE 3.5 STANDARD/CONE PENETRATION TEST RESULTS

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS101	1.00	MG Gravel	19	19.15	Medium Dense	N/A	N/A	N/A	192
WS101	2.00	MG Clay	50	45.68	N/A	Very Stiff	Very high strength	228	470
WS102	1.00	MG Gravel	17	17.14	Medium Dense	N/A	N/A	N/A	171
WS102	1.80	MG Clay	50	46.32	N/A	Very Stiff	Very high strength	232	476
WS103	1.00	CLAY	12	12.10	N/A	Stiff	Medium strength	60	124
WS103	2.00	CLAY	10	9.14	N/A	Stiff	Medium strength	46	94
WS103	3.00	CLAY	20	17.39	N/A	Very Stiff	High strength	87	179
WS103	4.00	CLAY	19	16.05	N/A	Very Stiff	High strength	80	165
WS103	5.00	CLAY	28	23.23	N/A	Very Stiff	High strength	116	239
WS104	1.00	MG Clay	8	8.07	N/A	Stiff	Medium strength	40	83
WS104	2.00	CLAY	10	9.14	N/A	Stiff	Medium strength	46	94
WS104	3.00	CLAY	20	17.39	N/A	Very Stiff	High strength	87	179
WS104	4.00	CLAY	19	16.05	N/A	Very Stiff	High strength	80	165
WS104	5.00	CLAY	32	26.55	N/A	Very Stiff	High strength	133	273
WS105	1.00	MG Gravel	11	11.09	Medium Dense	N/A	N/A	N/A	111
WS105	2.00	MG Clay	10	9.14	N/A	Stiff	Medium strength	46	94
WS105	3.00	CLAY	8	6.96	N/A	Firm	Low strength	35	72
WS105	4.00	CLAY	9	7.60	N/A	Firm	Low strength	38	78



BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS105	5.00	CLAY	4	3.32	N/A	Soft	Very low strength	17	34
WS106	1.00	MG Clay	4	4.03	N/A	Firm	Low strength	20	41
WS106	2.00	CLAY	7	6.39	N/A	Firm	Low strength	32	66
WS106	3.00	CLAY	8	6.96	N/A	Firm	Low strength	35	72
WS106	4.00	CLAY	10	8.45	N/A	Stiff	Medium strength	42	87
WS106	5.00	CLAY	18	14.93	N/A	Stiff	Medium strength	75	154
WS107	1.00	CLAY	10	10.08	N/A	Stiff	Medium strength	50	104
WS107	2.00	CLAY	14	12.79	N/A	Stiff	Medium strength	64	131
WS107	3.00	SILT	25	21.74	N/A	Very Stiff	High strength	109	224
WS107	4.00	SILT	41	34.64	N/A	Very Stiff	Very high strength	173	356
WS107	5.00	SILT	16	13.27	N/A	Stiff	Medium strength	66	136
WS108	1.00	MG Sand	8	8.07	Loose	N/A	N/A	N/A	81
WS108	2.00	MG Sand	12	10.96	Medium Dense	N/A	N/A	N/A	110
WS108	3.00	MG Gravel	21	18.26	Medium Dense	N/A	N/A	N/A	183
WS108	4.00	MG Gravel	28	23.66	Medium Dense	N/A	N/A	N/A	237
WS108	5.00	SAND	24	19.91	Medium Dense	N/A	N/A	N/A	199
WS108	6.00	SAND	50	40.99	Dense	N/A	N/A	N/A	410
WS109	1.00	MG Gravel	22	22.18	Medium Dense	N/A	N/A	N/A	222



BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS109	2.00	MG Gravel	21	19.18	Medium Dense	N/A	N/A	N/A	192
WS109	2.80	MG Gravel	50	43.82	Dense	N/A	N/A	N/A	438
WS110	0.50	MG Sand	50	56.02	Very Dense	N/A	N/A	N/A	560
WS111	1.00	MG Clay	8	8.07	N/A	Stiff	Medium strength	40	83
WS111	2.00	MG Clay	7	6.39	N/A	Firm	Low strength	32	66
WS111	3.00	SAND	17	14.78	Medium Dense	N/A	N/A	N/A	148
WS111	4.00	CLAY	19	16.05	N/A	Very Stiff	High strength	80	165
WS111	5.00	CLAY	25	20.74	N/A	Very Stiff	High strength	104	213
BH101	1.20	MG Gravel	36	35.32	Dense	N/A	N/A	N/A	353
BH101	2.00	MG Gravel	29	26.49	Medium Dense	N/A	N/A	N/A	265
BH101	3.00	MG Gravel	9	7.83	Loose	N/A	N/A	N/A	78
BH101	4.00	CLAY	14	11.83	N/A	Stiff	Medium strength	59	122
BH101	6.50	SANDSTONE	50	40.82	Dense	N/A	N/A	N/A	408
BH101	8.00	SANDSTONE	50	40.47	Dense	N/A	N/A	N/A	405
BH102	1.20	MG Gravel	7	6.87	Loose	N/A	N/A	N/A	69
BH102	2.00	SAND	7	6.39	Loose	N/A	N/A	N/A	64
BH102	3.00	SAND	12	10.44	Medium Dense	N/A	N/A	N/A	104
BH102	5.00	CLAY	16	13.27		Stiff	Medium strength	66	136



BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
BH102	6.50	SANDSTONE	50	40.82	Dense	N/A	N/A	N/A	408
BH102	7.50	SANDSTONE	50	40.56	Dense	N/A	N/A	N/A	406
BH103	1.20	MG Gravel	12	11.77	Medium Dense	N/A	N/A	N/A	118
BH103	2.00	MG Gravel	5	4.57	Loose	N/A	N/A	N/A	46
BH103	3.00	MG Gravel	11	9.57	Loose	N/A	N/A	N/A	96
BH103	4.00	SAND and GRAVEL	25	21.12	Medium Dense	N/A	N/A	N/A	211
BH103	5.00	SANDSTONE	50	41.48	Dense	N/A	N/A	N/A	415
BH103	6.50	SANDSTONE	50	40.82	Dense	N/A	N/A	N/A	408
BH103	7.50	SANDSTONE	50	40.56	Dense	N/A	N/A	N/A	406
BH104	1.20	MG Gravel	5	4.91	Loose	N/A	N/A	N/A	49
BH104	2.00	CLAY	6	5.48	N/A	Firm	Low strength	27	56
BH104	3.00	CLAY	5	4.35	N/A	Firm	Low strength	22	45
BH104	4.00	SAND	6	5.07	Loose	N/A	N/A	N/A	51
BH104	5.00	SAND	20	16.59	Medium Dense	N/A	N/A	N/A	166
BH104	8.00	SANDSTONE	50	40.47	Dense	N/A	N/A	N/A	405
BH104	9.50	SANDSTONE	50	40.30	Dense	N/A	N/A	N/A	403
BH104	11.00	SANDSTONE	50	38.67	Dense	N/A	N/A	N/A	387

NOTES

* The Allowable Bearing Pressure (ABP) should be considered indicative.



The interpretation of in situ mass undrained shear strength (c_u) data from SPT Blow Count (N) results and the influence of the Plasticity Index (PI) was reported in Standard Penetration Test in Insensitive Clays and Soft Rocks. Stroud (1974). The standard penetration test and the engineering properties of glacial materials subsequently. Stroud and Butler (1975) and (1989). Allowable bearing pressure on sands. Soil Mechanics in Engineering Practice Terzaghi, K. & Peck, R.B. 1996.



3.9. PARTICLE SIZE DISTRIBUTION

Particle Size Distribution Tests have been undertaken on selected samples via a wet sieve to obtain information on the soil fractions. The results are included in Table 3.6. The full results can be found in Appendix VIII.

TABLE 3.6 SUMMARY OF PARTICLE SIZE DISTRIBUTION TEST RESULTS

LOCATION	DEPTH (m)	SOIL FRACTION (%)			
		COBBLES	GRAVEL	SAND	SILT/CLAY
BH104	5.00 (Natural)	0	0	3	97
BH101	4.00 (Natural)	0	0	5	95

3.10. SOIL INFILTRATION

The initial scope of works included BRE 365 Soakaway Testing however within the three trial pit locations advanced to carry out the testing, deep Made Ground was encountered (>2.20 m bgl) therefore the tests were not viable due to potential contamination and instability within the side walls.

In order to obtain an indication of infiltration rates within the underlying natural strata, in-situ variable (falling) head permeability tests were undertaken within monitoring well installations located in four probeholes (WS103, WS111, BH102 and BH103).

The locations were noted to be dry prior to the test being undertaken, therefore the tests were undertaken in the unsaturated zone. Tests in WS111 were completed within Made Ground CLAY and natural SAND deposits, testing in BH103 was undertaken within natural granular drift stratum, while WS103 and BH102 were undertaken in response zones located within the natural clay stratum.

The results are presented in Table 3.7 and the test certificates are included within Appendix IX.

TABLE 3.7 SOIL INFILTRATION RESULTS

LOCATION	DEPTH (m)	MATERIAL	TEST No.	SOIL INFILTRATION RATE (m/s)
WS103	1.00 – 4.00	Silty CLAY / GRAVEL	1	7.81E-07
WS111	1.00 – 4.00	Made Ground Clay / Gravelly SAND	1	4.6E-07
BH102	3.50 – 5.50	Silty CLAY	1	5.04E-07
BH103	3.50 – 4.50	SAND and GRAVEL	1	5.13E-06 (Test terminated due to flooding of the well – results not representative).

Results of the infiltration tests were varied with both the cohesive and granular strata displaying a generally poor soakage potential. WS103 failed to infiltrate at all during the testing period while BH103 was terminated early due to significant rainfall and the well subsequently flooding ultimately indicating poor infiltration within these locations. The test within BH103 is considered to have failed.



The variability in ground conditions across the site with Made Ground to depths of between 0.50 m bgl and >3.50 m bgl, which is typically underlain by clay deposits with localised interbedded SAND and GRAVEL, the potential of identifying a suitable stratum with sufficient soakaway potential is limited.

The application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – *Soakaway Design*.

3.11. SOIL PLASTICITY

The Atterberg limits determinations, summarised in Table 3.8, show the clay to be of low plasticity.

TABLE 3.8 SUMMARY OF PLASTICITY INDEX TEST RESULTS

LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 µm SIEVE (%)	MODIFIED PLASTICITY INDEX	NHBC VOLUME CHANGE POTENTIAL
BH104	4.00	20	16	36	20	98	19.60	Low

The results of the Atterberg limits testing confirmed that the soils would be deemed to be Low Volume Change Potential in accordance with the classification system utilised by the LABC/NHBC industry guidance.

3.12. pH AND SULPHATE

Chemical analyses for pH and soluble sulphate content contained in Appendix VI (summarised in Table 3.9), shows that the soils at the site meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE *Special Digest 1* (2005).

TABLE 3.9 SUMMARY OF pH AND SULPHATE DATA

LOCATION	DEPTH (m)	SO ₄ IN 2:1 WATER/SOIL (g/l)	pH VALUE	CLASSIFICATION
WS101	0.80	0.13	11.1	DS-1/AC-1s
WS104	0.80	0.33	9.8	DS-1/AC-1s
WS104	2.00	0.21	8.9	DS-1/AC-1s
WS105	2.50	0.0080	7.9	DS-1/AC-1s
WS106	1.70	0.17	7.7	DS-1/AC-1s
WS106	2.50	0.012	7.7	DS-1/AC-1s
WS108	5.60	0.076	8.0	DS-1/AC-1s
WS109	0.80	0.46	8.4	DS-1/AC-1s
WS110	0.50	0.042	7.9	DS-1/AC-1s
WS111	2.60	0.021	8.3	DS-1/AC-1s
TP102	0.50	0.14	8.7	DS-1/AC-1s
TP103	0.50	0.065	8.7	DS-1/AC-1s



3.13. UNIAXIAL COMPRESSION TESTS ON ROCK

Uniaxial compression tests were performed on samples of sandstone obtained from the four rotary boreholes advanced on-site. Samples were carried out where single core lengths of >200 mm could be obtained. As the sandstone cores had significant fracturing (both naturally and drilling induced), the testing for UCS was limited. It is possible that additional samples may be viable if required.

The results of which are presented within Appendix VIII and are summarised in Table 3.10.

TABLE 3.10 SUMMARY OF UNIAXIAL COMPRESSION TESTS

LOCATION	DEPTH (m)	TEST TYPE	ORIENTATION	LOAD FAILURE (kN)	UCS - MPa
BH101	24.00 – 24.40	C	Unknown	55.7	9.8
BH102	9.30 – 9.55	C	Unknown	45.0	7.9
BH103	15.60 – 16.00	C	Unknown	21.5	3.8
BH104	24.55 – 24.90	C	Unknown	75.2	13.3

The results indicate a strength of between 3.8 and 13.3 (MPa) which equates to 3800–13300 kN/m².

3.14. POINT LOAD TESTS

Point index load tests were performed on samples of sandstone obtained from the four rotary boreholes advanced on-site to assess the suitability of the bedrock. The results of which are presented within Appendix VIII and are summarised in Table 3.11.

TABLE 3.11 SUMMARY OF POINT LOAD TEST DATA

LOCATION	DEPTH (m)	TEST TYPE	ORIENTATION	FAILURE LOAD (kN)	UNCORRECTED POINT LOAD STRENGTH INDEX (I ^s) - MPa	POINT LOAD STRENGTH INDEX (I ^{s50}) - MPa
BH101	20.00	A	Perpendicular	0.88	0.17	0.20
BH101	20.00	D	Parallel	0.57	0.079	0.10
BH101	23.00	A	Perpendicular	0.36	0.08	0.09
BH101	23.00	D	Parallel	0.24	0.033	0.04
BH102	8.10	A	Perpendicular	0.63	0.15	0.17
BH102	8.10	D	Parallel	0.41	0.057	0.07
BH102	12.80	A	Perpendicular	1.03	0.24	0.27
BH102	12.80	D	Parallel	0.87	0.120	0.15
BH103	18.95	A	Perpendicular	0.71	0.18	0.20
BH103	18.95	D	Parallel	0.37	0.051	0.07
BH104	28.00	A	Perpendicular	0.79	0.16	0.19
BH104	28.00	D	Parallel	0.47	0.065	0.08

The results of the point load tests indicate that at a depth of between 8.10 m bgl – 28.00 m bgl the bedrock recorded a strength of between 0.04 and 0.27 (MPa) which equates to 40–270 kN/m².



4. TIER I QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 1 qualitative risk assessment to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

4.1. HUMAN HEALTH RISK ASSESSMENT

At Tier 1 stage, the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published in LQM/CIEH S4UL (S4UL3267). The assessment has been completed by soil concentrations against residential with plant uptake as a conservative approach given the site will comprise residential dwellings.

Where Tier 1 screening values are not provided by LQM, other screening values have been used and these are referenced in Table 4.1.

The results of this comparison have been summarised in Table 4.1.



TABLE 4.1 SUMMARY OF INORGANIC AND HYDROCARBON TOXICITY ASSESSMENT FOR A RESIDENTIAL END USE

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PATH-WAY	ASSESSMENT
Arsenic	mg/kg	37	15	29	N/A	1	No Further Action
Cadmium	mg/kg	11	15	<0.2	N/A	1	No Further Action
Chromium (VI)	mg/kg	6.0	15	<4.0	N/A	1	No Further Action
Lead	mg/kg	200	15	170	N/A	1	No Further Action
Mercury	mg/kg	1.2	15	<0.3	N/A	2	No Further Action
Nickel	mg/kg	130	15	54	N/A	1	No Further Action
Selenium	mg/kg	250	15	<1.0	N/A	1	No Further Action
Copper	mg/kg	2400	15	170	N/A	1	No Further Action
Zinc	mg/kg	3700	15	120	N/A	1	No Further Action
Cyanide – Total	mg/kg	791	15	<1.0	N/A	1	No Further Action
Phenols – Total	mg/kg	120	12	<1.0	N/A	1	No Further Action
Asbestos	Fibres	NFD	8	NFD	N/A	3	No Further Action
Naphthalene	mg/kg	2.3	17	2.3	WS109 – 0.80m	4	Further Action
Acenaphthylene	mg/kg	170	17	<0.05	N/A	2	No Further Action
Acenaphthene	mg/kg	210	17	2.3	N/A	1	No Further Action
Fluorene	mg/kg	170	17	1.3	N/A	1	No Further Action
Phenanthrene	mg/kg	95	17	10	N/A	2	No Further Action
Anthracene	mg/kg	2400	17	2.0	N/A	2	No Further Action
Fluoranthene	mg/kg	280	17	9.8	N/A	2	No Further Action
Pyrene	mg/kg	620	17	8.7	N/A	2	No Further Action
Benzo(a)Anthracene	mg/kg	7.2	17	4.5	N/A	2	No Further Action
Chrysene	mg/kg	15	17	4.2	N/A	2	No Further Action
Benzo(b)Fluoranthene	mg/kg	2.6	17	4.4	WS111 – 0.80m	2	Further Action
Benzo(k)Fluoranthene	mg/kg	77	17	1.9	N/A	2	No Further Action
Benzo(a)Pyrene	mg/kg	2.2	17	4.0	WS111 – 0.80m	2	Further Action
Indeno(123-cd)Pyrene	mg/kg	27	17	2.2	N/A	2	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	0.24	17	0.53	WS111 – 0.80m	2	Further Action
Benzo(ghi)Perylene	mg/kg	320	17	2.6	N/A	2	No Further Action
TPH C5-C6 (aliphatic)*	mg/kg	42	17	<1.0	N/A	4	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	100	17	<0.1	N/A	4	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	27	17	<0.1	N/A	4	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	74	17	6.7	N/A	4	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	140	17	30	N/A	4	No Further Action
TPH C16-C21 (aromatic)*	mg/kg	260	17	760	WS108 - 5.60m	1	Further Action
TPH C21-C35 (aromatic)*	mg/kg	1100	17	2700	WS108 - 5.60m	1	Further Action



DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PATH-WAY	ASSESSMENT
2-Methylnaphthalene	mg/kg	720***	3	1.0	N/A	4	No Further Action
Dibenzofuran	mg/kg	230***	3	1.1	N/A	4	No Further Action
Carbazole	mg/kg	TBC	3	0.8	WS111 – 0.80m	4	Further Action

Notes

PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation; PL5 = Vertical / Lateral Migration; PL6 = Corrosion of concrete; PL7=Tainting of water supply; PL8 = Uptake by plants

Abbreviations: GAC = general assessment criteria, n = number of samples, MC = maximum concentration; Loc of Ex = location of exceedance; NFD = no fibres detected.

* The Tier 1 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. E3P has utilised the Tier 1 values for aliphatic compounds for the volatile and semi volatile fractions (C5-C12) and the Tier 1 values for aromatic compound for the non-volatile fractions (C12-C35). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

** Atkins ATRISK

*** USEPA Risk Management Levels

Referring to Table 4.1, the result of this direct comparison indicates that the data exceeds the screening criteria for a residential end-use for the following contaminants:

- ☛ Naphthalene
- ☛ Benzo(b)Fluoranthene
- ☛ Benzo(a)Pyrene
- ☛ Dibenzo(a,h)Anthracene
- ☛ TPH C16-C21
- ☛ TPH C21-C35
- ☛ Carbazole

Asbestos has not been identified in any of the soils submitted for analysis.

No significant concentrations of VOCs were identified in the soils submitted for chemical analysis.

The laboratory analysis confirms the assessment within the initial conceptual site model that the main constituents of concern were likely to be PAHs, SVOCs, hydrocarbon compounds and heavy metals.

In relation to these exceedances, the following can be determined:

- ☛ The main exposure pathways based on the Tier I exceedances are:
 - Soil ingestion;
 - Dermal Contact and Ingestion;
 - Vapour inhalation (indoor).



HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

The identified elevated concentrations have primary exposure pathways related to soil ingestion (TPH), dermal contact and ingestion (PAH), and indoor vapour inhalation (naphthalene and carbazole).

The risk to chronic human health associated with the elevated concentrations on inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed landscaping and public open space to remove any potential for direct exposure to impacted soils.

The specific design and installation process for the appropriate cover systems will be clearly defined within the site remediation and enabling works strategy.

Naphthalene has been identified within one isolated location on site (WS109 at 0.80 m bgl) and presents a risk of vapour inhalation. This material is currently capped by hardstand and therefore does not present a risk to current site users. As the proposed development comprises residential apartments, this material will require delineation and removal in its entirety from the footprint of the buildings to render the site suitable for residential development. The materials would likely be suitable for retention within areas of Public Open Space (POS).

TPH C16-C21 and TPH C21-C35 have been identified in one location on site (WS108 at 5.60 m bgl), however the pathway for these compounds is dermal contact and ingestion and given the depth of the identified impact (>5.00 m bgl), it is unlikely that this will pose a future risk to the proposed development in terms of human health. As such it is not considered that further works in this area are required; during remediation and enabling works further investigation within this area should be completed to confirm it is not part of a wider hydrocarbon plume.

Carbazole above the limit of detection were identified within WS111 at 0.80m at a concentration of 0.80 mg/kg.

Carbazole is a non-threshold substance and is a white, crystalline solid. It has a characteristic odour. It is a product of incomplete combustion of organic matter and occurs in petroleum, coal, peat, crude oil and coal tar.

There is no toxicological data available to inform the preparation of a robust site-specific risk based assessment criteria that would model the potential for ingress of vapour to indoor air.

The US national library for medicine confirms:

"Carbazole released to air will also be in or on particles that eventually fall to the ground. It is expected to be broken down by sunlight, depending on environmental conditions. It will not move into air from moist soil and water surfaces."

If released to soil, carbazole can have high to no mobility based upon a Koc range of 114-4980, with most values suggesting low mobility to immobility. Volatilisation from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 1.16×10^{-7} atm-cu m/mole. Carbazole is not expected to volatilise from dry soil surfaces based upon its vapour pressure.

It is accepted that carbazole is a non-threshold substance, however, it will be encapsulated in soils with a temperature in the region of 10°C, furthermore given that it is highly unlikely to move into the ambient air via a vapour phase migratory pathway from a soil or water there cannot be a complete pollutant linkage in this instance.

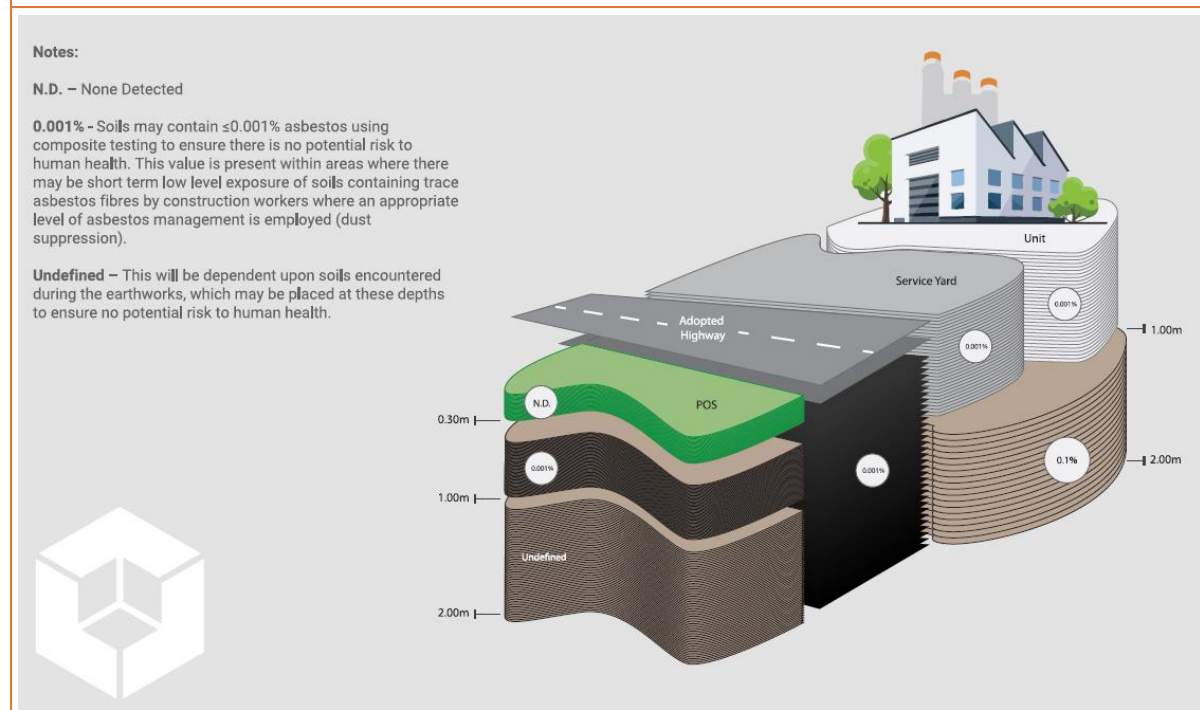
The recorded concentration is marginally above the limit of detection for the analytical method.



Carbazole can also be banded with dibenzofuran due to the absence of a GAC. Based on the threshold of 230 mg/kg, the concentrations within WS111 are not considered to be exceeding and will not present a risk to future end-users.

Asbestos was identified as a potential contaminant based on the historic site use however no asbestos was identified within the 8 samples analysed and no visual ACM was noted during the intrusive works. During remediation and enabling works, further testing of Made Ground will likely be required to confirm the findings of the ground investigation. Should any ACM be identified, this should be analysed and either appropriately placed on site in line with the E3P Asbestos Conceptual Site Model (see Figure 4.1) or removed from site by a licensed waste contractor.

FIGURE 4.1 ASBESTOS RISK MITIGATION CONCEPTUAL SITE MODEL



Chemical analysis of the natural drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas with the exception of drift deposits noted to contain hydrocarbon impact; however, further chemical validation samples will be required to confirm this. The use of the natural clay soils will also be dependent on the requirements for the site as there is significant depths of Made Ground encountered across the majority of the site therefore the cut/fill works to 'win' the subsoil may be significant.

There are no suitable sources of topsoil available on the site.



4.2. CONTROLLED WATERS RISK ASSESSMENT

E3P has undertaken a controlled waters risk assessment for the site based on the consideration of the conceptual site model and the sensitive receptors which are summarised in Table 4.2.

TABLE 4.2 CONTROLLED WATERS CONCEPTUAL MODEL AND SENSITIVITY PROFILE

DISCUSSION		SENSITIVITY RATING
Contaminant Source		
Made Ground The historical construction and redevelopment activities (construction and demolition of former buildings and possible cut/fill earthworks) on-site may have generated significant amounts of Made Ground that could contain contaminants such as inorganic heavy metals and polycyclic aromatic hydrocarbons (PAHs). The Made Ground is anticipated across the entire site.		High
Former Manufacturing Processes (Printworks, garage, factory) Given the various manufacturing processes that have been undertaken on-site previously, there is a potential for halogenated solvents and chlorinated hydrocarbons associated with the former print works, various works, factories, garage and oil store.		High
Former Brewery and other Industrial Activities Former industrial activities on the site associated with various works, brewery, boot repairs, warehouses, factories, mortar mill, garage and an oil store are considered to have been sources of hydrocarbons or solvents on-site. It is likely given the types of former development that UST or ASTs have been present on the subject site likely to contain fuel or oils for heating, degreasing agents or lubrication		High
Pathway		
Vertical Migration Bedrock has been identified at shallow depths between 4.60 m bgl and 6.70 m bgl across the site which is underlying variable interbedded CLAY and SAND deposits. CLAY deposits encountered within 10 exploratory hole locations are considered to be of low permeability, therefore, restricting the vertical movement of groundwater and any soluble phase contaminants to the underlying principal aquifer. Where CLAY deposits are not present and where permeable SAND and GRAVEL is recorded, this stratum will typically provide a preferential pathway for any dissolved phase contaminants directly to the underlying aquifer. Within three locations, the Made Ground has been proven to be in direct contact with granular drift deposits and subsequently the bedrock.		High
Lateral migration Given the variable interbedded SAND and CLAY drift deposits recorded across the site, the lateral migration of groundwater with any dissolved phase contaminants is possible, particularly through the granular strata where a preferential pathway is provided. The CLAY deposits are low-permeability and will somewhat restrict the lateral migration of contaminants to any adjacent surface water features.		Medium
Receptor		
Aquifer Classification in Superficial Drift Deposits	The site is underlain by a secondary undifferentiated/secondary A drift aquifer and in turn underlain by a principal bedrock aquifer meaning the site is located within a potentially highly sensitive area with respect to groundwater.	High
Aquifer Classification in Bedrock		



Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not located within a groundwater source protection zone.	Low
Distance to the Closest Groundwater Abstraction Point	The closest potable abstraction points, recorded to be between 8 m and 51m from the site, are associated with a former brewery (Strangeways Brewery) which is no longer present, and the area is being redeveloped. The next recorded abstraction points are located 480 m northeast and 486 m north of the site relating to process water for a brewery (Joseph Holt Brewery) and potable water for a dairy (Lancashire Daires Ltd), respectively.	Low
Is the Site Located Within 50 m of a Surface Watercourse?	The River Irwell is located in excess of 150m west of the site and therefore is not considered to be a sensitive receptor.	Low
The ICSM developed within the context of the site setting has viable pollutant pathway, which would be the downward migration of potentially mobile phase-soluble contaminants towards the underlying principal aquifer.		

To ensure a robust appraisal of the identified risk to controlled waters, E3P has identified the sources of potential contamination that represent a risk to controlled waters from the initial CSM, we have then assessed the availability of ground investigation data in the form of analysis of the solid phase (soil) and dissolved phase within the perched groundwater or aquifer. The results of this assessment are presented in Table 4.3.

TABLE 4.3 QUALITATIVE RISK TO CONTROLLED WATERS FROM SOIL ANALYTICAL RESULTS

CONTAMINANT	ASSESSMENT RATING	DISCUSSION
BTEX > 1 mg/kg	The soil data analysis has not identified any detectable concentrations of VOCs above 1mg/kg or TPH C5 to C6 that might otherwise be indicative of VOC impact. No concentrations of VOCs above the limit of detection have been identified.	None
Total VOC > 1 mg/kg		
Total SVOC > 1 mg/kg	SVOC analysis recorded concentrations > 1mg/kg within one location (WS111 – 0.80 m bgl) with a total SVOC of 2.9 mg/kg. The remaining concentrations were all below the laboratory LOD.	Further discussion
C5-C10 > 5 mg/kg	All concentrations are below or slightly exceeding the laboratory LOD.	None
C10-C12 > 10 mg/kg	All concentrations are <10 mg/kg with the majority below the laboratory LOD.	None
C12-C16 > 50 mg/kg	All concentrations are <30 mg/kg with the majority below the laboratory LOD.	None
Phenols > 2 mg/kg	All concentrations are below the laboratory LOD.	None
Naphthalene > 2 mg/kg	Naphthalene has been recorded at 2.3 mg/kg within one location on site (WS109 – 0.80 m bgl) with the majority of concentrations below the laboratory LOD.	Further discussion
Total PAH > 10 mg/kg	Concentrations of total PAH have been identified at 60 mg/kg within WS111 (0.80 m bgl). The remaining concentrations are all recorded to be <10 mg/kg.	Further discussion
PCB > 1 mg/kg	No potential sources of PCB have been identified on site	None



Heavy metals > 500 mg/kg	All concentrations of heavy metals are recorded at <500 mg/kg.	None
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The Tier I assessment has included a comparison of leachate analysis from samples of the Made Ground and groundwater samples to drinking water standards in the first instance and where GAC values are not available, to environmental quality standards (EQS).

These are presented in Table 4.4.



TABLE 4.4 COMPARISON OF GROUNDWATER AND LEACHATE ANALYSIS WITH TIER 1 SCREENING LEVELS

DETERMINAND	UNIT	EQS ^{1,2,3}	DWS _{3,4,5}	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA								
Arsenic	µg/l	50	10	1	0.47	N/A	3	7.4	N/A	No Further Action
Cadmium	µg/l	0.08-0.25	5	1	0.06	N/A	3	<0.08	N/A	
Chromium (VI)	µg/l	3.4	–	1	<5.0	N/A	3	<5.0	N/A	
Chromium (III)	µg/l	4.7	50	1	3.9	N/A	3	3.4	N/A	
Copper	µg/l	1	2000	1	3.0	N/A	3	5.1	N/A	
Total Cyanide	µg/l	1	50	1	<1.0	N/A	3	<1.0	N/A	
Lead	µg/l	1.2	10	1	0.2	N/A	3	2.7	N/A	
Mercury	µg/l	–	1.0	1	<0.05	N/A	3	<0.5	N/A	
Nickel	µg/l	4	20	1	4.3	N/A	3	3.2	N/A	
Selenium	µg/l	–	10	1	11	WS108	3	<4.0	N/A	Further Action
Zinc	µg/l	10.9	–	1	9.6	N/A	3	8.8	N/A	No Further Action
pH	6–9			1	7.3	N/A	3	7.3–8.4		
Naphthalene	µg/l	2	10*	1	<0.01	N/A	3	<0.01	N/A	
Anthracene	µg/l	0.1	10*	1	<0.01	N/A	3	<0.01	N/A	
Benzo[b]fluoranthene	µg/l	0.00017*	10*	1	<0.01	N/A	3	<0.01	N/A	
Benzo[k]fluoranthene	µg/l	0.00017*	10*	1	<0.01	N/A	3	<0.01	N/A	
Benzo(a)pyrene	µg/l	0.00017*	10*	1	<0.01	N/A	3	<0.01	N/A	
Indeno(123-cd)pyrene	µg/l	0.00017*	10*	1	<0.01	N/A	3	<0.01	N/A	
Fluoranthene	µg/l	0.0063	10*	1	<0.01	N/A	3	<0.01	N/A	



DETERMINAND	UNIT	EQS 1, 2, 3	DWS 3,4,5	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA								
Benzo(ghi)perylene	µg/l	1.7–4	10*	1	<0.01	N/A	3	<0.01	N/A	No Further Action
TPH Aromatic										
TPH C5-C6 (benzene)	µg/l	10	1	1	<1.0	N/A	3	<1.0	N/A	No Further Action
TPH C6-C8 (toluene)	µg/l	74	700	1	<1.0	N/A	3	<1.0	N/A	
TPH C8-C10 (ethyl benzene)	µg/l	20	300	1	<1.0	N/A	3	<1.0	N/A	
TPH C10-C12 (xylene)	µg/l	30	500	1	<10	N/A	3	<10	N/A	
TPH C10-C12 (xylene)	µg/l	30	500	1	<10	N/A	3	<10	N/A	
TPH C12-C16	µg/l	2	90 ⁵	1	<10	N/A	3	<10	N/A	
TPH C16-C35	µg/l	50#	90 ⁵	1	<10	N/A	3	<10	N/A	
TPH Aliphatic										
TPH C5-C6	µg/l	–	15000	1	<1.0	N/A	3	<1.0	N/A	No Further Action
TPH C6-C8	µg/l	–	15000	1	<1.0	N/A	3	<1.0	N/A	
TPH C8-C10	µg/l	–	300	1	<1.0	N/A	3	<1.0	N/A	
TPH C10-C12	µg/l	–	300	1	<10	N/A	3	<10	N/A	
TPH C12-C16	µg/l	–	300	1	<10	N/A	3	<10	N/A	
TPH C16-C21	µg/l	–	300**	1	200	N/A	3	<10	N/A	
TPH C21-C35	µg/l	–	300**	1	2100	WS108	3	<10	N/A	Further Action

Notes

Solubility <0.01µg/l

AA – Annual Average

MAC- Maximum Admissible Concentration

* Polyaromatic hydrocarbons (PAH) - Benzo(a)pyrene (BaP), Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the biota EQS or the corresponding AA-EQS in water



** There are no WHO Guideline Values for aliphatic fractions C16-C21 and C21-C35, therefore the guideline value for aliphatic fractions inclusive of C8-C16 (300µg/l) has been applied.

1. The Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations (2015)
2. Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)
3. Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances
4. Council Directive on the quality of water intended for human consumption (Drinking Water Directive)
5. WHO Guidelines for Drinking Water Quality. Third edition (2004)



4.2.1. CONTROLLED WATER RISK ASSESSMENT AND MITIGATION

A comparison of leachate samples and groundwater samples has been carried out against Drinking Water Standards (DWS) as the underlying aquifers have been identified as potential sensitive receptors. The following contaminants have been identified at levels exceeding the respective DWS levels.

- ✿ Selenium (Groundwater (WS108) – DWS)
- ✿ TPH Aliphatic C21-C35 (Groundwater (WS108) – DWS)

The elevated concentrations of selenium are considered marginal and likely to be associated with the deep Made Ground in this location.

Elevated TPH Aliphatic C21-C35 within WS108 are considered to be associated with the hydrocarbon impacted SAND deposits. The CL:AIRE *Petroleum Hydrocarbons in Groundwater* guidance document shows the mobility ranking of TPH carbon bandings; TPH Aliphatic C21-C35 are not included however TPH Aliphatic C16-C21 are considered to have a very low sorption ranking and potential mobility ranking, and overall relative mobility in groundwater assessed as being very low. Given the elevated TPH bandings identified in the groundwater analysis it is considered they will have low mobility so are unlikely to migrate. The groundwater samples were obtained using a low flow technique, and it is recommended further monitoring is completed across the site to understand if there is site wide impact.

It should be noted that the elevated concentrations of selenium and TPH Aliphatic C21-C35 are typically considered to be of low mobility.

The site is underlain by a secondary undifferentiated/secondary A drift aquifer and principal bedrock aquifer meaning the site is located within a potentially highly sensitive area with respect to groundwater. However, the closest potable abstraction points, recorded to be between 8 m and 51 m from the site, are associated with a former brewery (Strangeways Brewery) which is no longer present, and the area is being redeveloped. E3P has not been made aware that these abstraction points have been decommissioned following the demolition of the brewery. No new groundwater abstraction licenses are recorded for the development therefore it is anticipated that these are no longer active and can be disregarded from this assessment. It should be noted that the boreholes will have previously acted as preferential pathway.

The next recorded abstraction points are located 480 m northeast and 486 m north of the site relating to process water for a brewery (Joseph Holt Brewery) and potable water for a dairy (Lancashire Dairies Ltd), respectively. Given the substantial distance from the site, these are not considered to be within influencing distance of the site and therefore are not deemed to be at risk from the identified contaminants.

The River Irwell is located in excess of 150m west of the site and therefore is not considered to be a sensitive receptor.

Based on the above assessment, there is considered a low risk to controlled waters from the identified determinants however further groundwater monitoring should be completed to confirm the site poses a low risk.



4.3. GROUND GAS

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 – *Assessing risks posed by hazardous ground gases to buildings* (2007). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

4.1. INVESTIGATION RATIONALE

The ICSM has identified that the underlying Made Ground may represent a potential source of ground gas generation. Volatile compounds may also be present in relation to the potential halogenated solvents and chlorinated hydrocarbons underlying the site however the historic sources identified on-site are limited. Based on the identification of these sources, E3P has determined that the site represents a low ground gas source generation potential.

Within the context of the proposed residential end-use and ground gas generation potential, the gas assessment requires that 6 visits are required over 3 months, with at least two sets of readings at low or falling atmospheric pressure as set out within CIRIA 665 Tables 5.5a and 5.5b.

The spacing requirements for monitoring wells are detailed within CIRIA 665 Table 4.2, which indicates that for low gas hazard sites (Made Ground with limited degradable material, organic clay of limited thickness) and a high sensitivity development, nominal well spacing should be between 25 m and 50 m.

TABLE 4.5 GROUND GAS MONITORING LOCATION RATIONALE

LOCATION	GROUND GAS SOURCE	DEPTH OF MONITORING WELL (m)
WS103	Natural CLAY / deeper groundwater well	1.00-4.00
WS105	Made Ground	0.50-2.00
WS108	Made Ground / Hydrocarbon odour within natural SAND / deeper groundwater well	1.00-6.00
WS109	Made Ground	0.50-2.50
WS111	Made Ground / Natural SAND / Deeper Groundwater Well	1.00-4.00
BH102	Natural CLAY / Deeper Groundwater Well	3.50-5.50
BH103	Natural SAND and GRAVEL / Deeper Groundwater Well	3.50-4.50

4.2. MONITORING METHODOLOGY

Concentrations of methane (CH₄), carbon dioxide (CO₂) and oxygen (O₂) were measured using a calibrated infra-red gas analyser (GFM435) with gas flow rates were measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 300 seconds at each location, at which point the maximum concentration of CH₄ and CO₂, together with the lowest concentration of O₂ were recorded. The results of the ground gas monitoring are presented in Table 4.7.



The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 – *Assessing risks posed by hazardous ground gases to buildings* (2007) due to the proposed construction of the development. However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

CIRIA C665 and NHBC Report No 10627-R01 provide assessments for carbon dioxide and methane based upon gas screening values (GSVs) utilising flow rates and concentrations. The site-based GSVs for steady state methane and carbon dioxide are based upon the following equation:

$$GSV = \frac{\text{concentration (by vol)}}{100} \times \text{flowrate (1 / hr)}$$

The GSVs within CIRIA C665 are based upon all buildings other than standard residential houses. The thresholds for GSVs based upon CIRIA guidance are provided within Table 4.6 (below). Given the proposed development it is likely the structures will be designed in such a way that there is unlikely to be a sub-floor void and as such CIRIA guidance has been followed rather than NHBC guidance. Should the development be constructed using a sub-floor void the gas risk assessment should be completed in relation to NHBC guidance.

TABLE 4.6 THRESHOLDS FOR GAS SCREENING VALUES (GSV) IN ACCORDANCE WITH CIRIA C665

CIRIA – NO SUBFLOOR VOID	
CLASSIFICATION	GSV (METHANE AND CARBON DIOXIDE)
CS1	< 0.07
CS2	< 0.70
CS3	< 3.5
CS4	< 15
CS5	< 70
CS6	> 70

4.2.1. SUMMARY OF MONITORING RESULTS

Table 4.7 presents the ground gas and groundwater monitoring results to date.



TABLE 4.7 SUMMARY OF GROUND GAS MONITORING RESULTS

WELL	DATE	CH ₄ INITIAL (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ GSV (l/hr)	CO ₂ INITIAL (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ GSV (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)										
WS103	05/11/2021	0.1	0.1	0.0036	0.1	0.1	0.0036	18.8	1020	Steady	3.6	1.00-4.00	3.76	0.79										
	18/11/2021	0.1	0.1	0.0001	0.1	0.1	0.0001	18.4	1020	Steady	0.1		3.70	1.10										
	23/11/2021	0.1	0.1	0.0001	0.1	0.1	0.0001	18.6	1020	Steady	0.1		3.70	1.30										
WS105	05/11/2021	Monitoring well inaccessible due to vehicle										0.50-2.00	3.60	3.40										
	18/11/2021												3.60	3.40										
	23/11/2021												–	–										
WS108	05/11/2021	0.1	0.1	0.0001	1.9	1.9	0.0019	10.8	1020	Steady	0.1	1.00-6.00	5.35	4.80										
	18/11/2021	0.1	0.1	0.0001	2.1	1.8	0.0021	13.2	1021	Steady	0.1		5.30	4.15										
	23/11/2021	Monitoring well inaccessible due to vehicle											–	–										
WS109	05/11/2021	0.1	0.1	0.0001	2.3	2.3	0.0023	14.9	1020	Steady	0.1	0.50-2.50	2.25	2.20										
	18/11/2021	0.1	0.1	0.0001	2.0	1.9	0.0020	15.5	1020	Steady	0.1		2.25	Dry										
	23/11/2021	Monitoring well inaccessible due to vehicle											–	–										
WS111	05/11/2021	Monitoring well inaccessible due to vehicle										1.00-4.00	–	–										
	18/11/2021												0.1	0.1	0.0001	1.9	1.5	0.0019	18.6	1022	Steady	0.1	4.30	Dry
	23/11/2021												0.1	0.1	0.0001	2.2	2.2	0.0022	17.2	1020	Steady	0.1	4.30	3.90
BH102	05/11/2021	0.1	0.1	0.0001	0.1	0.1	0.0001	20.2	1019	Steady	0.1	3.50-5.50	4.70	Dry										
	18/11/2021	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	1020	Steady	0.1		4.65	4.10										
	23/11/2021	0.1	0.1	0.0001	0.1	0.1	0.0001	19.7	1021	Steady	0.1		4.70	Dry										



WELL	DATE	CH ₄ INITIAL (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ GSV (l/hr)	CO ₂ INITIAL (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ GSV (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
BH103	05/11/2021	Monitoring well inaccessible due to vehicle										3.50-4.50	-	-
	18/11/2021												-	-
	23/11/2021												-	-

NOTES

Values in **BOLD** exceed CS1 Thresholds

Values in **BLUE** denote water above monitoring well



4.2.2. SOURCES OF GROUND GAS

The Phase I report and subsequent ground investigation has identified the following potential sources of ground gas:

- ✳ Made Ground deposits;
- ✳ Volatile Compounds (within Made Ground); and
- ✳ Infilled ground (off-site).

4.2.3. GROUNDWATER

Groundwater was typically encountered at depths in excess of 3.00 m bgl with the exception of WS103 where groundwater was recorded at 0.79 m bgl in the first visit which indicated the well was flooded above the response zone during this visit. No other occurrences of flooded wells have been noted in the monitoring to date.

Groundwater levels only appeared to fluctuate slightly within the monitoring visits to date and typically remained within 1.00m of the base of the well. The greatest groundwater change occurred within WS108 where levels increased by 0.65 m over two monitoring visits.

4.2.4. GAS FLOW

During the monitoring a positive flow was noted within all monitoring locations typically recorded as 0.1 l/hr however a flow of 3.6 l/hr was recorded during the initial monitoring visit within WS103.

4.2.5. GAS CONCENTRATIONS

Methane has not been recorded above the limit of detection (LOD) within any monitoring locations during the initial monitoring visits completed to date.

Carbon dioxide concentrations were recorded within all the monitoring wells at concentrations ranging from 0.1% v/v (LOD) to 2.3 % v/v (WS109). The maximum carbon dioxide levels were also associated with low oxygen concentrations and appear to be associated with Made Ground, identified in WS109.

4.2.6. GAS ASSESSMENT

In accordance with the methodology outlined with the CIRIA publication C665, E3P has utilised the results of the ground gas monitoring surveys to calculate a tentative gas screening value (GSV). The GSVs for the monitoring positions are summarised in Table 4.8.

TABLE 4.8 GAS RISK PROFILE AND LOCATION

LOCATION	MAX CH ₄ (% v/v)	GSV (l/hr)	MAX CO ₂ (% v/v)	GSV (l/hr)	CLASSIFICATION
WS103	0.10	0.0036	0.10	0.0036	CS1
WS105	Monitoring well inaccessible due to vehicle				
WS108	0.10	0.0001	2.10	0.0021	CS1
WS109	0.10	0.0001	2.30	0.0023	CS1



LOCATION	MAX CH ₄ (% v/v)	GSV (l/hr)	MAX CO ₂ (% v/v)	GSV (l/hr)	CLASSIFICATION
WS111	0.10	0.0001	2.20	0.0022	CS1
BH102	0.10	0.0001	0.10	0.0001	CS1
BH103	Monitoring well inaccessible due to vehicle				

The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.

Preliminary ground gas monitoring suggests that the site can be predominantly classified as CS1, and it is considered that ground gas protection measures will not be required. The final ground gas protection measures will need to be confirmed upon completion of the full ground gas monitoring programme. The final results will be issued as an addendum to this report.



4.3. POTABLE WATER SUPPLY

This section provides a summary of the site investigation data with reference to the selection of potable water supply pipework. The assessment is made with reference to the UK Water Industry Research (UKWIR) publication "Guidance on the selection of Water Supply Pipes to be used in Brownfield Sites".

Under the scope of these works, a UU Risk Assessment has been carried out based on the current ground conditions which is presented in Appendix XI and summarised below.

TABLE 4.9 PIPELINE SELECTION PE THRESHOLD CONCENTRATIONS

Contaminant Group	PE-threshold (mg/kg)	Concentrations at <u>Current</u> pipeline depth (mg/kg)
Total VOC	0.5	<1.0
Total BTEX And MTBE	0.1	<1.0
Total SVOCs (Excluding PAH and those substances marked with an *)	2	2.9
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2	<1.0
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10	17
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	1673
Phenols (From SVOC Analysis)*	2	<1.0
Cresols and Chlorinated Phenols (From SVOC Analysis)	2	NA
Ethers*	0.5	NA
Nitrobenzene*	0.5	NA
Ketones*	0.5	NA
Aldehydes*	0.5	NA
Amines	Fail	NA
Other Consideration		
Are there any exceedances of the PE threshold outside of the pipeline depth?	Yes – Elevated levels of TPH EC10-EC40 have been identified at a depth of 5.60 m bgl within one location (WS108).	
Is free product present in soil and groundwater?	Localised free product is likely present in 5.60 m bgl (WS108).	
Could hydrocarbon impact at greater depth than current pipeline depth be mobilised by rising groundwater levels?	Groundwater levels have been encountered between the depths of 0.79 m bgl and 4.80 m bgl. Where impact has been identified at greater depths than pipeline depths (WS108 – 5.60 m bgl), it is possible for this to be mobilised by rising groundwater. The underlying clay deposits will somewhat mitigate the movement of the groundwater and therefore the mobilisation of impact.	
Will soils impacted with above determinands likely be utilised elsewhere on site?	This is currently unknown but likely.	



Will soils be imported to site as part of any future earth works

Currently unknown, should materials be imported to site and placed at pipeline depth they may affect the UKWIR.

Notes - Pipe line depth normally between 0.75m–1.35m

Based on the assessment of current site conditions it is likely that barrier pipe will be required at the proposed development. Remediation and enabling works will be carried out on site which may alter the current ground conditions. Post-remediation sampling will be required to re-inform the UKWIR assessment for the final pipe selection.



4.4. CONCEPTUAL SITE MODEL

Following the completion of the intrusive site investigation, chemical analysis and risk assessment, the conceptual model shown in Table 4.10 has been prepared for the site. A Conceptual Site Model Drawing is also presented in Appendix III (Drawing Ref: 15-175-010).

TABLE 4.10 CONCEPTUAL MODEL

POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
PL1 PL2	Non-volatile PAHs and heavy end TPHs (Made Ground, former works, brewer, tanks, oil storage etc.)	Dermal contact and ingestion. Soil ingestion.	Future site users. Off-site receptors.	Likely	High	LOW
Discussion: The site has been heavily developed since the mid-1800s resulting in significant depths of Made Ground across the site. Non-volatile PAHs and TPHs have been identified at levels exceeding the threshold for residential end-use. TPH C16-C35 has been identified within WS108 at 5.60 m bgl within natural SAND deposits noted to be impacted with hydrocarbons, and non-volatile PAHs have been identified within WS111 at 0.80 m bgl within Made Ground deposits. Recommendation: A chemically suitable cover system to landscaped areas or areas of public open space where impacted Made Ground is present will remove the pathway for dermal contact and ingestion, therefore, preventing exposure to future site users. The site is currently capped with hardstanding, therefore, removing the pathway for current site users; however, non-volatile PAHs may pose a short-term risk to construction workers who may come into contact with impacted soils during earthworks therefore, construction works should be completed with PPE and provision of suitable welfare.						



POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
PL3	ACM in Made Ground	Inhalation of dust.	Future site users. Buildings. Off-site land users.	Likely	Moderate	LOW

Assessment:

Asbestos has previously been noted to be present within the building fabric of previous developments on the site. Asbestos has not been identified in any of the samples analysed to date. ACM may be encountered during remediation and enabling works within the underlying Made Ground.

Recommendation:

If identified, ACM and or asbestos soils will require placement in accordance with the asbestos CSM and construction works completed with PPE and provision of welfare.

PL4	Volatile determinands such as hydrocarbons, solvents (Made Ground, mills, works, print works, factories)	Inhalation of vapours. Migration through permeable strata and preferential pathways.	Future site users. Off-site receptors.	Likely	Moderate	LOW
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Assessment:

Naphthalene has been identified within one isolated location on site, WS109, within shallow Made Ground at 0.80 m bgl.

Recommendation:

This material is currently capped by hardstand and therefore does not present a risk to current site users. As the proposed development comprises residential apartments, this material will require delineation and removal in its entirety to render the site suitable for residential development. During a process of cut/fill enabling works, a hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on-site in an area of no future sensitivity. A watching brief may be required during remediation and enabling works to assess the Made Ground to confirm no further impacted material is present indicated by visual and olfactory evidence.



POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
PL4	Methane, carbon dioxide (Made Ground, potentially infilled features on and within 250 m of the site)	Inhalation of gas. Migration through permeable strata and preferential pathways. Explosion in confined spaces.	Future site users. Buildings. Off-site land users.	Low likelihood	Moderate	LOW
Assessment: The preliminary ground has monitoring suggests that the site can be classified as CS1 and in these areas, it is considered that ground gas protection measures will not be required. However, this will be confirmed following the completion of all ground gas monitoring. Recommendation: The final ground gas monitoring regime will be confirmed upon completion of the monitoring.						
PL5	Mobile contaminants such as metals, PAHs, hydrocarbons, volatile compounds (Made Ground, mills, works, factories, printworks etc.)	Surface runoff. Migration through permeable strata and preferential pathways. Perched waters migration.	Groundwater (Principal aquifer).	Likely	Moderate	LOW



POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
Assessment: A comparison of leachate samples and groundwater samples has been carried out against Drinking Water Standards (DWS) as the underlying aquifers have been identified as potential receptors. Elevated levels of selenium and TPH Aliphatic C21-C35 have been identified within groundwater samples obtained from the monitoring well installed at WS108. The site is underlain by a secondary undifferentiated/secondary A drift aquifer and underlying principal bedrock aquifer meaning the site is located within a potentially highly sensitive area with respect to groundwater. However, the closest potable abstraction points, recorded to be between 8m and 51m from the site, are associated with a former brewery (Strangeways Brewery) which is no longer present, and the area is being redeveloped. E3P have not been made aware that these abstraction points have been decommissioned following the demolition of the brewery. The next recorded abstraction points are located 480 m northeast and 486 m north of the site relating to process water for a brewery (Joseph Holt Brewery) and potable water for a dairy (Lancashire Daires Ltd), respectively. Given the substantial distance from the site, these are not within influencing distance of the site and therefore are not deemed to be at risk from the identified contaminants. The River Irwell is located in excess of 150m west of the site therefore is not considered to be a sensitive receptor. Recommendation: Based on the above assessment, there considered a low risk to controlled waters from the identified determinants however further groundwater monitoring should be completed to confirm the site poses a low risk given the identification of TPH compounds.						
PL6	Sulphate (potential ash within Made Ground)	Sulphate attack on concrete.	Building structure.	Likely	Moderate/Low	LOW
Assessment: The soils at the site meet class DS-1, AC-1s. Recommendation: Concrete should be designed in accordance with the chemical testing results.						



POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
PL7	Organic contaminants such as hydrocarbons, solvents (Made Ground, mills, works, factories, printworks etc.)	Ingestion of tainted water supply.	Future site users. Water pipes.	Likely	Moderate	LOW
Assessment: A UKWIR risk assessment has been completed for the site based on current ground conditions. Elevated concentrations of TPH and SVOC have been identified at the proposed pipeline depth (0.75 m – 1.35 m). Impact has also been identified at depths below proposed pipeline depth which may be mobilised by rising groundwater. Recommendation: Based on the assessment of current site conditions, it is likely that barrier pipe will be required. Post remediation sampling may be required to further inform the pipe assessment and the requirements for the proposed development.						
PL8	Phytotoxic contaminants (Made Ground)	Direct Contact (plant uptake).	Flora.	Likely	Low	LOW
Assessment: Contamination has been encountered within shallow Made Ground across the site which may be taken up by flora in soft landscaping. Recommendation: Installation of a clean cover system within any areas of soft landscaping to prevent plant uptake of contaminants.						

Main exposure pathways:

PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation; PL5 = Vertical / Lateral Migration; PL6 = Corrosion of concrete; PL7=Tainting of water supply; PL8 = Uptake by plants;



5. GEOTECHNICAL ASSESSMENT

5.1. PROPOSED DEVELOPMENT

E3P understands that Latimer Developments Ltd is involved with a proposed scheme to redevelop the site for residential use. Assael Architects have completed a feasibility study for a car-free development comprising 442 homes and commercial spaces. The development will comprise two main blocks with differing number of stories, between 1 story and 27 stories.

The site forms part of the adopted Great Ducie Street Strategic Regeneration Framework Masterplan, bringing forward the redevelopment of the former Boddingtons Brewery demolished circa 10 years ago. The site has been purchased from LTE Group (trading as Manchester College) who are delivering a new college facility on the southern part of the site, this is due for completion by summer 2022.

5.2. SUMMARY OF GROUND CONDITIONS

MADE GROUND

Made Ground was encountered within all exploratory hole locations to a maximum proven depth of 5.10 m bgl (WS108), however, typically Made Ground deposits were encountered at depths less than 3.00 m bgl.

The majority of locations comprised concrete or asphalt in the upper 0.3 m with the exception of WS101, WS102, WS104 and WS108 which comprised brown sandy gravel or gravelly sandy clay with gravel of brick, mudstone, concrete and sandstone.

The underlying Made Ground deposits generally comprised sandy gravel with brick, coal, sandstone, concrete and occasional clinker (TP102 and WS110) and metal (WS110). Reworked silty clay deposits were identified within TP102 (1.40-2.20 m bgl), WS105 (2.00-3.10 m bgl), WS108 (1.00-2.60 m bgl).

An organic odour was identified within Made Ground clay deposits in WS106 at 1.60-1.80 m bgl.

A Depth of Made Ground Plan is presented as Drawing 15-175-006 in Appendix III.

DRIFT DEPOSITS

Drift deposits were encountered within the majority of exploratory locations with the exception to those where the full depth of Made Ground could not be proven. Drift deposits were not encountered within TP102, TP103, WS101, WS102, WS109 and WS110.

Brown silty CLAY was encountered within ten exploratory hole locations between the depths of 0.40m bgl to a maximum encountered depth of 6.00 m bgl. CLAY deposits were generally firm to stiff, however soft very low strength CLAY was identified within WS105 at circa 5.00mbgl.

The CLAY deposits were typically identified to be underlain by a silty fine to medium SAND within four exploratory locations between depths of 1.80 m bgl to a maximum confirmed depth of 6.70 m bgl. SAND deposits were noted to be loose to medium dense. Loose SAND deposits were noted in BH102 at 2.00mbgl. and BH104 at 4.00mbgl.

A SAND and GRAVEL and GRAVEL band were noted within WS103 (1.65-1.80mbgl) and BH103 (3.50-4.60mbgl.)



A stiff to very stiff clayey SILT was identified in WS107 at 3.20-5.45mbgl.

SOLID GEOLOGY

Sandstone bedrock was encountered within four exploratory hole locations from 4.60 m bgl - 6.70 m bgl.

Deep rotary boreholes confirmed the presence of a weak to moderately strong sandstone bedrock to a maximum depth of 29.00 m bgl.

A Depth to Bedrock Plan is presented as Drawing 15-175-007 as an attachment to this letter.

GROUNDWATER

Groundwater strikes were encountered during the ground investigation at 2.00 m bgl and 3.10 m bgl. Initial monitoring visits indicate groundwater at depths between 0.80 m bgl and 4.80 m bgl however within the majority of locations groundwater is at a depth >2.00 m bgl.

5.3. SITE PREPARATION

The site should be cleared in accordance with Series 200 of the *Manual of Contract Documents for Highway Works (MCHW)*. This should include the following:

- ✦ Removal of all concrete hardstanding.
- ✦ Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill.
- ✦ Buried structures and old foundations are likely to be encountered on site. These should be excavated from below the proposed development footprint with the resulting void backfilled.

5.4. FOUNDATION CONDITIONS AND ASSESSMENT OF POTENTIAL BEARING CAPACITIES

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has undertaken an assessment of the net safe allowable bearing pressure (ABP) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum. The results of this assessment are summarised in Table 5.1.



TABLE 5.1 SUMMARY OF ABP

GRANULAR SOILS			
Description	Depth (Range m bgl)	Relative Density	Allowable Bearing Pressure (kN/m ²)
SAND	2.00 – 4.45	Loose	51 – 64
Silty SAND and GRAVEL	3.00-5.45	Medium Dense	105-211
Silty SAND	6.00-6.45	Dense	409
SANDSTONE	5.00–11.45	Dense	387–415
COHESIVE SOILS			
Description	Depth (range m bgl)	Undrained Shear Strength (Cu) (kN/m ²)	Allowable Bearing Pressure (kN/m ²)
Soft CLAY (1 Location – WS105)	5.00– 5.45	17	34
Firm low strength CLAY	2.00-4.45	22-38	45-78
Stiff medium strength CLAY	1.00-5.45	42-75	87-154
Very Stiff high to very high strength	3.00-5.45	80-173	165-356

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe net allowable bearing pressure, the suitable target founding stratum has been identified as the sandstone bedrock.

A programme of remediation and enabling works will be required to remove the extensive buried obstructions and cut/fill the site to provide suitable development platform levels.

As the proposed buildings will be up to 26 storeys, the structural loads will necessitate the use of piled foundations.

While a detailed assessment of pile depths and bearing capacity is beyond the scope of this report, piles would likely achieve a 'set' within the sandstone bedrock. Consideration of the effects of negative skin friction due to variability on the Made Ground and natural drift strata will be required.

Geotechnical testing undertaken on selected rock cores indicate a strength of between 3.8 and 13.3 MPa, equating to 3800–13300 kN/m² from UCS tests carried out at depths of between 9.30 m bgl and 24.40 m bgl. The results of the point load tests indicate that at a depth of between 10.80 m bgl – 16.47 m bgl the bedrock recorded a strength of between 0.04 and 0.27 (MPa) which equates to 40–270 kN/m².

A specialist piling contractor should undertake detailed designs and costs for a specialist piling technique and to allow them to reduce the factor of safety based on their extensive pile testing data.



5.5. GROUND FLOOR SLABS

Given the nature of the proposed high-rise residential development it is recommended that a ground bearing floor slab be utilised however, it will need to be constructed on a granular sub-base with the thickness designed by a structural engineer to ensure that settlement tolerances are taken into consideration.

To accommodate for differential settlement and slab failure, it is recommended further Plate Load Testing is undertaken on the sub-grade following the breaking out of hardstand and reduced level dig to understand settlement characteristics and inform a geotechnical design specification in order to engineer to the required level to support a proposed ground bearing slab.

A suspended floor slab may also be viable but will require specialist design by a structural engineer.

5.6. HEAVE PRECAUTIONS

Given that the underlying clay is of moderate volume change potential, heave precautions will be required to the internal face of a foundation. As cohesive deposits have been identified over shallow bedrock, with medium volume change potential, a specialist pile design is required in order to prevent pile failure generated from heave. Piles may need to be socketed into the underlying bedrock through CFA method or a sleeve design applied to a pile precast.

5.7. HIGHWAYS CONSTRUCTION

A programme of remediation and enabling works will be required to remediate the proposed road subgrade in accordance with the requirements of the Manual of Contract Documents for Highway Works Volume 1 Specification for Highway Works (Series 600-Earthworks) for a method compaction.

It is considered that the material can be re-engineered using method compaction to achieve a CBR in excess of 5% if works are completed in favourable climatic conditions.

5.8. DRAINAGE

The presence of substantial depths of Made Ground across some areas of the site may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

Results of the infiltration tests generally displayed a poor soakage potential.

The variability in ground conditions across the site with Made Ground to depths of between 0.50 m bgl to 3.50 m bgl, which is typically underlain by clay deposits with localised interbedded SAND and GRAVEL, the potential of identifying a suitable stratum with sufficient soakaway potential is limited.

As there is a significant volume of low permeability CLAY present on site, and as the lateral continuity of the Made Ground cannot be assured, it is not recommended that soakaways are utilised for disposal of surface water runoff.

The application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – Soakaway Design.



5.9. CONCRETE DURABILITY

Based upon the results of the chemical analyses it is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with the recommendations provided in BRE *Special Digest 1* (2005).

5.10. EXCAVATIONS

Made Ground was encountered to depths in excess of 2.00 m bgl within all three trial pits therefore excavations were unstable and sidewall collapse occurred within two locations.

Due to the depth and variability of the Made Ground and the likelihood of trench collapse, it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.

Site observations indicated that excavations should be feasible in the near-surface with normal plant; however, obstructions may be present in the near-surface, including former foundations and former floor slabs. Concrete slabs were encountered on-site to a maximum proven depth of 0.60 m bgl. It is anticipated that any obstructions will be grubbed out during the reduced-level dig for the substructure works.

If local pumping of groundwater is required during the advancement of excavations for the proposed foundations, then consideration should be given to the potential for dewatering gravels in the surrounding areas that may cause structural damage to building substructures in close proximity to the site.

TABLE 5.2 CIVIL ENGINEERING EXCAVATION RISK MATRIX

RISK ITEM	PRESENT	COMMENT
Running Sands	No	No running sand has been identified.
Minor Water Ingress	Yes	Minor water ingress will require localised dewatering/sump pumping during the construction of site drainage infrastructure.
Shallow Bedrock	Yes	Bedrock has been identified at depths in excess of 4.60 m bgl therefore, depending on final development levels and drainage requirements, the underlying bedrock may impede excavations and specialist equipment may be required.



5.11. CONSTRUCTION ACTIVITY AND INSPECTION

The following activities and inspections should be incorporated into the site works:

- ✿ Due to the variability of the soils at the site, it is recommended that sufficient allowance is made for the inspection of formations and sub-formations to foundations and pavement construction.
- ✿ Excavations where access is required should be subject to a risk assessment from a competent person and, where appropriate, mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 should be utilised.
- ✿ It is considered that dewatering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to the provision of space for settling tanks or an attenuation pond.
- ✿ Where access to confined spaces is required, appropriate mitigation measures should be addressed within the construction stage health and safety plan. Particular account should be taken of the gas results.
- ✿ The presence of potential contamination and mitigation measures should be addressed as part of the construction stage health and safety plan and should include measures to design out the risks, reduce their impact and, finally, to include the use of personnel protective equipment (PPE).



5.12. GEOTECHNICAL RISK REGISTER

POTENTIAL CONSTRAINT	ABNORMAL	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Remediation of contaminated soils		On site	TBC	Identified contaminants include Naphthalene, non-volatile PAHs and TPH within shallow Made Ground soils on site. Localised deeper impact has been encountered within the natural SAND at 5.60 m bgl. It is anticipated that during remediation and enabling works, the shallow naphthalene impact will be delineated in its entirety and the resulting void will be backfilled with suitable engineered fill. The TPH impact identified at 5.60 m bgl relates to soil ingestion and therefore does not pose a risk to the proposed site users therefore delineation is not required. If any additional impacted ground is identified during the remediation and enabling works, this will need further assessment and possibly delineation will be undertaken.
Bedrock		On-site	All	Shallow bedrock has been encountered at depths in excess of 4.60 m bgl. It is anticipated that dependent on final development levels, specialist measures may be required.
Cohesive Stratum overlying shallow Bedrock (<5.00m)		On-site	TBC	Where a potential for volumetric instability is present in cohesive deposits over shallow bedrock a specialist pile design is required in order to prevent pile failure generated from heave. Piles may need to be socketed into the underlying bedrock through CFA method or a sleeve design applied to a pile precast.
Obstructions		On-site	TBC	The site has been subject to significant historical development and, while above-ground structures have been removed, potential subsurface obstruction from relict foundations and slabs remain. Concrete has been identified at depths of circa 0.60 m bgl which will require removal in its entirety. All underground obstructions will require removal in order to provide a development platform.
Artificially levelled and filled platforms		N/A	N/A	The site has been developed for over 150 years therefore it is unclear as to the previous levelling and infill processes are undertaken on-site, however significant depths of Made Ground have been encountered so it is likely works have previously been completed.



POTENTIAL CONSTRAINT	ABNORMAL	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Retaining walls		Off-site (northeast)	N/A	A retaining wall is present off-site to the northeast. It is not anticipated that the retaining wall will impact the proposed development however its presence has been noted.
Trench collapse		All	TBC	Made Ground encountered within trial pits on-site was unstable and predominantly of a granular nature. It is anticipated that trench collapse is likely therefore mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 should be utilised.
Volume change potential clay		On site	TBC	Cohesive soils have been identified on site which have been proven to be of medium volume change potential.
Peat		N/A	N/A	Not identified.
Running sands		N/A	N/A	Data searches indicate low risk.
Ground dissolution		N/A	N/A	Data searches indicate no hazard.
Concrete design		On-site	All	Concrete to be designed to concrete classification DS-1, AC-1s based on current ground conditions.
Low-permeability ground		On site	All	The presence of low-permeability clay and variable depths of Made Ground is likely to preclude the use of soakaway drainage on site. The underlying cohesive and granular stratum have indicated a poor soakaway potential.
Services/sensitive structures		On site	TBC	Services are present underneath the site from historic developments. Redundant services require grubbing out in their entirety and backfilling with suitable engineered fill. If there are any sensitive services identified on-site that cannot be re-located or removed, piling may not be viable.
Abnormal foundation solutions		All	All	Shallow bedrock has been encountered on-site at depths in excess of 4.60 m bgl which has been identified as the suitable founding strata. The proposed development comprises a 26-storey building which will result in significant loadings onto the underlying strata therefore the bedrock has been assessed as the most suitable solution. A piled foundation will be required.



5.13. FURTHER WORKS

Based on the findings of the intrusive site investigation, the following additional works are recommended to be completed in due course:

-  Further investigation of inaccessible areas.
-  Specific foundation schedule (upon receipt of the final development levels).
-  Geotechnical earthworks strategy (infrastructure).
-  Remediation and enabling works strategy.
-  Construction phase Surface Water Management Plan.



6. CONCLUSIONS AND RECOMMENDATIONS

6.1. CONTAMINATED LAND ASSESSMENT

Human Health	The Tier I Human Health Risk Assessment has identified exceedances in Naphthalene, non-volatile PAH and TPH C16-C35 when compared to the relevant Tier I thresholds for residential end use. A conservative assessment has been completed using residential with plant uptake. The identified elevated concentrations have primary exposure pathways related to soil ingestion (TPH), dermal contact and ingestion (PAH), and indoor vapour inhalation (Naphthalene). The risk to chronic human health associated with the elevated concentrations on inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed landscaping and public open space to remove any potential for direct exposure to impacted soils. Naphthalene has been identified within one isolated location on site (WS109 at 0.80 m bgl) and presents a risk of vapour inhalation. This material is currently capped by hardstand and therefore does not present a risk to current site users. As the proposed development comprises residential apartments, this material will require delineation and removal in its entirety from the footprint of the buildings to render the site suitable for residential development. The materials would likely be suitable for retention within areas of Public Open Space (POS). TPH C16-C21 and TPH C21-C35 have been identified in one location on site (WS108 at 6.60 m bgl), however the pathway for these compounds is dermal contact and ingestion and given the depth of the identified impact (>5.00 m bgl), it is unlikely that this will pose a future risk to the proposed development in terms of human health. Chemical analysis of the natural drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas with the exception of drift deposits noted to contain hydrocarbon impact; however, further chemical validation samples will be required to confirm this. The use of the natural clay soils will also be dependent on the requirements for site as there is significant depths of Made Ground encountered across the majority of the site therefore the cut/fill works to 'win' the subsoil may be significant. There are no suitable sources of topsoil available on the site.
Controlled Waters	A comparison of leachate samples and groundwater samples has been carried out against Drinking Water Standards (DWS) as both the underlying aquifers have been identified as potential receptors. Elevated concentrations of selenium and TPH Aliphatic C21-C35 have been identified in groundwater within WS108. The determinants are typically considered low mobility.



Controlled Waters Cont.	The site is underlain by a secondary undifferentiated/secondary A drift aquifer and underlying principal bedrock aquifer meaning the site is located within a potentially highly sensitive area with respect to groundwater. However, the closest potable abstraction points, recorded to be between 8m and 51m from the site, are associated with a former brewery (Strangeways Brewery) which is no longer present, and the area is being redeveloped. E3P have not been made aware that these abstraction points have been decommissioned following demolition of the brewery. No new groundwater abstraction licenses are recorded for the development therefore it is anticipated that these are no longer active and as such the risk can be disregarded from this assessment. It should be noted that the boreholes will have previously acted as preferential pathway. The next recorded abstraction points are located 480 m northeast and 486 m north of the site relating to process water for a brewery (Joseph Holt Brewery) and potable water for a dairy (Lancashire Dairies Ltd), respectively. Given the substantial distance from the site, these are not within influencing distance of the site and therefore are not deemed to be at risk from the identified contaminants. The River Irwell is located in excess of 150m west of the site therefore is not considered to be a sensitive receptor. Based on the above assessment, there considered a low risk to controlled waters from the identified determinants however further groundwater monitoring should be completed to confirm the site poses a low risk.
Ground Gas	Ground gas monitoring (to date) indicates the site falls under Characteristic Situation 1 and protection measures are unlikely to be required should the site be redeveloped. This will need to be confirmed following completion of the ground gas monitoring.
Potable Water	Under the scope of these works, a UU Risk Assessment has been carried out based on the current ground conditions which is presented in Appendix XI. Based on the assessment of current site conditions and the presence of TPH and SVOCs within Made Ground at pipeline depth, it is likely that barrier pipe will be required at the proposed development. Remediation and enabling works will be carried out on site which may alter the current ground conditions. Post-remediation sampling may be required to re-inform the UKWIR assessment for the final pipe selection.



6.2. GEOTECHNICAL ASSESSMENT

The site has been subject to significant historical development and, while above-ground structures have been removed, potential subsurface obstruction from relict foundations and slabs remain. Concrete has been identified at depths of circa 0.60 m bgl; all underground obstructions will require removal in their entirety. During a phase of cut-and-fill enabling works to create a developable platform, all below-ground obstructions will require grubbing out to the base of the Made Ground to enable the construction of proposed plots.

As the proposed buildings will be up to 26 storeys, the structural loads will necessitate the use of piled foundations. While a detailed assessment of pile depths and bearing capacity is beyond the scope of this report, piles would likely achieve a 'set' within the sandstone bedrock. Consideration of the effects of negative skin friction due to variability on the Made Ground and natural drift strata will be required.

A specialist piling contractor should be contacted to obtain detailed designs and costs for a specialist piling technique and to allow them to reduce the factor of safety based on their extensive pile testing data.

Cohesive soils have been identified on site which have been proven to be of medium volume change potential. Where a potential for volumetric instability is present in cohesive deposits over shallow bedrock a specialist pile design is required in order to prevent pile failure generated from heave. Piles may need to be socketed into the underlying bedrock through CFA method or a sleeve design applied to a pile precast.

END OF REPORT



APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the client as indicated in Section 1.3.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information, it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.
8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.
10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.



APPENDIX II

GLOSSARY

TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme



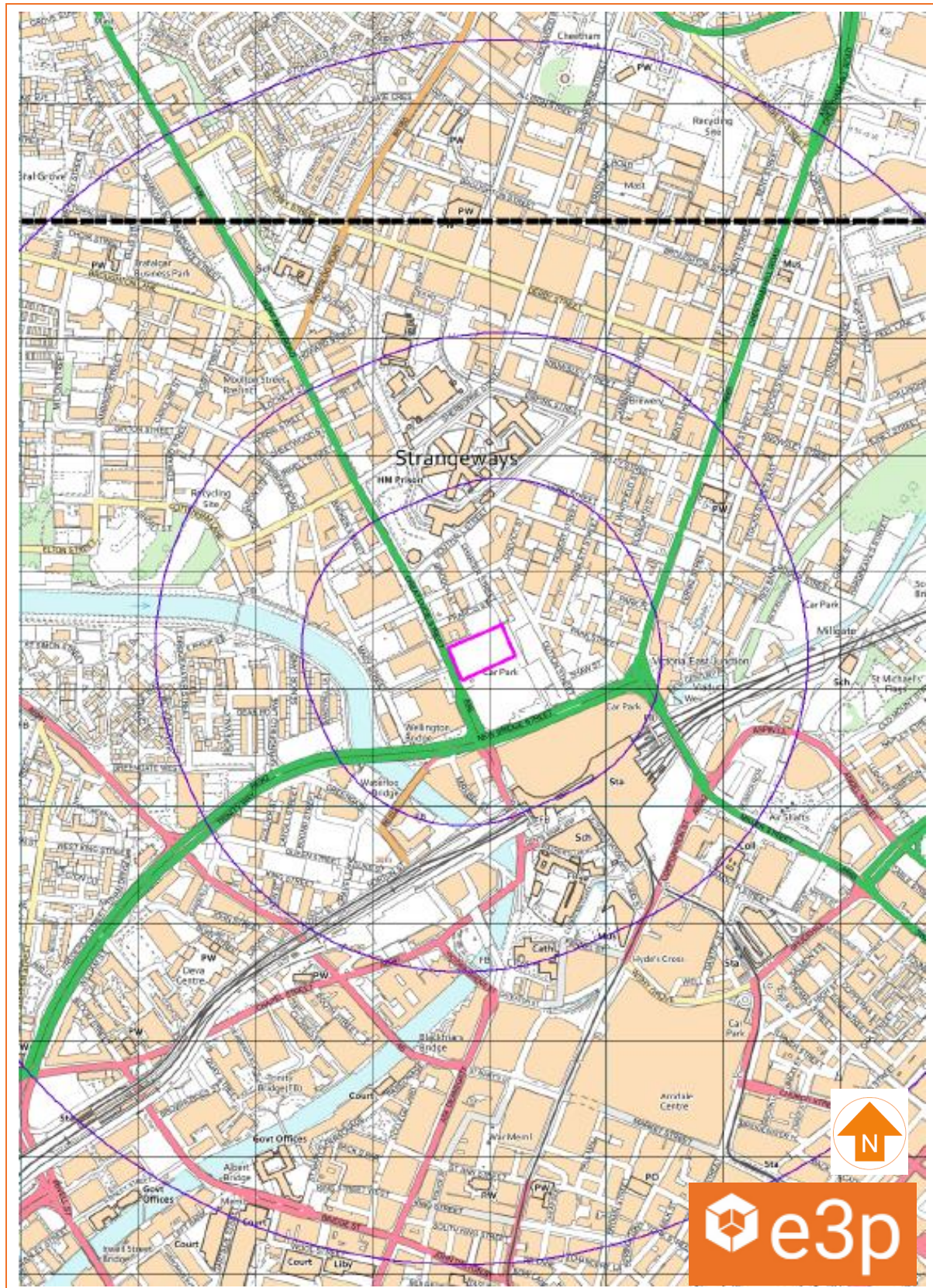
MIBK	Methyl isobutyl ketone	WTE	Water table elevation
m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	SSRT	Site Specific Remediation Target
PSD	Particle Size Distribution	DD	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	Mc	Moisture Content
ρ	Bulk Density	GPR	Ground Penetrating Radar
NDP	Nuclear Density Probe	FFL	Finished Floor Level
LEL	Lower Explosive Limit	UKWIR	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	LOD	Limit of Detection



APPENDIX III

DRAWINGS

DRAWING 15-175-001 – SITE LOCATION PLAN





Notes:				
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P1	REVA	14.10.2021	CB	BH
Phase	Issue	Date	Drawn	Checked

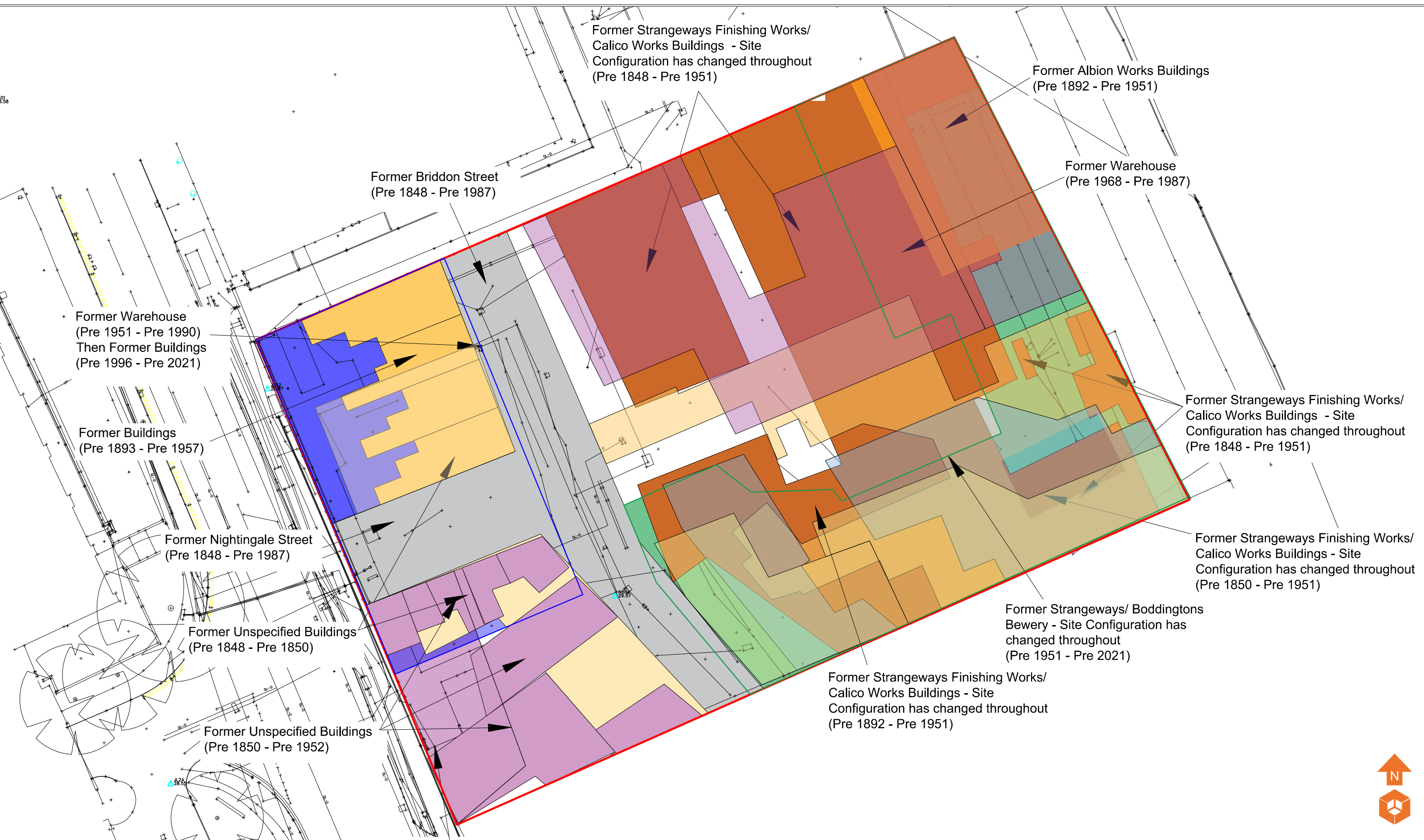
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Job Title:	Former Boddingtons Site, Great Ducie Street

Job No:	15-175	Date:	24.11.2021
Drawing No:	002	Scale:	NTS
Drawing Title:		Proposed Development Plan	



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Historical Features

- Former Unspecified Buildings (Pre 1850 - Pre 1952)
- Former Unspecified Buildings (Pre 1848 - Pre 1950)
- Former Street (Pre 1848 - Pre 1987)
- Former Residential buildings (Pre 1893 - Pre 1957)
- Former Warehouse Then Buildings (Pre 1951 - Pre 2021)
- Former Strangeways Finishing Works/ Calico Works Buildings (Pre 1848 - Pre 1951)
- Former Strangeways/ Boddingtons Brewery (Pre 1951 - Pre 2021)
- Former Warehouse (Pre 1968 - Pre 1987)
- Former Albion Works Buildings (Pre 1892 - Pre 1951)

Notes:

P1	REVD	24.11.2021	EB	ND
P1	REVC	15.10.2021	EB	BH
P1	REVB	12.10.2021	EB	ND
P1	REVA	06.10.2021	HM	BH
Phase	Issue	Date	Drawn	Checked

Client:

Latimer Developments LTD

Job Title:

Former Boddingtons Site, Great Ducie Street

Job No:

15-175

Drawing No:

003

Date:

24.11.2021

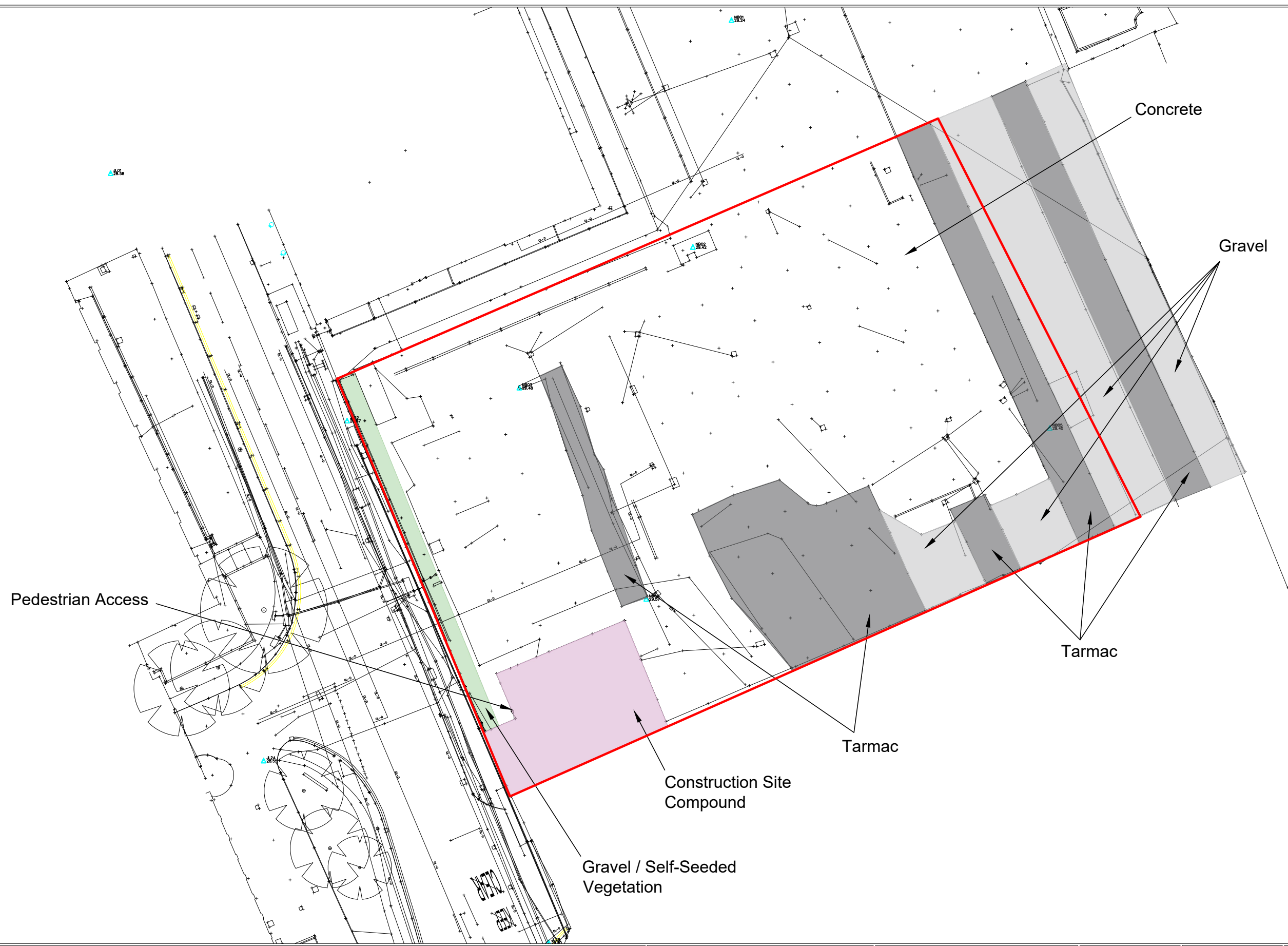
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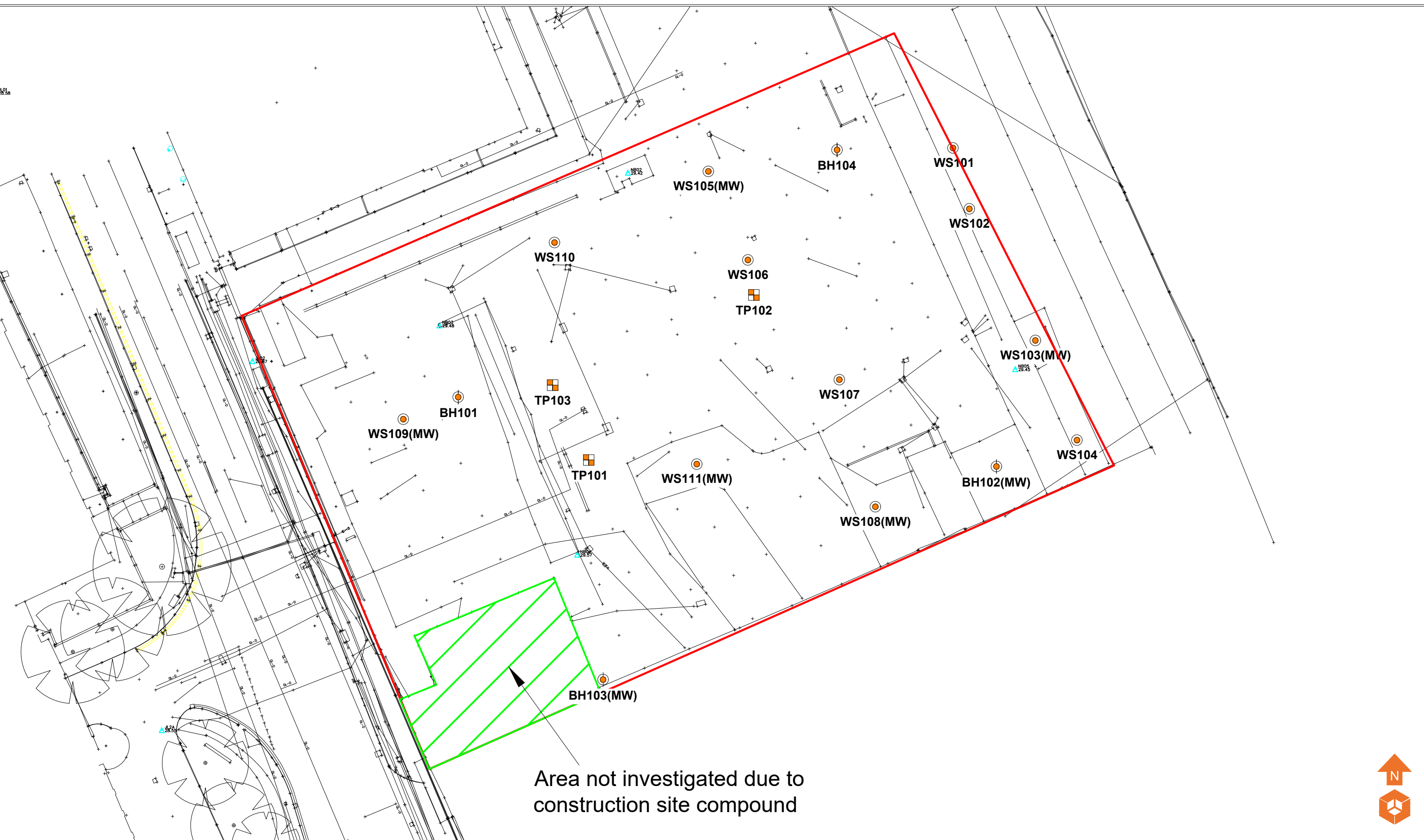
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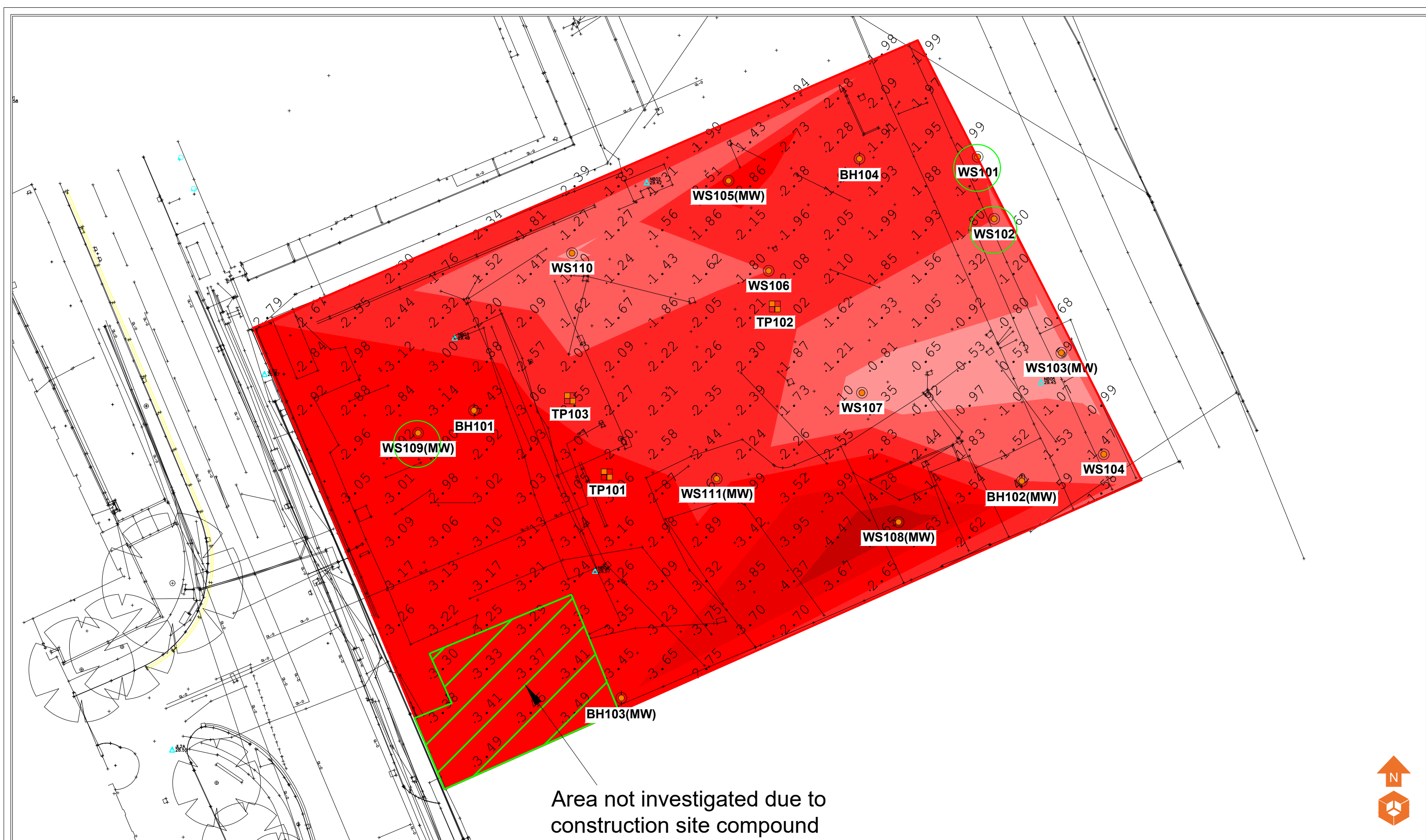
Site Features Construction Site Compound Gravel / Self-Seeded Vegetation Tarmac Gravel		Notes:		Client: Latimer Developments LTD		Job No: 15-175		Date: 24.11.2021		e3p Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk	
						Drawing No: 004		Scale: NTS			
P1 P1		REVB REVA		24.11.2021 14.10.2021		EB CB		ND BH		Job Title: Former Boddingtons Site, Great Ducie Street	
Phase		Issue		Date		Drawn		Checked		Drawing Title: Site Features Plan	
										The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.	



Area not investigated due to
construction site compound



Location Symbols WS101 Approximate Window Sample Probehole Location WS101(MW) Approximate Window Sample Probehole Location with Install TP101 Approximate Trial Pit Location BH101 Approximate Rotary Borehole Location  Area not investigated					Notes: <table><tr><td>P1</td><td>REVF</td><td>26.11.2021</td><td>EB</td><td>BH</td></tr><tr><td>P1</td><td>REVE</td><td>24.11.2021</td><td>EB</td><td>ND</td></tr><tr><td>P1</td><td>REVD</td><td>10.11.2021</td><td>HM</td><td>ND</td></tr><tr><td>P1</td><td>REVC</td><td>12.10.2021</td><td>HM</td><td>ND</td></tr><tr><td>P1</td><td>REVB</td><td>07.10.2021</td><td>LM</td><td>MD</td></tr><tr><td>P1</td><td>REVA</td><td>05.10.2021</td><td>LM</td><td>MD</td></tr><tr><td>Phase</td><td>Issue</td><td>Date</td><td>Drawn</td><td>Checked</td></tr></table>					P1	REVF	26.11.2021	EB	BH	P1	REVE	24.11.2021	EB	ND	P1	REVD	10.11.2021	HM	ND	P1	REVC	12.10.2021	HM	ND	P1	REVB	07.10.2021	LM	MD	P1	REVA	05.10.2021	LM	MD	Phase	Issue	Date	Drawn	Checked	Client: Latimer Developments LTD		Job No: 15-175 Drawing No: 005	Date: 26.11.2021 Scale: NTS	 Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk	
P1	REVF	26.11.2021	EB	BH																																														
P1	REVE	24.11.2021	EB	ND																																														
P1	REVD	10.11.2021	HM	ND																																														
P1	REVC	12.10.2021	HM	ND																																														
P1	REVB	07.10.2021	LM	MD																																														
P1	REVA	05.10.2021	LM	MD																																														
Phase	Issue	Date	Drawn	Checked																																														
					Job Title: Former Boddingtons Site, Great Ducie Street		Drawing Title: Exploratory Hole Location Plan		The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.																																									



- Location Symbols**
- WS101 Approximate Window Sample Probehole Location
 - WS101(MW) Approximate Window Sample Probehole Location with Install
 - TP101 Approximate Trial Pit Location
 - BH101 Approximate Rotary Borehole Location
 - Full Extent of Made Ground Not Identified

- Depth of Made Ground (m)**
- Depth of Made Ground 0.00 - 0.89m
 - Depth of Made Ground 0.90 - 1.79m
 - Depth of Made Ground 1.80 - 2.69m
 - Depth of Made Ground 2.70 - 3.59m
 - Depth of Made Ground 3.60 - 4.49m
 - Depth of Made Ground >4.50m

Notes:				
P1	REVC	26.11.2021	EB	BH
P1	REVB	24.11.2021	EB	ND
P1	REVA	10.11.2021	HM	ND
Phase	Issue	Date	Drawn	Checked

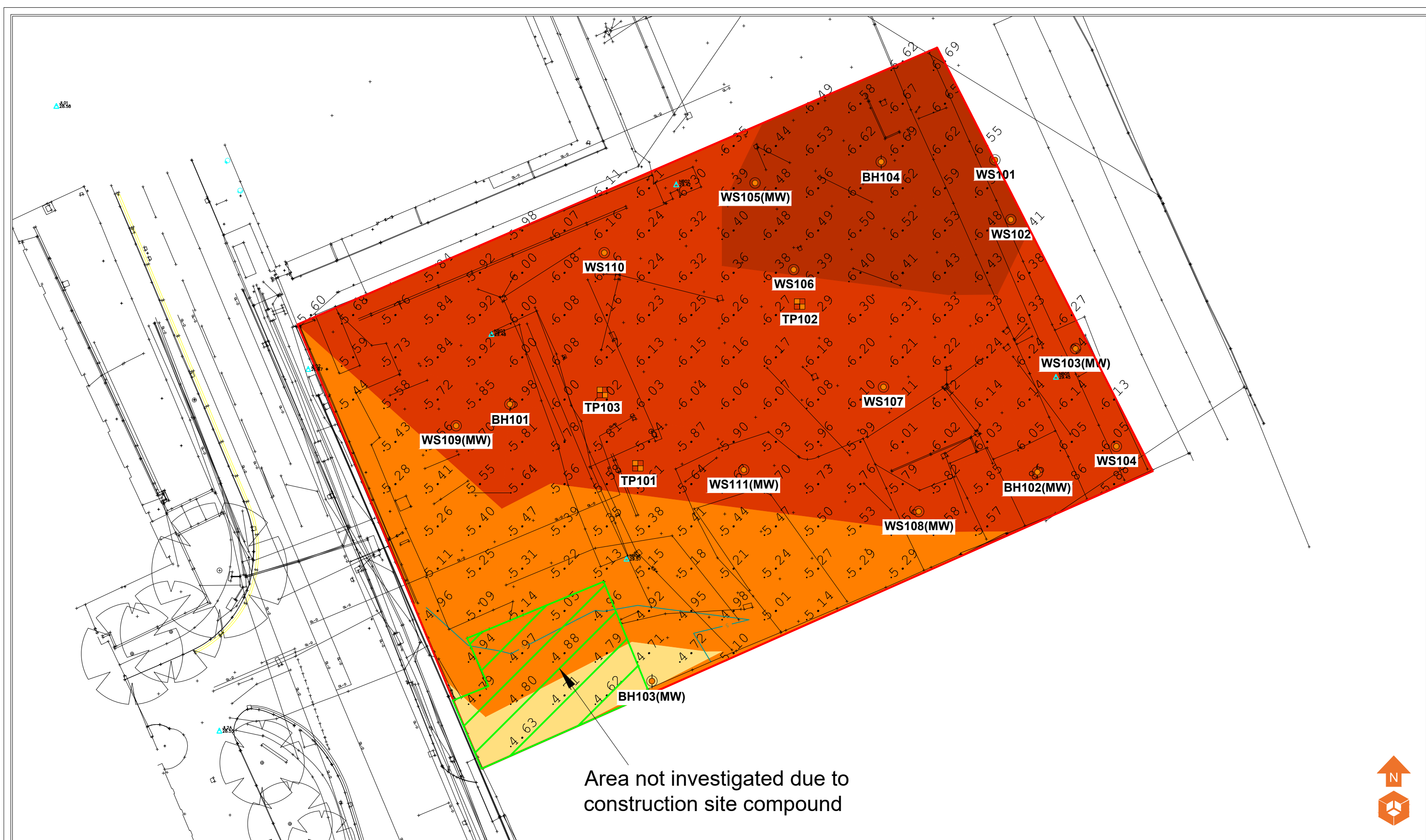
Client:	
Latimer Developments LTD	
Job Title:	
Former Boddingtons Site, Great Ducie Street	

Job No:	15-175	Date:	26.11.2021
Drawing No:	006	Scale:	NTS
Drawing Title:		Depth of Made Ground Plan	



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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Rotary Borehole Location

Depth to Bedrock (m)

- Depth to Bedrock 4.00 - 4.79m
- Depth to Bedrock 4.80 - 5.59m
- Depth to Bedrock 5.60 - 6.39m
- Depth to Bedrock >6.40m

Notes:

P1	REVC	26.11.2021	EB	BH
P1	REVB	24.11.2021	EB	ND
P1	REVA	10.11.2021	HM	ND
Phase	Issue	Date	Drawn	Checked

Client:

Latimer
Developments LTD

Job Title:

Former Boddingtons Site,
Great Ducie Street

Job No:

15-175

Drawing No:

007

Date:

26.11.2021

Scale:

NTS

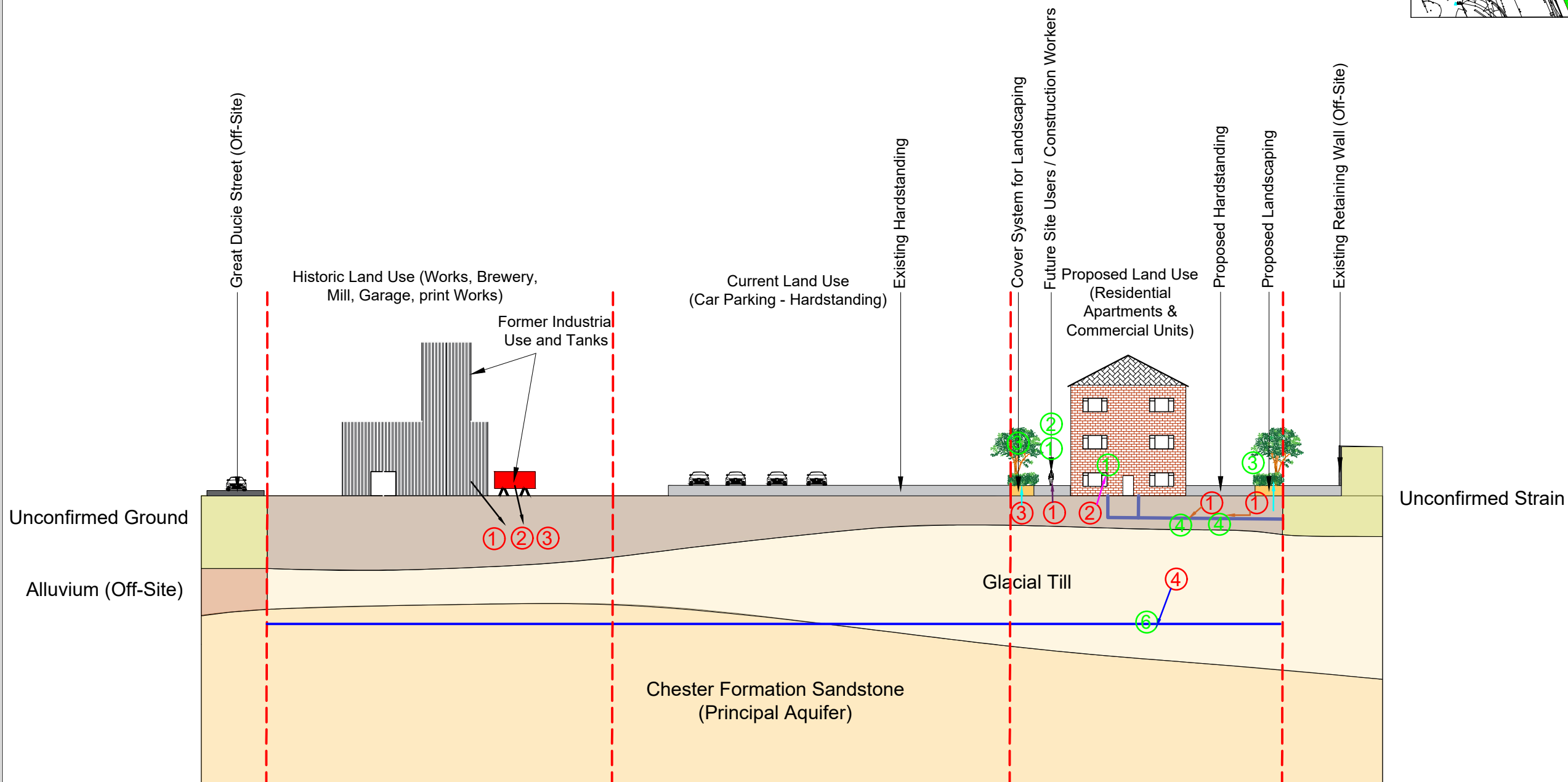
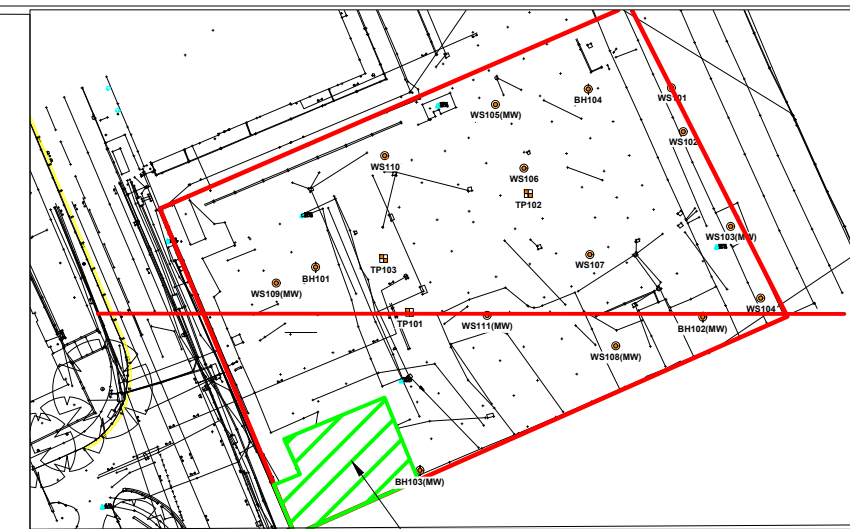
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Depth to Bedrock
Plan

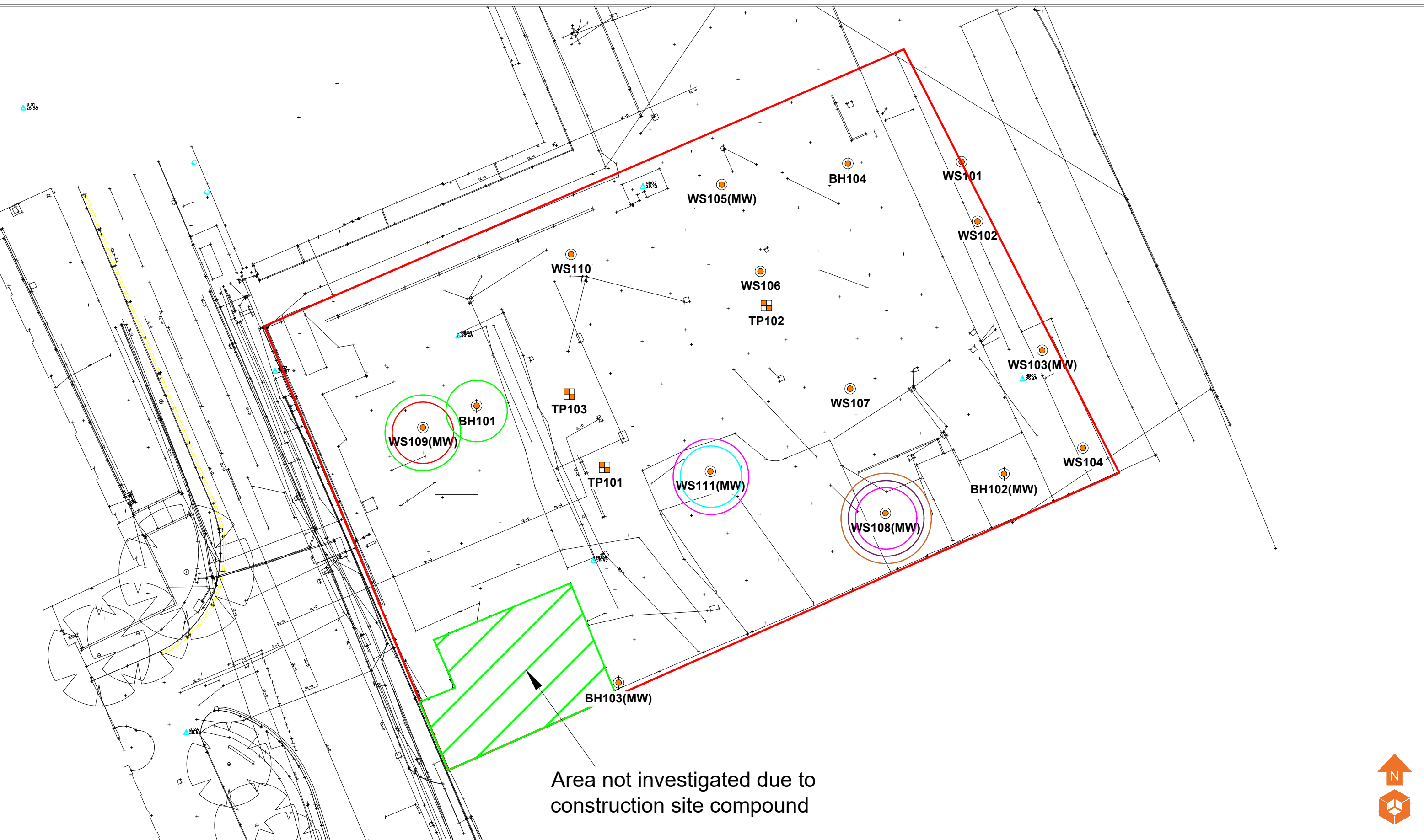


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Geology Key Chester Formation Sandstone Glacial Till Alluvium Unconfirmed Ground Great Ducie Street Hardstanding Retaining Wall Groundwater Potable Water Supply	Sources ①TPH & PAH (Made Ground) ②Napthalene (Made Ground) ③Phytotoxic Contaminants (Made Ground) ④TPH (Natural Sand drift deposits)	Receptors ①Future End User ②Construction Workers ③Vegetation / Landscaping ④Water Pipes ⑤Buildings ⑥Principal Aquifer (Groundwater)	Pathways ↑Dermal Contact / Ingestion ↑Inhalation / Accumulation ↑Plant Uptake ↑Tainted Water Supply ↑Vertical Migration	Notes:					Client: Latimer Developments LTD		Job No: 15-175		Date: 26.11.2021		e3p Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JL Tel: 0161 707 9611 E-mail: info@e3p.co.uk Website: www.e3p.co.uk	
									Job Title: Former Boddingtons Site, Great Ducie Street		Drawing No: 010		Scale: NTS@ A3			
				P1 REVB 26.11.2021 EB ND P1 REVA 24.11.2021 EB ND					Drawing Title: Conceptual Site Model		The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.					



Location Symbols		Development Constraints		Notes:		Client: Latimer Developments LTD		Job No: 15-175		Date: 26.11.2021		Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk																
WS101 Approximate Window Sample Probehole Location		Concrete Slab > 0.50m BGL Napathalene (Soil Exceedances) TPH (Soil Exceedances) PAH (Soil Exceedances) Selenium (Groundwater Exceedances) TPH Aliphatic C21-C35 (Groundwater Exceedances) Approximate Window Sample Probehole Location with install						Approximate Trial Pit Location		Approximate Rotary Borehole Location																		
TPH101 Approximate Trial Pit Location				<table><tr><td>P1</td><td>REVB</td><td>26.11.2021</td><td>EB</td><td>BH</td></tr><tr><td>P1</td><td>REVA</td><td>24.11.2021</td><td>EB</td><td>ND</td></tr><tr><td>Phase</td><td>Issue</td><td>Date</td><td>Drawn</td><td>Checked</td></tr></table>		P1	REVB	26.11.2021	EB	BH	P1	REVA	24.11.2021	EB	ND	Phase	Issue	Date	Drawn	Checked	Job Title: Former Boddingtons Site, Great Ducie Street		Drawing No: 015		Scale: NTS		The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.	
P1	REVB	26.11.2021	EB	BH																								
P1	REVA	24.11.2021	EB	ND																								
Phase	Issue	Date	Drawn	Checked																								
						Drawing Title: Development Constraints Plan																						

APPENDIX IV PHOTOGRAPHS

PLATE 1 VIEW OF SITE FACING SOUTHWEST



PLATE 2 VIEW OF SITE FACING NORTHEAST TOWARDS THE RETAINING WALL (OFF-SITE)



APPENDIX V

E3P EXPLORATORY HOLE LOGS

Project Name: Former Boddingtons Site, Great Ducie Street

Project No.
15175

Co-ords: 383770.02 - 399253.21
Level: 29.74

Date
28/09/2021

Location: Manchester

Dimensions (m): 2.40

Scale
1:30

Client: Latimer Developments Ltd

Depth
3.10

0.60

Logged
N.Dawson

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20			0.20	29.54		MADE GROUND: Concrete.	
	0.50	ES					MADE GROUND: Brown slightly clayey gravelly fine to medium sand. Gravel is fine to coarse angular of brick and sandstone.	
	3.00			3.00	26.74			
	3.10	D ES		3.10	26.64		Brown sandy very silty CLAY.	
							End of Pit at 3.10m	

Trial Pit Photographs



Trial Pit 101



Trial Pit 101 Spoil

Remarks: 1. Complete. 2. Water strike at 3.10 m bgl as minor ingress from land drain.

Stability: Stable.

Project Name: Former Boddingtons Site, Great Ducie Street

Project No.
15175

Co-ords: 383789.16 - 399272.34
Level: 29.42

Date
28/09/2021

Location: Manchester

Dimensions (m): 2.40

Scale
1:30

Client: Latimer Developments Ltd

Depth
2.20

Logged
N.Dawson

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20			0.20	29.22		MADE GROUND: Concrete.	
	0.50	ES					MADE GROUND: Black sandy gravel. Gravel is fine to coarse angular to subangular of clinker, coal, mudstone, sandstone and brick.	1
	1.20	B		1.40	28.02		MADE GROUND: Brown very silty sandy clay (reworked).	2
	2.00	ES		2.20	27.22		End of Pit at 2.20m	3
								4

Trial Pit Photographs



Trial Pit 102



Trial Pit 102 Spoil

Remarks: 1. Complete. 2. Land drain encountered at 1.90m bgl.

Stability: Unstable.

Project Name:	Former Boddingtons Site, Great Ducie Street	Project No.	15175	Co-ords:	383765.84 - 399261.89	Level:	29.56	Date	28/09/2021
Location:	Manchester	Dimensions (m):	2.40	Scale	1:30	Depth	2.20	Logged	N.Dawson
Client:	Latimer Developments Ltd								

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES		0.20	29.36		MADE GROUND: Concrete.	
	0.50	ES					MADE GROUND: Brownish grey sandy gravel. Gravel is fine to coarse angular of sandstone and mudstone.	
	1.50	B						1
	2.00	ES						2
				2.20	27.36		End of Pit at 2.20m	3
								4

Trial Pit Photographs



Trial Pit 103

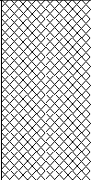
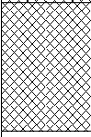


Trial Pit 103 Spoil

Remarks: 1. Complete.

Stability: Unstable.

				Borehole Log				Borehole No. WS101 Sheet 1 of 1	
Project Name:		Former Boddingtons Site, Great Ducie Street		Project No.		15175		Co-ords: 383812E - 399289N	
Location:		Manchester		Level:		29.63 m AOD		Hole Type WS	
Client:		Latimer Developments Ltd		Dates:		27/09/2021		Scale 1:50	
Logged By		N.Dawson							

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.80	ES	N=19 (3,5/5,4,5,5)	1.20	29.63		MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick, mudstone, concrete and sandstone.	1
		1.00	SPT						
		1.50	ES	50 (25 for 5mm/50 for 10mm)	2.05	28.43		MADE GROUND: Brown gravelly sandy clay. Gravel is fine to coarse angular to subangular of mudstone, brick, concrete, plastic and sandstone.	2
		2.00	SPT						
End of Borehole at 2.05m									
									3
									4
									5
									6
									7
									8
									9
									10

Remarks

1. Terminated due to refusal in Made Ground on possible concrete cobble.



Borehole Log

Borehole No.

WS102

Sheet 1 of 1

Project Name: Former Boddingtons Site, Great Ducie Street

Project No.
15175

Co-ords: 383814E - 399282N

Hole Type
WS

Location: Manchester

Level: 29.55 m AOD

Scale
1:50

Client: Latimer Developments Ltd

Dates: 27/09/2021

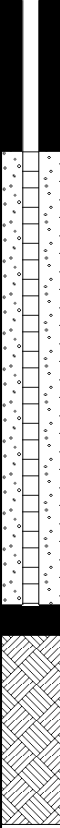
Logged By
N.Dawson

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.60	ES					MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick, mudstone, concrete and sandstone.	
		1.00	SPT	N=17 (5,5/6,6,2,3)	1.20	29.55			1
		1.80	SPT	50 (25 for 10mm/50 for 15mm)	1.83	28.35		MADE GROUND: Brown gravelly sandy clay. Gravel is fine to coarse angular to subangular of mudstone, brick, concrete, plastic and sandstone.	
								End of Borehole at 1.83m	2
									3
									4
									5
									6
									7
									8
									9
									10

Remarks

1. Terminated due to refusal in Made Ground and possible concrete cobble.

				Borehole Log				Borehole No. WS103 Sheet 1 of 1			
Project Name:		Former Boddingtons Site, Great Ducie Street		Project No.		15175		Co-ords: 383822E - 399267N		Hole Type WS	
Location:		Manchester				Level:		29.44 m AOD		Scale 1:50	
Client:		Latimer Developments Ltd				Dates:		27/09/2021		Logged By N.Dawson	

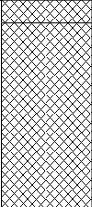
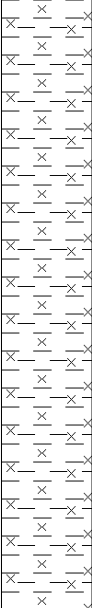
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.40	29.44		MADE GROUND: Concrete.	
	0.50	ES						Stiff medium strength brown slightly silty CLAY.	1
	1.00	D							
	1.00	SPT	N=12 (3,3/3,3,3,3)						
					1.65	29.04		Brownish grey sandy GRAVEL. Gravel is fine to coarse angular of sandstone (fragments of a cobble).	2
	2.00	D						Stiff medium strength brown silty CLAY. (Becoming very stiff high strength at circa 3.00m bgl).	
	2.00	ES							
	2.00	SPT	N=10 (2,2/2,3,2,3)						
	3.00	D							3
	3.00	SPT	N=20 (3,4/4,4,6,6)						
4.00	D							4	
4.00	SPT	N=19 (3,4/4,4,5,6)							
5.00	D							5	
5.00	SPT	N=28 (4,3/5,6,7,10)			5.45	27.64		End of Borehole at 5.45m	6
									7
									8
									9
									10

Remarks

1. Complete. 2. Monitoring well installed (response zone: 1.00 m - 4.00 m bgl)



				Borehole Log				Borehole No. WS104 Sheet 1 of 1	
Project Name:		Former Boddingtons Site, Great Ducie Street		Project No. 15175		Co-ords: 383827E - 399256N		Hole Type WS	
Location:		Manchester				Level: 29.57 m AOD		Scale 1:50	
Client:		Latimer Developments Ltd				Dates: 27/09/2021		Logged By N.Dawson	

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES	N=8 (2,2/2,2,2,2)	0.15	29.57		MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick, mudstone, concrete and sandstone. MADE GROUND: Brown gravelly sandy clay. Gravel is fine to coarse angular of subangular of mudstone, brick, concrete and sandstone.	1
		0.80	ES						
		1.00	SPT						
					1.40	29.42		Stiff medium strength brown slightly silty CLAY. (Becoming very stiff high strength at circa 3.00m bgl).	2
		2.00	D	N=10 (2,2/2,3,2,3)					
		2.00	ES						
		2.00	SPT						
		3.00	SPT						
				4.00	D	N=19 (3,4/4,4,5,6)			
4.00	SPT								
		5.00	D				N=32 (3,4/4,8,9,11)		
5.00	SPT								
					5.45	28.17	End of Borehole at 5.45m	6	
								7	
								8	
								9	
								10	

Remarks
 1. Complete.



Borehole Log

Borehole No.

WS105

Sheet 1 of 1

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383784E - 399287N

Hole Type
WS

Location: Manchester

Level: 29.38 m AOD

Scale
1:50

Client: Latimer Developments Ltd

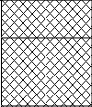
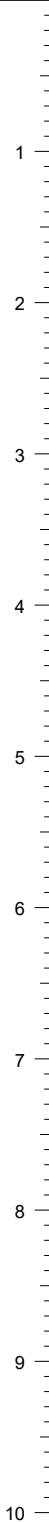
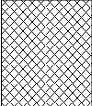
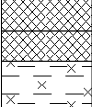
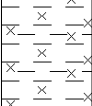
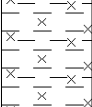
Dates: 28/09/2021

Logged By
N.Dawson

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30			0.30	29.38		MADE GROUND: Concrete.	
		0.60	ES						
		1.00	SPT	N=11 (1,1/2,3,3,3)					1
		2.00	SPT	N=10 (2,2/3,2,2,3)	2.00	29.08		MADE GROUND: Soft to firm brown sandy very silty clay (reworked).	2
		2.50	ES						
		3.00	SPT	N=8 (2,2/2,2,2,2)	3.10	27.38			3
		3.80	D						
		4.00	SPT	N=9 (2,2/2,2,2,3)					4
		5.00	SPT	N=4 (1,1/1,1,1,1)					5
		5.45			5.45	26.28		End of Borehole at 5.45m	6
									7
									8
									9
									10

Remarks

1. Complete. 2. Water strike at 2.00 m bgl. 3. Monitoring well installed (Response zone 0.50m-2.00m bgl).

				Borehole Log				Borehole No. WS106 Sheet 1 of 1			
Project Name:		Former Boddingtons Site, Great Ducie Street		Project No.		15175		Co-ords: 383788E - 399276N		Hole Type WS	
Location:		Manchester				Level:		29.41 m AOD		Scale 1:50	
Client:		Latimer Developments Ltd				Dates:		28/09/2021		Logged By N.Dawson	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.25			0.25	29.41		MADE GROUND: Concrete.			
		0.50	ES		0.70	29.16				MADE GROUND: Brown silty gravelly fine to medium sand. Gravel is fine to coarse angular to subangular of sandstone.	
		1.00	SPT	N=4 (1,1/1,1,1,1)							MADE GROUND: Soft to firm reddish brown slightly gravelly silty sandy clay. Gravel is fine to medium angular to subrounded of brick and sandstone.
		1.20	ES								
		1.60	ES		1.80	28.71		MADE GROUND: Blackish grey silty clay (organic odour).			
		2.00	D							Firm low strength greyish brown silty CLAY with bands of fine to medium silty SAND. (Becoming stiff medium strength at circa 4.00m bgl).	
		2.00	SPT	N=7 (2,2/1,2,2,2)							
		2.50	ES								
		3.00	D								
		3.00	SPT	N=8 (2,2/2,2,2,2)							
4.00	D										
4.00	SPT	N=10 (2,3/2,2,3,3)									
5.00	D										
5.00	SPT	N=18 (2,3/3,4,5,6)									
					5.45	27.61		End of Borehole at 5.45m			
Remarks 1. Complete.											

				Borehole Log				Borehole No. WS107 Sheet 1 of 1			
Project Name:		Former Boddingtons Site, Great Ducie Street		Project No.		15175		Co-ords: 383799E - 399263N			
Location:		Manchester		Level:		29.37 m AOD		Hole Type WS			
Client:		Latimer Developments Ltd		Dates:		28/09/2021		Logged By N.Dawson			
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.40	ES	N=10 (2,2/2,2,3,3)	0.25	29.37		MADE GROUND: Concrete.	1 2 3 4 5 6 7 8 9 10		
		1.00	D		0.60	29.12				MADE GROUND: Brownish grey sandy gravel. Gravel is fine to coarse angular of sandstone.	
		1.00	SPT								Stiff medium strength brown slightly sandy silty CLAY with coal traces.
		1.40	ES	N=14 (2,3/3,3,4,4)							
		2.00	D								
		2.00	SPT								
		3.00	D	N=25 (4,3/5,5,7,8)	3.20	28.77					
		3.00	SPT								
		4.00	D								
		4.00	SPT	N=41 (6,8/9,12,10,10)							
5.00	D										
5.00	SPT										
				N=16 (3,2/3,4,4,5)	5.45	26.17		Very stiff high strength brown slightly clayey SILT. (Becoming very stiff very high strength at circa 4.00m bgl, becoming stiff medium strength at circa 5.00m bgl).			
End of Borehole at 5.45m											
Remarks 1. Complete.											

Borehole Log

Borehole No.

WS108

Sheet 1 of 1

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383803E - 399248N

Hole Type
WS

Location: Manchester

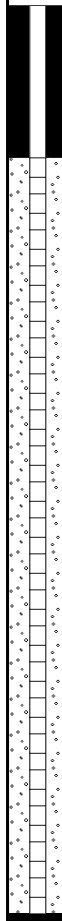
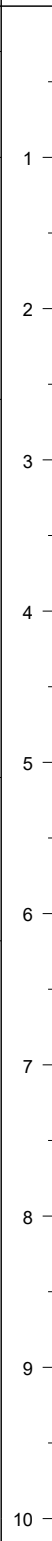
Level: 29.44 m AOD

Scale
1:50

Client: Latimer Developments Ltd

Dates: 28/09/2021

Logged By
N.Dawson

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.30	29.44		MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick, asphalt and mudstone.	
								MADE GROUND: Brown very silty clay (reworked).	
		1.00	D		1.00	29.14		MADE GROUND: Brown silty fine to medium sand (reworked).	
		1.00	SPT	N=8 (2,2/2,2,2,2)					
		2.00	SPT	N=12 (2,2/3,3,3,3)					
		2.50	ES		2.60	28.44		MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular to subrounded of sandstone.	
		3.00	SPT	N=21 (5,6/5,6,5,5)					
		4.00	SPT	N=28 (7,7/7,7,7,7)					
		5.00	SPT	N=24 (7,7/6,6,6,6)	5.10	26.84		Medium dense reddish brown silty SAND (Hydrocarbon odour and sheen) (Becoming dense at circa 6.00m bgl).	
		5.60	ES						
		6.00	SPT	50 (7,9/50 for 177mm)	6.18	24.34		End of Borehole at 6.18m	

Remarks

1. Complete. 2. Monitoring well installed. (Response zone 1.00m-6.00m bgl). 3. Hydrocarbon odour and sheen noted 5.10-6.45m bgl.

Borehole Log

Borehole No.

WS109

Sheet 1 of 1

Project Name:	Former Boddingtons Site, Great Ducie Street	Project No.	15175	Co-ords:	383749E - 399258N	Hole Type	WS
Location:	Manchester	Level:	29.48 m AOD	Scale	1:50	Logged By	N.Dawson
Client:	Latimer Developments Ltd	Dates:	29/09/2021				

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20 0.25 0.45	29.48 29.28 29.24		MADE GROUND: Concrete.	
		0.80	ES					MADE GROUND: Grey sandy gravel. Gravel is fine to medium angular of limestone (subbase).	
		1.00	SPT	N=22 (4,5/7,5,5,5)	1.00	29.04		MADE GROUND: Concrete.	
		1.50	ES					MADE GROUND: Blackish brown very gravelly clay. Gravel is fine to coarse angular of mudstone, coal and brick.	1
		2.00	SPT	N=21 (3,2/2,5,8,6)				MADE GROUND: Reddish brown sandy gravel. Gravel is fine to coarse angular of mudstone, brick and coal.	
		2.20 2.30				28.48 27.28		MADE GROUND: Grey sandy gravel. Gravel is fine to medium angular of concrete (fragments of a concrete cobble).	2
		2.80 2.80	ES SPT	50 (25 for 20mm/50 for 15mm)	2.84	27.18		MADE GROUND: Reddish brown sandy gravel. Gravel is fine to coarse angular of concrete, brick and sandstone.	3
								End of Borehole at 2.84m	
									4
									5
									6
									7
									8
									9
									10

Remarks

1. Terminated at 2.84 m bgl due to refusal in Made Ground. 2. Monitoring well installed (response zone: 0.50 m - 2.50m bgl)

					Borehole Log			Borehole No. WS110 Sheet 1 of 1		
Project Name: Former Boddingtons Site, Great Ducie Street					Project No. 15175		Co-ords: 383766E - 399278N		Hole Type WS	
Location: Manchester					Level: 29.27 m AOD		Scale 1:50			
Client: Latimer Developments Ltd					Dates: 29/09/2021		Logged By N.Dawson			
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.50 0.50	ES SPT	50 (25 for 15mm/50 for 10mm)	0.25 0.53	29.27 29.02		MADE GROUND: Concrete. MADE GROUND: Brown gravelly fine to medium sand. Gravel is fine to coarse angular of sandstone, clinker and metal fragments. End of Borehole at 0.53m		
									1	
									2	
									3	
									4	
									5	
									6	
									7	
									8	
									9	
									10	
Remarks 1. Terminated at 0.80 m bgl due to refusal in Made Ground.										

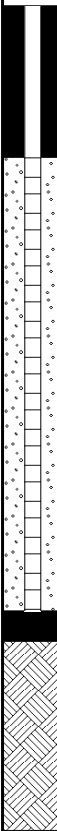
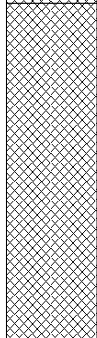
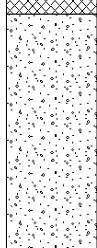
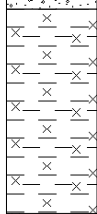
Borehole Log

Borehole No.

WS111

Sheet 1 of 1

Project Name:	Former Boddingtons Site, Great Ducie Street	Project No.	15175	Co-ords:	383783E - 399253N	Hole Type	WS
Location:	Manchester	Level:	29.79 m AOD	Scale	1:50	Logged By	N.Dawson
Client:	Latimer Developments Ltd	Dates:	29/09/2021				

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.05 0.20	29.79 29.74		MADE GROUND: Asphalt.	1
								MADE GROUND: Brown grey sandy gravel. Gravel is fine to coarse angular of brick and sandstone.	
								MADE GROUND: Brown silty gravelly clay. Gravel is fine to medium angular to subrounded of brick and coal.	
		0.80	ES						2
		1.00	SPT	N=8 (2,2/2,2,2,2)					
		2.00	SPT	N=7 (2,1/2,1,2,2)					3
		2.60	ES		2.50	29.59			
		3.00	SPT	N=17 (5,5/4,5,4,4)				Medium dense brown very gravelly fine to medium SAND. Gravel is fine to coarse angular of sandstone.	4
		4.00	SPT	N=19 (4,5/5,5,4,5)	4.10	27.29		Very stiff high strength brown silty CLAY.	
									5
		5.00	SPT	N=25 (4,4/5,6,6,8)					
					5.45	25.69		End of Borehole at 5.45m	
									6
									7
									8
									9
									10

Remarks
1. Complete. 2. Monitoring well installed (response zone: 1.00 m - 4.00 m bgl)

Rotary Core Log

Borehole No.

BH101

Sheet 1 of 3

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383754.89 - 399260.50

Hole Type CP+RC

Location: Manchester

Level: 29.47mbgl

Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 27/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		1.20					N=36 (2,4/7,10,9,10)	0.60	28.86		MADE GROUND: Concrete.	1
		2.00					N=29 (4,5/5,9,3,12)				MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick and concrete.	2
		3.00					N=9 (2,1/2,1,3,3)					3
		4.00					N=14 (2,3/3,3,2,6)	3.50	25.96		Stiff medium strength brown silty CLAY.	4
		6.50	U				50 (25 for 40mm/50 for 165mm)	6.00	23.46		Dense reddish brown SANDSTONE	6
		6.50										
		6.95	D									7
		8.00					50 (25 for 25mm/50 for 10mm)					8
												9
												10

Continued on next sheet

Remarks

1. Complete. 2. Chiselled for 1 hour 20 minutes between 7.50m to 8.30m bgl. 3. Rotary open hole from 8.30m to 20.00m bgl. 4. Rotary coring from 20.00m to 29.00m bgl.



Rotary Core Log

Borehole No.

BH101

Sheet 3 of 3

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383754.89 - 399260.50

Hole Type CP+RC

Location: Manchester

Level: 29.47mbgl

Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 27/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		20.00 - 21.00		86	57	26					Weak to moderately strong thinly bedded reddish brown fine to medium grained SANDSTONE. Fractures are closely spaced smooth planar with rare sand infill.	
											NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	
											NON-INTACT	21
		21.00 - 22.00		88	28	17						
											Assumed Zone of Core Loss (AZCL)	22
		22.00 - 23.00		83	36	0					NON-INTACT	
											NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	23
		23.00 - 24.00		100	56	50					NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	24
		24.00 - 25.00		100	90	83					Assumed Zone of Core Loss (AZCL)	25
											NON-INTACT	
		25.00 - 26.00		90	59	52					NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	26
											NON-INTACT	
		26.00 - 27.00		70	11	0					Assumed Zone of Core Loss (AZCL)	27
											NON-INTACT	
		27.00 - 28.00		78	25	0					Assumed Zone of Core Loss (AZCL)	28
											NON-INTACT	
		28.00 - 29.00		74	35	35					Assumed Zone of Core Loss (AZCL)	29
								29.00	0.46		End of borehole at 29.00 m	29
												30

Remarks

1. Complete. 2. Chiselled for 1 hour 20 minutes between 7.50m to 8.30m bgl. 3. Rotary open hole from 8.30m to 20.00m bgl. 4. Rotary coring from 20.00m to 29.00m bgl.

Rotary Core Log

Borehole No.

BH102

Sheet 1 of 2

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383817.29 - 399252.45

Hole Type CP+RC

Location: Manchester

Level: 29.43mbgl

Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 28/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
1		0.15	U				N=7 (2,3/3,2,1,1)	0.15	29.28		MADE GROUND: Asphalt.	1
		1.20									MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick and concrete.	
		2.00					N=7 (2,1/2,2,1,2)	1.80	27.63		Loose brown fine silty clayey SAND. (Becoming medium dense at circa 3.00m bgl).	2
		3.00					N=12 (2,3/2,3,3,4)					3
		4.00					N=16 (2,4/3,4,4,5)	3.50	25.93		Stiff medium strength brown silty CLAY.	4
		5.00										5
		6.50					50 (7, 10/50 for 10mm)	5.60	23.83		Dense reddish brown SANDSTONE (Weathered).	6
		7.50					50 (25 for 50mm/50 for 10mm)	7.50	21.93		Weak to moderately strong thinly bedded reddish brown fine to medium grained SANDSTONE. Fractures are closely spaced smooth planar with rare sand infill.	7
		7.50 - 8.50			99	72	32				NON-INTACT	8
		8.50 - 9.50			98	38	22				Assumed Zone of Core Loss (AZCL) NON-INTACT	9
											Assumed Zone of Core Loss (AZCL) NON-INTACT	10

Continued on next sheet

Remarks

1. Complete. 2. Monitoring well installed (response zone: 3.50 m - 5.50 m bgl). 3. Chiselled for 1 hour between 6.50m to 7.50m bgl. 4. Rotary coring from 7.50m to 16.50m bgl.

Rotary Core Log

Borehole No.

BH102

Sheet 2 of 2

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383817.29 - 399252.45

Hole Type CP+RC

Location: Manchester

Level: 29.43mbgl

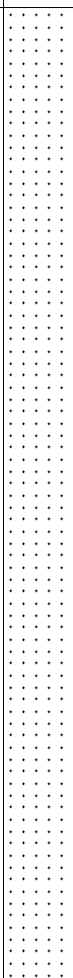
Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 28/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		9.50 - 10.50		27	5	0		16.50	12.93		Assumed Zone of Core Loss (AZCL) NON-INTACT Assumed Zone of Core Loss (AZCL) NON-INTACT Assumed Zone of Core Loss (AZCL) NON-INTACT NON-INTACT Assumed Zone of Core Loss (AZCL) NON-INTACT	11 12 13 14 15 16
		10.50 - 11.50		90	72	51						
		11.50 - 12.50		73	62	40						
		12.50 - 13.50		85	76	57						
		13.50 - 14.50		97	35	10						
		14.50 - 15.50		105	53	42						
		15.50 - 16.50		90	46	45						
											17 18 19 20	

Remarks

1. Complete. 2. Monitoring well installed (response zone: 3.50 m - 5.50 m bgl). 3. Chiselled for 1 hour between 6.50m to 7.50m bgl. 4. Rotary coring from 7.50m to 16.50m bgl.

Rotary Core Log

Borehole No.

BH103

Sheet 1 of 2

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383776.87 - 399239.30

Hole Type CP+RC

Location: Manchester

Level: 29.70mbgl

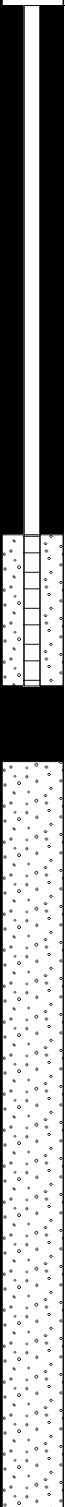
Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 29/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
								0.25	29.45		MADE GROUND: Concrete.	
		1.20					N=12 (2,3/3,4,3,2)				MADE GROUND: Brown sandy gravel. Gravel is fine to coarse angular of brick and concrete.	1
		2.00					N=5 (2,1/1,1,2,1)					2
		3.00					N=11 (2,1/3,3,2,3)					3
		4.00					N=25 (2,4/5,5,7,8)	3.50	26.20		Medium dense light brown SAND and GRAVEL. Gravel is fine to medium sub angular to rounded of mudstone and sandstone.	4
		5.00					50 (9,7/50 for 235mm)	4.60	25.10		Dense reddish brown SANDSTONE	5
		6.50					50 (25 for 75mm/50 for 35mm)					6
		7.50					50 (25 for 50mm/50 for 45mm)					7
		7.50 - 8.50		80	47	32		7.95	21.75		NON-INTACT Weak to moderately strong thinly bedded reddish brown fine to medium grained SANDSTONE. Fractures are closely spaced smooth planar with rare sand infill.	8
		8.50 - 9.50		85	28	13					Assumed Zone of Core Loss (AZCL) NON-INTACT	9
											Assumed Zone of Core Loss (AZCL)	10

Continued on next sheet

Remarks

1. Complete. 2. Monitoring well installed (response zone: 3.50 m - 4.50 m bgl). 3. Chiselling for 1 hour 30 minutes between 1.60m and 7.50m bgl. 4. Rotary coring from 7.50m to 19.50m bgl.

Rotary Core Log

Borehole No.

BH103

Sheet 2 of 2

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383776.87 - 399239.30

Hole Type CP+RC

Location: Manchester

Level: 29.70mbgl

Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 29/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		9.50 - 10.50		83	68	56					Assumed Zone of Core Loss (AZCL)	11
		10.50 - 11.50		70	34	0					NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	
		11.50 - 12.50		83	73	64					Assumed Zone of Core Loss (AZCL)	
											NON-INTACT	
		12.50 - 13.50		76	46	22					NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	
		13.50 - 14.50		86	70	53					Assumed Zone of Core Loss (AZCL)	
											NON-INTACT	
		14.50 - 15.50		85	49	30					NON-INTACT	
											NON-INTACT	
		15.50 - 16.50		78	60	60					Assumed Zone of Core Loss (AZCL)	
		16.50 - 17.50		43	12	12					Assumed Zone of Core Loss (AZCL)	17
											NON-INTACT	
		17.50 - 18.50		76	18	0					NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	
		18.50 - 19.50		81	65	56					NON-INTACT	19
											Assumed Zone of Core Loss (AZCL)	
								19.50	10.20		End of borehole at 19.50 m	20

Remarks

1. Complete. 2. Monitoring well installed (response zone: 3.50 m - 4.50 m bgl). 3. Chiselling for 1 hour 30 minutes between 1.60m and 7.50m bgl. 4. Rotary coring from 7.50m to 19.50m bgl.

Rotary Core Log



Rotary Core Log

Borehole No.

BH104

Sheet 2 of 3

Project Name: Former Boddingtons Site, Great Ducie Street

Project No.
15175

Co-ords: 383798.81 - 399289.16

Hole Type
CP+RC

Location: Manchester

Level: 24.47mbgl

Orientation: °
Inclination: °Scale
1:50

Client: Latimer Developments Ltd

Dates: 30/09/2021 -

Logged By
D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		11.00					50 (25 for 20mm/50 for 25mm)					11
												12
												13
												14
												15
												16
												17
												18
												19
								20.00	4.46		Continued on next sheet	20

Remarks

1. Complete. 2. Chiselling for 1 hour between 10.50m to 11.00m bgl. 3. Rotary open hole from 11.00m to 20.00m bgl. 4. Rotary coring from 20.00m to 29.00m bgl.



Rotary Core Log

Borehole No.

BH104

Sheet 3 of 3

Project Name: Former Boddingtons Site, Great Ducie Street

Project No. 15175

Co-ords: 383798.81 - 399289.16

Hole Type CP+RC

Location: Manchester

Level: 24.47mbgl

Orientation: °
Inclination: °

Scale 1:50

Client: Latimer Developments Ltd

Dates: 30/09/2021 -

Logged By D. Taylor (TDS)

Well	Water Strikes	Depth (m)	Type / FI	Coring			Results & Information	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		20.00 - 21.00		74	31	10					Weak to moderately strong thinly bedded reddish brown fine to medium grained SANDSTONE. Fractures are closely spaced smooth planar with rare sand infill.	
											NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	21
		21.00 - 22.00		73	25	13					NON-INTACT	
											Assumed Zone of Core Loss (AZCL)	
		22.00 - 23.00		78	77	56					Assumed Zone of Core Loss (AZCL)	22
											NON-INTACT	
		23.00 - 24.00		73	36	22					NON-INTACT	23
											Assumed Zone of Core Loss (AZCL)	
		24.00 - 25.00		89	65	47					NON-INTACT	24
											Assumed Zone of Core Loss (AZCL)	
		25.00 - 26.00		73	52	36					NON-INTACT	25
											Assumed Zone of Core Loss (AZCL)	
		26.00 - 27.00		56	24	12					NON-INTACT	26
											NON-INTACT	
		27.00 - 28.00		77	55	38					Assumed Zone of Core Loss (AZCL)	27
											NON-INTACT	
		28.00 - 29.00		86	66	67					Assumed Zone of Core Loss (AZCL)	28
											Assumed Zone of Core Loss (AZCL)	
								29.00	-4.54		End of borehole at 29.00 m	29
												30

Remarks

1. Complete. 2. Chiselling for 1 hour between 10.50m to 11.00m bgl. 3. Rotary open hole from 11.00m to 20.00m bgl 4. Rotary coring from 20.00m to 29.00m bgl.

APPENDIX VI

CHEMICAL TESTING

RESULTS

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Analytical Report Number : 21-18047-2

Replaces Analytical Report Number: 21-18047, issue no. 1
Client references/information amended.

Project / Site name:	Former Boddingtons Site, Great Ducie St	Samples received on:	20/10/2021
Your job number:		Samples instructed on/ Analysis started on:	21/10/2021
Your order number:		Analysis completed by:	01/12/2021
Report Issue Number:	2	Report issued on:	01/12/2021
Samples Analysed:	1 water sample		

Signed: *Karolina Marek*

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.



Analytical Report Number: 21-18047

Project / Site name: Former Boddingtons Site, Great Ducie St

Lab Sample Number				2056646
Sample Reference				WS108
Sample Number				None Supplied
Depth (m)				None Supplied
Date Sampled				19/10/2021
Time Taken				None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status	

General Inorganics

pH	pH Units	N/A	ISO 17025	7.3
Total Cyanide (Low Level 1 µg/l)	µg/l	1	ISO 17025	< 1.0
Dissolved Organic Carbon (DOC)	mg/l	0.1	ISO 17025	9.27

Total Phenols

Total Phenols (monohydric)	µg/l	1	ISO 17025	< 1.0
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Heavy Metals / Metalloids

Calcium (dissolved)	mg/l	0.012	ISO 17025	98
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0

Arsenic (dissolved)	µg/l	0.15	ISO 17025	0.47
Cadmium (dissolved)	µg/l	0.02	ISO 17025	0.06
Chromium (dissolved)	µg/l	0.2	ISO 17025	3.9
Copper (dissolved)	µg/l	0.5	ISO 17025	3.0
Lead (dissolved)	µg/l	0.2	ISO 17025	0.2
Manganese (dissolved)	µg/l	0.05	ISO 17025	170
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05
Nickel (dissolved)	µg/l	0.5	ISO 17025	4.3
Selenium (dissolved)	µg/l	0.6	ISO 17025	11
Zinc (dissolved)	µg/l	0.5	ISO 17025	9.6

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0



Analytical Report Number: 21-18047

Project / Site name: Former Boddingtons Site, Great Ducie St

Lab Sample Number				2056646
Sample Reference				WS108
Sample Number				None Supplied
Depth (m)				None Supplied
Date Sampled				19/10/2021
Time Taken				None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status	

Petroleum Hydrocarbons

TPH1 (C10 - C40)	µg/l	10	NONE	2300
------------------	------	----	------	------

TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	200
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	2100
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	2300

TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10

VOCs

Chloromethane	µg/l	1	ISO 17025	< 1.0
Chloroethane	µg/l	1	ISO 17025	< 1.0
Bromomethane	µg/l	1	ISO 17025	< 1.0
Vinyl Chloride	µg/l	1	NONE	< 1.0
Trichlorofluoromethane	µg/l	1	NONE	< 1.0
1,1-Dichloroethene	µg/l	1	ISO 17025	< 1.0
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/l	1	ISO 17025	< 1.0
Cis-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0
1,1-Dichloroethane	µg/l	1	ISO 17025	< 1.0
2,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0
Trichloromethane	µg/l	1	ISO 17025	< 1.0
1,1,1-Trichloroethane	µg/l	1	ISO 17025	< 1.0
1,2-Dichloroethane	µg/l	1	ISO 17025	< 1.0
1,1-Dichloropropene	µg/l	1	ISO 17025	< 1.0
Trans-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0
Benzene	µg/l	1	ISO 17025	< 1.0
Tetrachloromethane	µg/l	1	ISO 17025	< 1.0
1,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0
Trichloroethene	µg/l	1	ISO 17025	< 1.0
Dibromomethane	µg/l	1	ISO 17025	< 1.0
Bromodichloromethane	µg/l	1	ISO 17025	< 1.0
Cis-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0
Trans-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0
1,1,2-Trichloroethane	µg/l	1	ISO 17025	< 1.0
1,3-Dichloropropane	µg/l	1	ISO 17025	< 1.0
Dibromochloromethane	µg/l	1	ISO 17025	< 1.0
Tetrachloroethene	µg/l	1	ISO 17025	< 1.0
1,2-Dibromoethane	µg/l	1	ISO 17025	< 1.0
Chlorobenzene	µg/l	1	ISO 17025	< 1.0
1,1,1,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0
p & m-Xylene	µg/l	1	ISO 17025	< 1.0



Analytical Report Number: 21-18047

Project / Site name: Former Boddingtons Site, Great Ducie St

Lab Sample Number				2056646
Sample Reference				WS108
Sample Number				None Supplied
Depth (m)				None Supplied
Date Sampled				19/10/2021
Time Taken				None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status	
Styrene	µg/l	1	ISO 17025	< 1.0
Tribromomethane	µg/l	1	ISO 17025	< 1.0
o-Xylene	µg/l	1	ISO 17025	< 1.0
1,1,2,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0
Isopropylbenzene	µg/l	1	ISO 17025	< 1.0
Bromobenzene	µg/l	1	ISO 17025	< 1.0
n-Propylbenzene	µg/l	1	ISO 17025	< 1.0
2-Chlorotoluene	µg/l	1	ISO 17025	< 1.0
4-Chlorotoluene	µg/l	1	ISO 17025	< 1.0
1,3,5-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0
tert-Butylbenzene	µg/l	1	ISO 17025	< 1.0
1,2,4-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0
sec-Butylbenzene	µg/l	1	ISO 17025	< 1.0
1,3-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0
p-Isopropyltoluene	µg/l	1	ISO 17025	< 1.0
1,2-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0
1,4-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0
Butylbenzene	µg/l	1	ISO 17025	< 1.0
1,2-Dibromo-3-chloropropane	µg/l	1	ISO 17025	< 1.0
1,2,4-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0
Hexachlorobutadiene	µg/l	1	ISO 17025	< 1.0
1,2,3-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0

SVOCs

Aniline	µg/l	0.05	NONE	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.05
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05
2-Methylphenol	µg/l	0.05	NONE	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05
Naphthalene	µg/l	0.01	ISO 17025	< 0.01
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.05
Dibenzofuran	µg/l	0.05	NONE	< 0.05



Analytical Report Number: 21-18047

Project / Site name: Former Boddingtons Site, Great Ducie St

Lab Sample Number				2056646
Sample Reference				WS108
Sample Number				None Supplied
Depth (m)				None Supplied
Date Sampled				19/10/2021
Time Taken				None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status	
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05
Fluorene	µg/l	0.01	ISO 17025	< 0.01
Azobenzene	µg/l	0.05	NONE	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.05
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01
Carbazole	µg/l	0.05	NONE	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01
3&4-Methylphenol	µg/l	0.1	NONE	< 0.10

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 21-18047

Project / Site name: Former Boddingtons Site, Great Ducie St

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 *for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 dphenylcarbazine followed by colorimetry.	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW.	L080-PL	W	ISO 17025
Monohydric phenols in water - LOW LEVEL 1 ug/l	Determination of phenols in water by continuous flow analyser. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Semi-volatile organic compounds in water	Determination of semi-volatile organic compounds in leachate by extraction in dichloromethane followed by GC-MS.	In-house method based on USEPA 8270	L102B-PL	W	NONE
TPH1 (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS.	In-house method	L070-PL	W	NONE
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	NONE
Volatile organic compounds in water	Determination of volatile organic compounds in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Dissolved Organic Carbon in water	Determination of dissolved inorganic carbon in water by TOC/DOC NDIR Analyser.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L037-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Low level total cyanide in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In house method.	L099-PL	W	ISO 17025

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

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Analytical Report Number : 21-13824-2

Replaces Analytical Report Number: 21-13824, issue no. 1
Client references/information amended.

Project / Site name:	Former Boddingtons Site, Great Ducie St	Samples received on:	30/09/2021
Your job number:	15-175	Samples instructed on/ Analysis started on:	04/10/2021
Your order number:	15175-ND-A	Analysis completed by:	01/12/2021
Report Issue Number:	2	Report issued on:	01/12/2021
Samples Analysed:	3 leachate samples - 15 soil samples		

Signed: *Karolina Marek*

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032411	2032412	2032413	2032414	2032415
Sample Reference				WS101	WS103	WS104	WS105	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.80	0.50	0.80	2.50	1.70
Date Sampled				27/09/2021	27/09/2021	27/09/2021	28/09/2021	28/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	6.6	6.1	14	11	15
Total mass of sample received	kg	0.001	NONE	0.60	0.60	0.60	0.60	0.60

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	Not-detected	-
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	11.1	-	9.8	7.9	7.7
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Sulphate as SO ₄	mg/kg	50	MCERTS	7300	-	2700	78	690
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	g/l	0.00125	MCERTS	0.13	-	0.33	0.0080	0.17
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/kg	2.5	MCERTS	270	-	670	16	330
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	134	-	333	8.0	166
Sulphide	mg/kg	1	MCERTS	8.7	-	8.4	1.4	110
Total Sulphur	mg/kg	50	MCERTS	3200	-	1600	1400	180
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	1.3	0.6	1.0	0.4	2.5

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.56	< 0.05	0.44	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	0.12	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.95	< 0.05	0.47	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	1.1	< 0.05	0.45	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.80	< 0.05	0.26	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	0.66	< 0.05	0.23	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.82	< 0.05	0.26	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.48	< 0.05	0.09	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.83	< 0.05	0.20	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.54	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.70	< 0.05	< 0.05	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	7.52	< 0.80	2.40	< 0.80	< 0.80
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Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032411	2032412	2032413	2032414	2032415
Sample Reference				WS101	WS103	WS104	WS105	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.80	0.50	0.80	2.50	1.70
Date Sampled				27/09/2021	27/09/2021	27/09/2021	28/09/2021	28/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					

Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	14	5.9	10	3.2	14
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	90	-	-	-
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	0.68	-	-	-
Boron (water soluble)	mg/kg	0.2	MCERTS	-	0.5	-	-	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	39	-	27	7.1	52
Copper (aqua regia extractable)	mg/kg	1	MCERTS	32	14	29	9.2	35
Lead (aqua regia extractable)	mg/kg	1	MCERTS	30	14	47	13	150
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	31	22	39	10	17
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	16	-	-	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	120	55	77	15	44

Petroleum Hydrocarbons

TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C6 - C8)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C8 - C10)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH (C12 - C16)	mg/kg	4	MCERTS	5.7	< 4.0	< 4.0	< 4.0	< 4.0
TPH (C16 - C21)	mg/kg	1	MCERTS	83	5.0	25	< 1.0	< 1.0
TPH (C21 - C35)	mg/kg	1	MCERTS	1000	50	75	< 1.0	< 1.0
TPH (C35 - C40)	mg/kg	10	MCERTS	590	25	24	< 10	< 10
TPH Total C5 - C40	mg/kg	10	MCERTS	1700	81	120	< 10	< 10

VOCs

Chloromethane	µg/kg	1	ISO 17025	-	-	-	-	-
Chloroethane	µg/kg	1	NONE	-	-	-	-	-
Bromomethane	µg/kg	1	ISO 17025	-	-	-	-	-
Vinyl Chloride	µg/kg	1	NONE	-	-	-	-	-
Trichlorofluoromethane	µg/kg	1	NONE	-	-	-	-	-
1,1-Dichloroethene	µg/kg	1	NONE	-	-	-	-	-
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	-	-	-	-
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	-
1,1-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
2,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	-
Trichloromethane	µg/kg	1	MCERTS	-	-	-	-	-
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,1-Dichloropropene	µg/kg	1	MCERTS	-	-	-	-	-
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	-	-	-	-
Benzene	µg/kg	1	MCERTS	-	-	-	-	-
Tetrachloromethane	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	-
Trichloroethene	µg/kg	1	MCERTS	-	-	-	-	-
Dibromomethane	µg/kg	1	MCERTS	-	-	-	-	-
Bromodichloromethane	µg/kg	1	MCERTS	-	-	-	-	-
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	-
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	-
Toluene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	-	-	-	-
Dibromochloromethane	µg/kg	1	ISO 17025	-	-	-	-	-

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032411	2032412	2032413	2032414	2032415
Sample Reference				WS101	WS103	WS104	WS105	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.80	0.50	0.80	2.50	1.70
Date Sampled				27/09/2021	27/09/2021	27/09/2021	28/09/2021	28/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Tetrachloroethene	µg/kg	1	NONE	-	-	-	-	-
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	-	-	-	-
Chlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
p & m-Xylene	µg/kg	1	MCERTS	-	-	-	-	-
Styrene	µg/kg	1	MCERTS	-	-	-	-	-
Tribromomethane	µg/kg	1	NONE	-	-	-	-	-
o-Xylene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	-
Isopropylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
Bromobenzene	µg/kg	1	MCERTS	-	-	-	-	-
n-Propylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
2-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	-
4-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	-
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
tert-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
sec-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	-
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	-	-	-	-
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
Hexachlorobutadiene	µg/kg	1	MCERTS	-	-	-	-	-
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	-

SVOCs

Aniline	mg/kg	0.1	NONE	-	-	-	-	-
Phenol	mg/kg	0.2	ISO 17025	-	-	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	-	-	-	-	-
Isophorone	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-	-	-

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032411	2032412	2032413	2032414	2032415
Sample Reference				WS101	WS103	WS104	WS105	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.80	0.50	0.80	2.50	1.70
Date Sampled				27/09/2021	27/09/2021	27/09/2021	28/09/2021	28/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-	-	-
Fluorene	mg/kg	0.05	MCERTS	-	-	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Carbazole	mg/kg	0.3	MCERTS	-	-	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	-	-

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032416	2032417	2032418	2032419	2032420
Sample Reference				WS106	WS108	WS109	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	5.60	0.80	1.50	0.50
Date Sampled				28/09/2021	28/09/2021	29/09/2021	29/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	18	14	11	6.2	10
Total mass of sample received	kg	0.001	NONE	0.60	1.1	0.60	0.60	0.60

Asbestos in Soil	Type	N/A	ISO 17025	-	-	-	Not-detected	Not-detected
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	7.7	8.0	8.4	-	7.9
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Sulphate as SO ₄	mg/kg	50	MCERTS	130	270	2600	-	350
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	g/l	0.00125	MCERTS	0.012	0.076	0.46	-	0.042
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/kg	2.5	MCERTS	24	150	910	-	83
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	11.8	75.9	455	-	41.5
Sulphide	mg/kg	1	MCERTS	3.5	3.6	6.7	-	34
Total Sulphur	mg/kg	50	MCERTS	310	1600	1700	-	600
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	-	1.0	2.5	-	0.6

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	2.3	0.78	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	-	1.5	0.30	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	-	0.17	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	0.53	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	-	0.49	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	0.40	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-	0.29	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	0.27	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	0.13	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	0.24	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	-	6.27	1.08	< 0.80
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Analytical Report Number: 21-13824
Project / Site name: Former Boddingtons Site, Great Ducie St
Your Order No: 15175-ND-A

Lab Sample Number				2032416	2032417	2032418	2032419	2032420
Sample Reference				WS106	WS108	WS109	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	5.60	0.80	1.50	0.50
Date Sampled				28/09/2021	28/09/2021	29/09/2021	29/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	4.0	3.2	16	14	11
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	200	-
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	-	-	1.3	-
Boron (water soluble)	mg/kg	0.2	MCERTS	-	-	-	0.3	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	29	9.3	16	-	19
Copper (aqua regia extractable)	mg/kg	1	MCERTS	17	5.3	35	32	19
Lead (aqua regia extractable)	mg/kg	1	MCERTS	13	4.2	25	22	28
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	28	8.7	30	33	18
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	29	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	76	23	61	65	37

Petroleum Hydrocarbons

TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C6 - C8)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C8 - C10)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	2	MCERTS	< 2.0	< 2.0	6.7	4.4	< 2.0
TPH (C12 - C16)	mg/kg	4	MCERTS	< 4.0	30	8.4	< 4.0	< 4.0
TPH (C16 - C21)	mg/kg	1	MCERTS	28	760	10	3.3	< 1.0
TPH (C21 - C35)	mg/kg	1	MCERTS	100	2700	42	14	< 1.0
TPH (C35 - C40)	mg/kg	10	MCERTS	< 10	130	< 10	< 10	< 10
TPH Total C5 - C40	mg/kg	10	MCERTS	130	3700	67	22	< 10

VOCs

Chloromethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Chloroethane	µg/kg	1	NONE	-	< 1.0	-	-	-
Bromomethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Vinyl Chloride	µg/kg	1	NONE	-	< 1.0	-	-	-
Trichlorofluoromethane	µg/kg	1	NONE	-	< 1.0	-	-	-
1,1-Dichloroethene	µg/kg	1	NONE	-	< 1.0	-	-	-
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1-Dichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
2,2-Dichloropropane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Trichloromethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2-Dichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1-Dichloropropene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	< 1.0	-	-	-
Benzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Tetrachloromethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2-Dichloropropane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Trichloroethene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Dibromomethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Bromodichloromethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Toluene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Dibromochloromethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032416	2032417	2032418	2032419	2032420
Sample Reference				WS106	WS108	WS109	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	5.60	0.80	1.50	0.50
Date Sampled				28/09/2021	28/09/2021	29/09/2021	29/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Tetrachloroethene	µg/kg	1	NONE	-	< 1.0	-	-	-
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
Chlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
p & m-Xylene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Styrene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Tribromomethane	µg/kg	1	NONE	-	< 1.0	-	-	-
o-Xylene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Isopropylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Bromobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
n-Propylbenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
2-Chlorotoluene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
4-Chlorotoluene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
tert-Butylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
sec-Butylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Butylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	< 1.0	-	-	-
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
Hexachlorobutadiene	µg/kg	1	MCERTS	-	< 1.0	-	-	-
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	< 1.0	-	-	-

SVOCs

Aniline	mg/kg	0.1	NONE	-	< 0.1	-	-	-
Phenol	mg/kg	0.2	ISO 17025	-	< 0.2	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	-	< 0.2	-	-	-
Isophorone	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	-	< 0.1	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	< 0.1	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	< 0.1	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032416	2032417	2032418	2032419	2032420
Sample Reference				WS106	WS108	WS109	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.50	5.60	0.80	1.50	0.50
Date Sampled				28/09/2021	28/09/2021	29/09/2021	29/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Dimethylphthalate	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	< 0.1	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	< 0.3	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Carbazole	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	< 0.2	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	-	< 0.3	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	< 0.3	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	-	-	-

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032421	2032422	2032423	2032424	2032580
Sample Reference				WS111	TP102	TP102	TP103	WS104
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.60	2.00	0.50	0.50	2.00
Date Sampled				29/09/2021	28/09/2021	28/09/2021	28/09/2021	27/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	14	19	14	11	13
Total mass of sample received	kg	0.001	NONE	0.60	0.60	1.4	0.60	0.60

Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected	Not-detected	Not-detected	-
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.3	-	8.7	8.7	8.9
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Sulphate as SO ₄	mg/kg	50	MCERTS	160	-	810	310	620
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	g/l	0.00125	MCERTS	0.021	-	0.14	0.065	0.21
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/kg	2.5	MCERTS	41	-	280	130	430
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	20.5	-	141	65.0	214
Sulphide	mg/kg	1	MCERTS	< 1.0	-	6.6	3.2	41
Total Sulphur	mg/kg	50	MCERTS	58	-	880	620	1200
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	0.4	2.0	2.7	0.7	1.0

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.36	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.37	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.40	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.33	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.24	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	1.70	< 0.80	< 0.80
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Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032421	2032422	2032423	2032424	2032580
Sample Reference				WS111	TP102	TP102	TP103	WS104
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.60	2.00	0.50	0.50	2.00
Date Sampled				29/09/2021	28/09/2021	28/09/2021	28/09/2021	27/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	7.0	18	29	7.0	8.5
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	110	-	-	-
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	1.3	-	-	-
Boron (water soluble)	mg/kg	0.2	MCERTS	-	1.6	-	-	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	15	-	20	20	21
Copper (aqua regia extractable)	mg/kg	1	MCERTS	16	58	170	19	24
Lead (aqua regia extractable)	mg/kg	1	MCERTS	12	170	110	10	14
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	16	27	54	26	29
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	31	-	-	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	48	68	84	59	62

Petroleum Hydrocarbons

TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C6 - C8)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C8 - C10)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH (C12 - C16)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
TPH (C16 - C21)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C21 - C35)	mg/kg	1	MCERTS	< 1.0	< 1.0	22	< 1.0	< 1.0
TPH (C35 - C40)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH Total C5 - C40	mg/kg	10	MCERTS	< 10	< 10	22	< 10	< 10

VOCs

Chloromethane	µg/kg	1	ISO 17025	-	-	-	-	-
Chloroethane	µg/kg	1	NONE	-	-	-	-	-
Bromomethane	µg/kg	1	ISO 17025	-	-	-	-	-
Vinyl Chloride	µg/kg	1	NONE	-	-	-	-	-
Trichlorofluoromethane	µg/kg	1	NONE	-	-	-	-	-
1,1-Dichloroethene	µg/kg	1	NONE	-	-	-	-	-
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	-	-	-	-
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	-
1,1-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
2,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	-
Trichloromethane	µg/kg	1	MCERTS	-	-	-	-	-
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,1-Dichloropropene	µg/kg	1	MCERTS	-	-	-	-	-
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	-	-	-	-
Benzene	µg/kg	1	MCERTS	-	-	-	-	-
Tetrachloromethane	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dichloropropane	µg/kg	1	MCERTS	-	-	-	-	-
Trichloroethene	µg/kg	1	MCERTS	-	-	-	-	-
Dibromomethane	µg/kg	1	MCERTS	-	-	-	-	-
Bromodichloromethane	µg/kg	1	MCERTS	-	-	-	-	-
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	-
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-	-	-	-
Toluene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	-	-	-	-
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	-	-	-	-
Dibromochloromethane	µg/kg	1	ISO 17025	-	-	-	-	-

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032421	2032422	2032423	2032424	2032580
Sample Reference				WS111	TP102	TP102	TP103	WS104
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.60	2.00	0.50	0.50	2.00
Date Sampled				29/09/2021	28/09/2021	28/09/2021	28/09/2021	27/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Tetrachloroethene	µg/kg	1	NONE	-	-	-	-	-
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	-	-	-	-
Chlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
p & m-Xylene	µg/kg	1	MCERTS	-	-	-	-	-
Styrene	µg/kg	1	MCERTS	-	-	-	-	-
Tribromomethane	µg/kg	1	NONE	-	-	-	-	-
o-Xylene	µg/kg	1	MCERTS	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-	-	-	-
Isopropylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
Bromobenzene	µg/kg	1	MCERTS	-	-	-	-	-
n-Propylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
2-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	-
4-Chlorotoluene	µg/kg	1	MCERTS	-	-	-	-	-
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
tert-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	-	-	-	-
sec-Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	-
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	-	-	-	-
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
Butylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	-	-	-	-
Hexachlorobutadiene	µg/kg	1	MCERTS	-	-	-	-	-
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	-	-	-	-

SVOCs

Aniline	mg/kg	0.1	NONE	-	-	-	-	-
Phenol	mg/kg	0.2	ISO 17025	-	-	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	-	-	-	-	-
Isophorone	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-	-	-

Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032421	2032422	2032423	2032424	2032580
Sample Reference				WS111	TP102	TP102	TP103	WS104
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.60	2.00	0.50	0.50	2.00
Date Sampled				29/09/2021	28/09/2021	28/09/2021	28/09/2021	27/09/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-	-	-
Fluorene	mg/kg	0.05	MCERTS	-	-	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Carbazole	mg/kg	0.3	MCERTS	-	-	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	-	-

U/S = Unsuitable Sample I/S = Insufficient Sample



Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032425	2032426	2032427
Sample Reference				WS108	WS109	TP102
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				5.60	0.80	0.50
Date Sampled				28/09/2021	29/09/2021	28/09/2021
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)				Units	Limit of detection	Accreditation Status

General Inorganics

pH (automated)	pH Units	N/A	ISO 17025	7.3	8.0	8.4
Total Cyanide (Low Level 1 µg/l)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0

Total Phenols

Total Phenols (monohydric)	µg/l	1	ISO 17025	14	12	9.6
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Speciated PAHs

Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01

Total PAH

Total EPA-16 PAHs	µg/l	0.2	NONE	< 0.2	< 0.2	< 0.2
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Heavy Metals / Metalloids

Arsenic (dissolved)	µg/l	1	ISO 17025	7.4	< 1.0	< 1.0
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08	< 0.08	< 0.08
Chromium (hexavalent)	µg/l	5	ISO 17025	U/S*	< 5.0	< 5.0
Chromium (dissolved)	µg/l	0.4	ISO 17025	1.5	0.5	3.4
Copper (dissolved)	µg/l	0.7	ISO 17025	4.0	2.9	5.1
Lead (dissolved)	µg/l	1	ISO 17025	1.3	1.7	2.7
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5	< 0.5	< 0.5
Nickel (dissolved)	µg/l	0.3	ISO 17025	2.8	2.3	3.2
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0	< 4.0	< 4.0
Zinc (dissolved)	µg/l	0.4	ISO 17025	5.2	8.8	5.3



Analytical Report Number: 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2032425	2032426	2032427
Sample Reference				WS108	WS109	TP102
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				5.60	0.80	0.50
Date Sampled				28/09/2021	29/09/2021	28/09/2021
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)				Units	Limit of detection	Accreditation Status

Monoaromatics & Oxygenates

Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	10	NONE	< 10	< 10	< 10

Petroleum Hydrocarbons

TPH1 (C10 - C40)	µg/l	10	NONE	< 10	< 10	< 10
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TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10

TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10

U/S = Unsuitable Sample I/S = Insufficient Sample

*U/S due to high variances between chromium (hexavalent) and chromium (dissolved) caused by method differences.

Analytical Report Number : 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
2032411	WS101	None Supplied	0.8	Brown clay and sand with gravel.
2032412	WS103	None Supplied	0.5	Brown clay and sand with gravel.
2032413	WS104	None Supplied	0.8	Brown clay and loam with gravel and brick.
2032414	WS105	None Supplied	2.5	Brown clay and sand with gravel.
2032415	WS106	None Supplied	1.7	Brown clay and loam with gravel and vegetation.
2032416	WS106	None Supplied	2.5	Grey clay.
2032417	WS108	None Supplied	5.6	Brown clay and sand.
2032418	WS109	None Supplied	0.8	Brown clay and sand.
2032419	WS109	None Supplied	1.5	Brown clay and sand with gravel.
2032420	WS110	None Supplied	0.5	Brown clay and sand with gravel.
2032421	WS111	None Supplied	2.6	Brown clay and sand with gravel.
2032422	TP102	None Supplied	2	Brown clay and sand with gravel.
2032423	TP102	None Supplied	0.5	Brown loam and clay with gravel and vegetation.
2032424	TP103	None Supplied	0.5	Brown clay.
2032580	WS104	None Supplied	2	Brown clay and sand.

Analytical Report Number : 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
BS EN 12457-1 (2:1) Leachate Prep	2:1 (as recieved, moisture adjusted) end over end extraction with water for 24 hours. Eluate filtered prior to analysis.	In-house method based on BSEN12457-1.	L043-PL	W	NONE
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Hexavalent chromium in leachate	Determination of hexavalent chromium in leachate by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Monohydric phenols in leachate - LOW LEVEL 1 ug/l	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
pH at 20oC in leachate (automated)	Determination of pH in leachate by electrometric measurement.	In house method.	L099B	W	ISO 17025
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-PL	D	MCERTS

Analytical Report Number : 21-13824

Project / Site name: Former Boddingtons Site, Great Ducie St

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
TPH1 (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
TPHCWG (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
TPH in (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	D	MCERTS
Total cyanide in leachate - 1µg/l	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080-PL	W	ISO 17025
D.O. for Gravimetric Quant if Screen/ID positive	Dependent option for Gravimetric Quant if Screen/ID positive scheduled.	In house asbestos methods A001 & A006.	A006-PL	D	NONE
Sulphate, water soluble, in soil (1hr extraction)	Sulphate, water soluble, in soil (1hr extraction)	In-house method	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

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Analytical Report Number : 21-14289-2

Replaces Analytical Report Number: 21-14289, issue no. 1
Client references/information amended.

Project / Site name:	Former Boddingtons Site, Great Ducie St	Samples received on:	05/10/2021
Your job number:	15-175	Samples instructed on/ Analysis started on:	05/10/2021
Your order number:	15175-ND-A	Analysis completed by:	01/12/2021
Report Issue Number:	2	Report issued on:	01/12/2021
Samples Analysed:	2 soil samples		

Signed: *Karolina Marek*

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 21-14289-2
 Project / Site name: Former Boddingtons Site, Great Ducie St
 Your Order No: 15175-ND-A

Lab Sample Number				2035586	2035587
Sample Reference				WS106	WS111
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	0.80
Date Sampled				28/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	17	13
Total mass of sample received	kg	0.001	NONE	0.50	0.50

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.9	8.2
Electrical Conductivity	µS/cm	10	ISO 17025	140	200
Redox Potential	mV	-800	NONE	198.60	348.10

Phenols by HPLC

Catechol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Resorcinol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Cresols (o-, m-, p-)	mg/kg	0.3	ISO 17025	< 0.30	< 0.30
Total Naphthols (sum of 1- and 2- Naphthol)	mg/kg	0.2	ISO 17025	< 0.20	< 0.20
2-Isopropylphenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Phenol	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Trimethylphenol (2,3,5-)	mg/kg	0.1	ISO 17025	< 0.10	< 0.10
Total Xylenols and Ethylphenols	mg/kg	0.3	ISO 17025	< 0.30	< 0.30

Total Phenols

Total Phenols (HPLC)	mg/kg	1.3	ISO 17025	< 1.3	< 1.3
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Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC10	mg/kg	1	NONE	< 1.0	< 1.0
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TPH-CWG - Aromatic >EC5 - EC10	mg/kg	1	NONE	< 1.0	< 1.0
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TPH Aliphatic (C10 - C16)	mg/kg	10	NONE	< 10	< 10
TPH Aliphatic (C16 - C40)	mg/kg	10	NONE	< 10	< 10

TPH Aromatic (C10 - C16)	mg/kg	10	NONE	< 10	17
TPH Aromatic (C16 - C40)	mg/kg	10	NONE	< 10	68

Chlorinated Solvents

Total Chlorinated Solvents	µg/kg	100	NONE	< 100	< 100
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Analytical Report Number: 21-14289-2
Project / Site name: Former Boddingtons Site, Great Ducie St
Your Order No: 15175-ND-A

Lab Sample Number				2035586	2035587
Sample Reference				WS106	WS111
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	0.80
Date Sampled				28/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		

VOCs

Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0

Analytical Report Number: 21-14289-2
Project / Site name: Former Boddingtons Site, Great Ducie St
Your Order No: 15175-ND-A

Lab Sample Number				2035586	2035587
Sample Reference				WS106	WS111
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	0.80
Date Sampled				28/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0

VOCs TICs

VOCs TICs Compound Name		N/A	NONE	ND	ND
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SVOCs

Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1
Phenol	mg/kg	0.2	ISO 17025	< 0.2	< 0.2
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	< 0.2
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	1.1
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1	1.0
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	2.3
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2	1.1
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Fluorene	mg/kg	0.05	MCERTS	< 0.05	1.3
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Phenanthrene	mg/kg	0.05	MCERTS	0.31	10
Anthracene	mg/kg	0.05	MCERTS	< 0.05	2.0
Carbazole	mg/kg	0.3	MCERTS	< 0.3	0.8
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Fluoranthene	mg/kg	0.05	MCERTS	0.21	9.8
Pyrene	mg/kg	0.05	MCERTS	0.20	8.7
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	4.5
Chrysene	mg/kg	0.05	MCERTS	< 0.05	4.2
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	4.4

Analytical Report Number: 21-14289-2

Project / Site name: Former Boddingtons Site, Great Ducie St

Your Order No: 15175-ND-A

Lab Sample Number				2035586	2035587
Sample Reference				WS106	WS111
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	0.80
Date Sampled				28/09/2021	29/09/2021
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	1.9
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	4.0
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	2.2
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.53
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	2.6

SVOCs TICs

SVOCs TICs Compound Name		N/A	NONE	Naphthalene, 2,6-dimethyl-	Triphenylene, 2-methyl-
SVOC % Match	%	N/A	NONE	96	98
SVOCs TICs Compound Name		N/A	NONE	Naphthalene, 1,3-dimethyl-	Benz[e]acephenanthrylene
SVOC % Match	%	N/A	NONE	96	98
SVOCs TICs Compound Name		N/A	NONE	Naphthalene, 1,6,7-trimethyl-	Naphthalene, 1,5-dimethyl-
SVOC % Match	%	N/A	NONE	96	97
SVOCs TICs Compound Name		N/A	NONE	Naphthalene, 2,3,6-trimethyl-	Naphthalene, 1,4-dimethyl-
SVOC % Match	%	N/A	NONE	96	96
SVOCs TICs Compound Name		N/A	NONE	9-Octadecenamide, (Z)-	Naphthalene, 1,2-dimethyl-
SVOC % Match	%	N/A	NONE	96	96
SVOCs TICs Compound Name		N/A	NONE	Tridecane	Dibenzothiophene
SVOC % Match	%	N/A	NONE	95	96
SVOCs TICs Compound Name		N/A	NONE	Dodecane, 2,6,11-trimethyl-	Phenanthrene, 2-methyl-
SVOC % Match	%	N/A	NONE	95	96
SVOCs TICs Compound Name		N/A	NONE	Heptadecane	Pyrene, 4-methyl-
SVOC % Match	%	N/A	NONE	95	96
SVOCs TICs Compound Name		N/A	NONE	Hexadecane	Tridecane
SVOC % Match	%	N/A	NONE	94	95

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 21-14289-2

Project / Site name: Former Boddingtons Site, Great Ducie St

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
2035586	WS106	None Supplied	1.2	Brown loam and clay.
2035587	WS111	None Supplied	0.8	Brown loam and clay with gravel.

Analytical Report Number : 21-14289-2

Project / Site name: Former Boddingtons Site, Great Ducie St

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Phenols, speciated, in soil, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	ISO 17025
Electrical conductivity of soil	Determination of electrical conductivity in soil by electrometric measurement.	In-house method	L031-PL	D	ISO 17025
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Redox Potential of soil	Determination of redox potential in soil by electrometric measurement.	In house method.	L084-PL	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Tentatively identified compounds (SVOC) in soil	Determination of semi-volatile organic compounds total ion count in soil by extraction with dichloromethane and hexane followed by GC-MS followed by a full library scan.	In-house method based on USEPA 8270	L064-PL	D	NONE
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Tentatively identified compounds (VOC) in soil	Determination of volatile organic compounds total ion count in soil by headspace GC-MS followed by a full library scan.	In-house method based on USEPA8260	L073-PL	W	NONE
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Total Chlorinated Solvents in soil	Determination of chlorinated solvents in soil by headspace GC-MS.	In-house method based on USEPA8260	L017-UK	W	MCERTS
TPH in (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

APPENDIX VII

ORIGIN OF TIER I GENERIC ASSESSMENT CRITERIA

CONSTITUENT	ORIGIN OF RISK ASSESSMENT VALUE
Arsenic	2014 LQM/CIEH S4ULs
Cadmium	2014 LQM/CIEH S4ULs
Chromium	2014 LQM/CIEH S4ULs
Lead	2014 LQM/CIEH S4ULs
Mercury	2014 LQM/CIEH S4ULs – methylmercury
Nickel	2014 LQM/CIEH S4ULs
Selenium	2014 LQM/CIEH S4ULs
Copper	2014 LQM/CIEH S4ULs
Zinc	2014 LQM/CIEH S4ULs
Cyanide – Total	2014 LQM/CIEH S4ULs
Phenols – Total	2014 LQM/CIEH S4ULs
Naphthalene	General assessment criteria (GAC) developed by CIEH/LQM Suitable 4 Use Levels with supporting data from SR3, SR7 and existing Tox report where applicable. 1% SOM.
Acenaphthylene	
Acenaphthene	
Fluorene	
Phenanthrene	
Anthracene	
Fluoranthene	
Pyrene	
Benzo(a)Anthracene	
Chrysene	
Benzo(b/k)Fluoranthene ⁽ⁱⁱⁱ⁾	
Benzo(a)Pyrene	
Indeno(123-cd)Pyrene	
Dibenzo(a,h)Anthracene	
Benzo(ghi)Perylene	
TPH C₅-C₆ (aliphatic)	
TPH C₆-C₈ (aliphatic)	
TPH C₈-C₁₀ (aliphatic)	
TPH C₁₀-C₁₂ (aliphatic)	
TPH C₁₂-C₁₆ (aromatic)	
TPH C₁₆-C₂₁ (aromatic)	
TPH C₂₁-C₃₅ (aromatic)	



APPENDIX VIII

GEOTECHNICAL TESTING

RESULTS



LABORATORY REPORT



4043

Contract Number: PSL21/8746

Report Date: 18 November 2021

Client's Reference: 15-175

Client Name: E3P
Taylor Road
Urmston
Manchester
M41 7JQ

For the attention of: Nicola Dawson

Contract Title: Great Ducie St

Date Received: 4/11/2021

Date Commenced: 4/11/2021

Date Completed: 18/11/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

R Berriman
(Quality Manager)

S Royle
(Laboratory Manager)

L Knight
(Assistant Laboratory Manager)


S Eyre
(Senior Technician)

T Watkins
(Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
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awatkins@prosoils.co.uk

Page 1 of

DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

[illegible]

Great Ducie St

Contract No:

PSL21/8746

Client Ref:

15-175

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

[illegible]

***Note** All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random

A = Axial, D = Diametral, I = Irregular



Great Ducie St

Contract No:

PSL21/8746

Client Ref:

15-175

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

[illegible]

***Note** All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random



Great Ducie St

Contract No:

PSL21/8746

Client Ref:

15-175



LABORATORY REPORT



4043

Contract Number: PSL21/8643

Report Date: 16 November 2021

Client's Reference: 15-175

Client Name: E3P
Taylor Road
Urmston
Manchester
M41 7JQ

For the attention of: Nicola Dawson

Contract Title: Great Ducie St

Date Received: 2/11/2021
Date Commenced: 2/11/2021
Date Completed: 16/11/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

R Berriman
(Quality Manager)

S Royle
(Laboratory Manager)

L Knight
(Assistant Laboratory Manager)

S Eyre
(Senior Technician)

M Fennell
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Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

4043

PSL
Professional Soils Laboratory

Great Ducie Street

Contract No:

PSL21/8643

Client Ref:

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

[illegible]

SYMBOLS : NP : Non Plastic

*** : Liquid Limit and Plastic Limit Wet Sieved.**



4043

PSL

Professional Soils Laboratory

Great Ducie Street

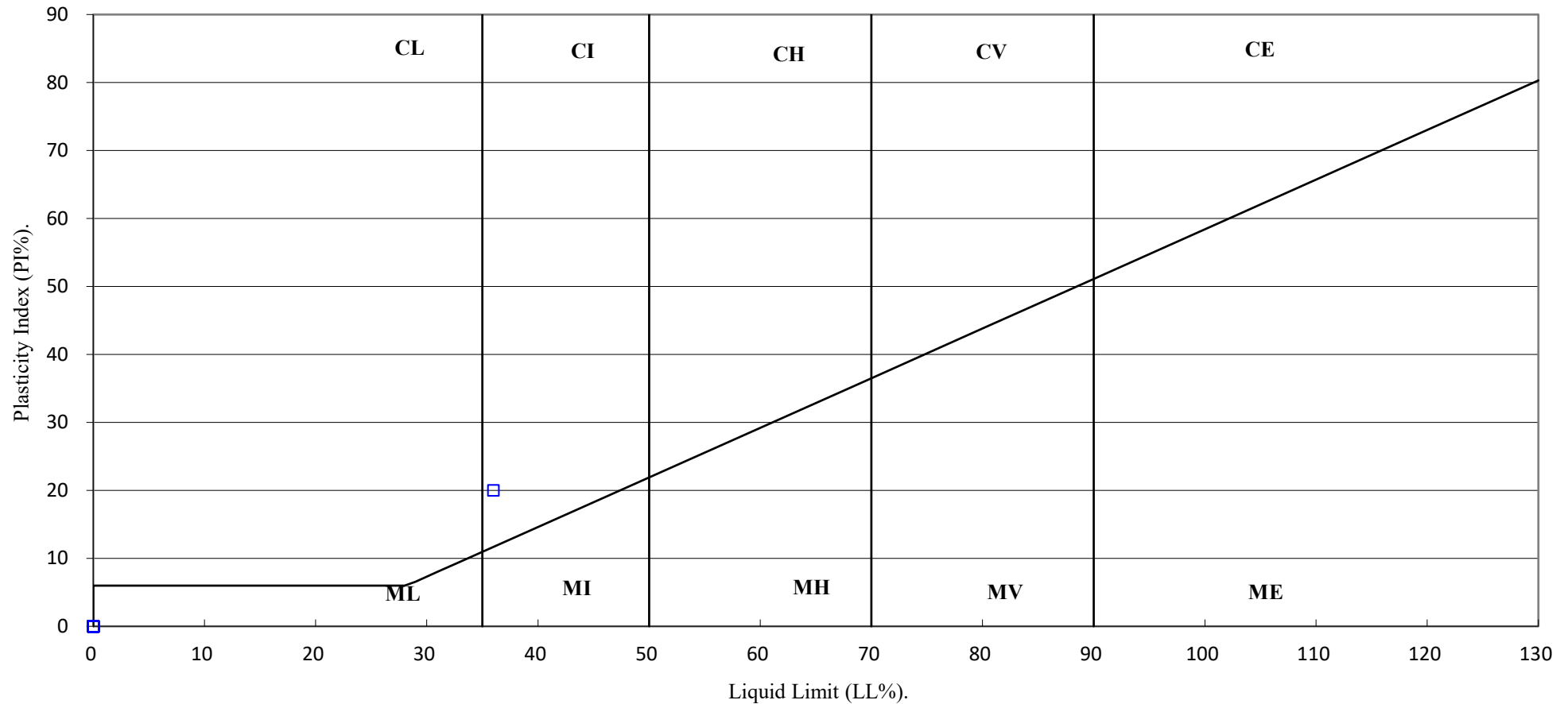
Contract No:

PSL21/8643

Client Ref:

15-175

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



4043

PSL

Professional Soils Laboratory

Great Ducie Street

Contract No:

PSL21/8643

Client Ref:

15-175

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

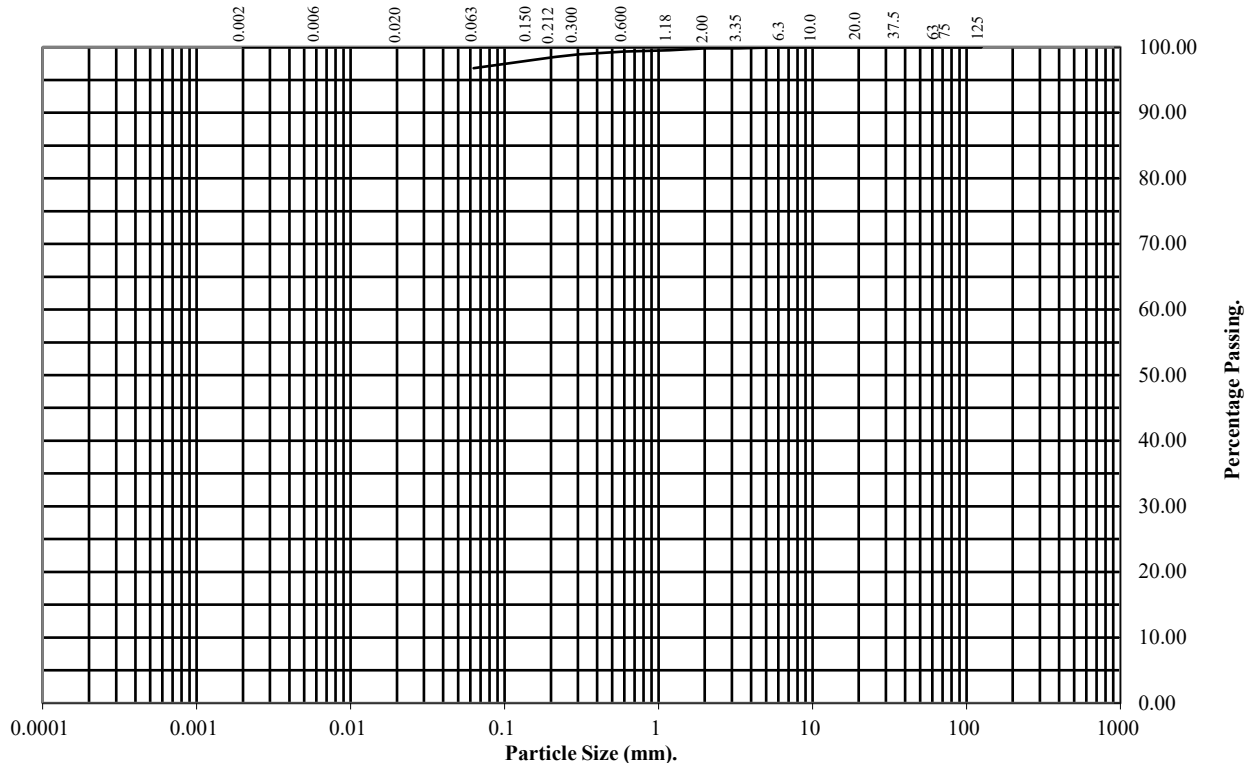
Hole Number: BH104

Top Depth (m): 5.00

Sample Number:

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	100
0.6	99
0.3	99
0.212	99
0.15	98
0.063	97

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	3
Silt/Clay	97

Remarks:

See Summary of Soil Descriptions



PSL
Professional Soils Laboratory

Great Ducie Street

Contract No:
PSL21/8643
Client Ref:
15-175

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

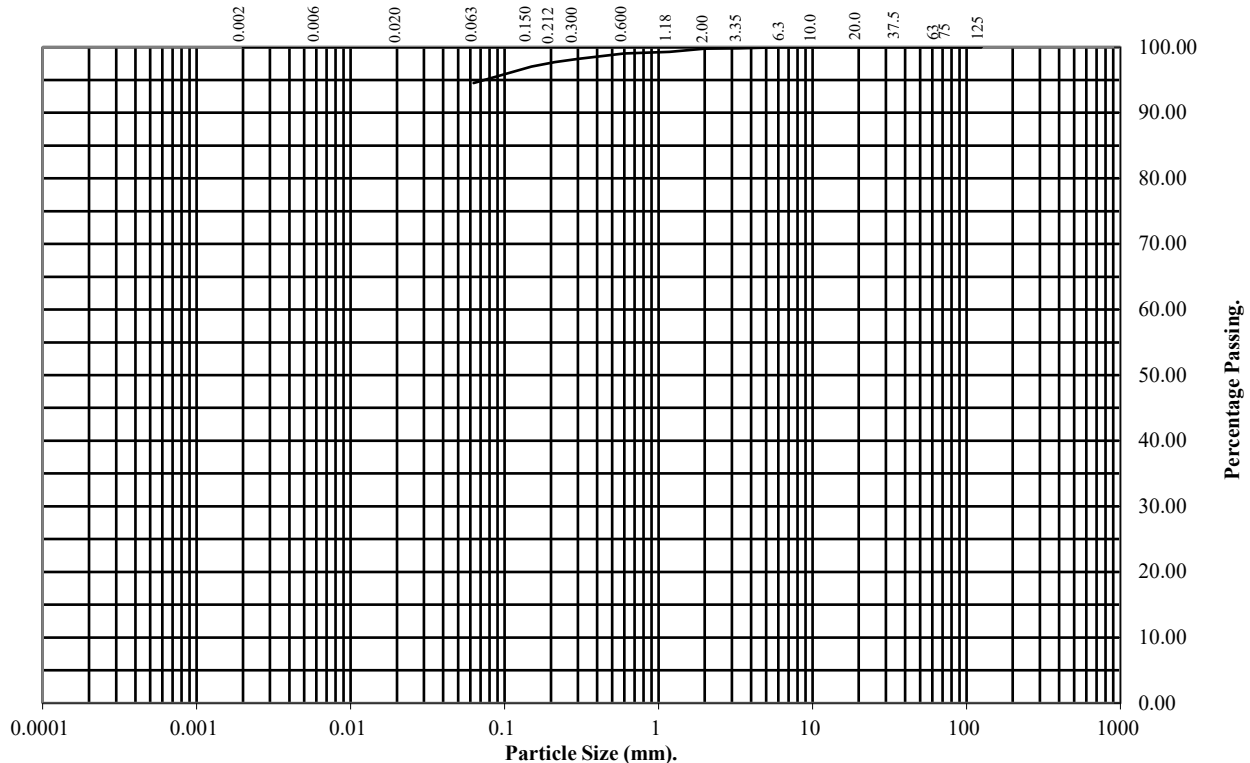
Hole Number: BH101

Top Depth (m): 4.00

Sample Number:

Base Depth(m): 4.45

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	99
0.6	99
0.3	98
0.212	98
0.15	97
0.063	95

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	5
Silt/Clay	95

Remarks:

See Summary of Soil Descriptions



PSL

Professional Soils Laboratory

Great Ducie Street

Contract No:

PSL21/8643

Client Ref:

15-175

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

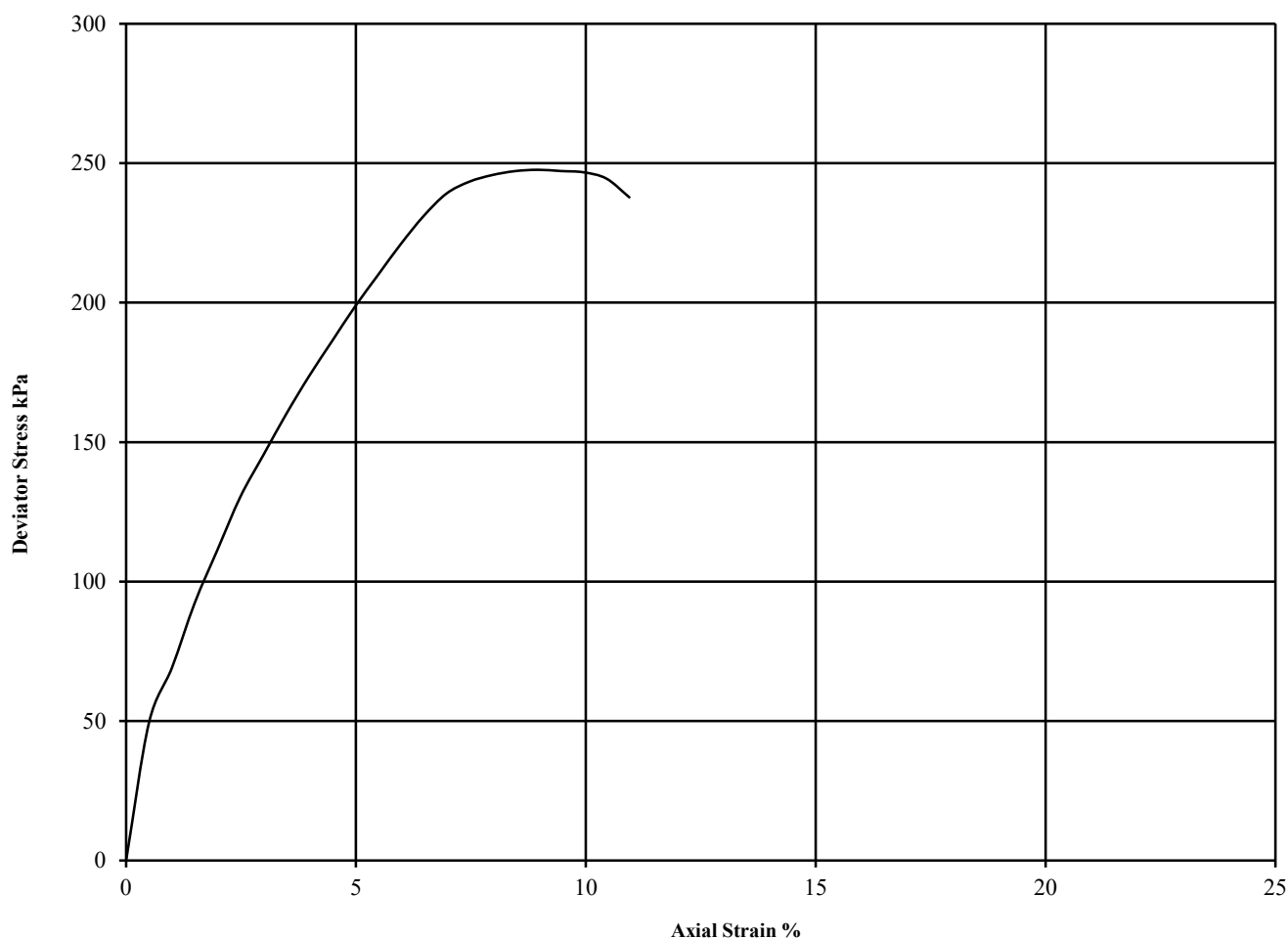
Hole Number: BH104

Top Depth (m): 6.50

Sample Number:

Base Depth (m): 6.95

Sample Type U



Diameter (mm):		103	Height (mm):		207	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Cell Pressure (kPa)	Corr. Max. Deviator Stress (kPa)	Shear Strength Cu (kPa)	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.35 See summary of soil descriptions
				θ_3	$(\theta_1 - \theta_3)_f$	$\frac{1}{2}(\theta_1 - \theta_3)_f$			
1	20	2.11	1.76	130	248	124	9.0	Brittle	



4043

PSL

Professional Soils Laboratory

Great Ducie Street

Contract No:

PSL21/8643

Client Ref:

15-175

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

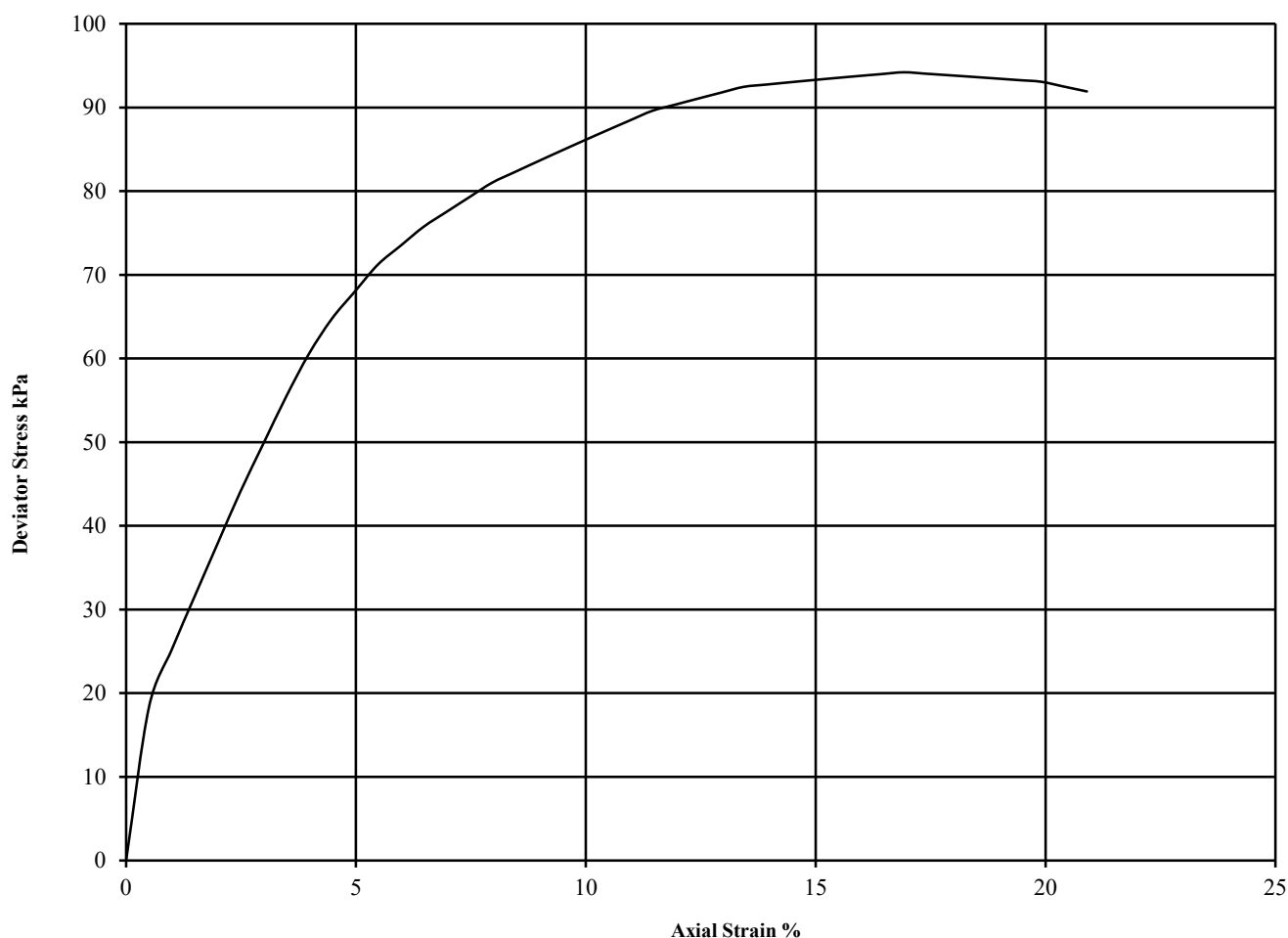
Hole Number: BH102

Top Depth (m): 4.00

Sample Number:

Base Depth (m): 4.45

Sample Type U



Diameter (mm):		103	Height (mm):		207	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa)	Corr. Max. Deviator Stress (kPa)	Shear Strength Cu (kPa)	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.34 See summary of soil descriptions
				θ_3	$(\theta_1 - \theta_3)_f$	$\frac{1}{2}(\theta_1 - \theta_3)_f$			
1	21	2.07	1.71	80	94	47	16.9	Plastic	



4043

PSL

Professional Soils Laboratory

Great Ducie Street

Contract No:

PSL21/8643

Client Ref:

15-175

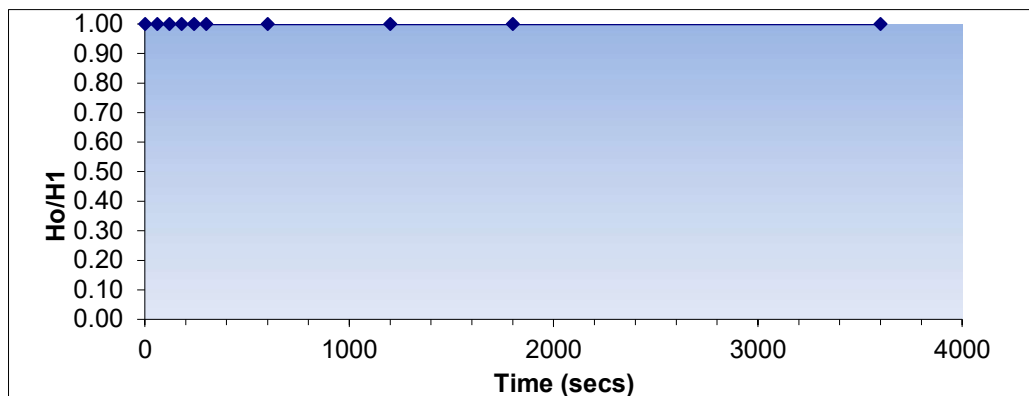
APPENDIX IX FALLING HEAD PERMEABILITY TEST CERTIFICATES

Falling Head Test

Borehole: **WS103** Test No: **1**

Contract No:	15-175	Casing Diameter: (m)	0.05
Contract Title:	Former Boddingtons Site	Height of Casing:	0
Date of Test:	19/10/2021	Depth of Borehole: (m)	3.90

Recorded Time			Total Time (secs)	Depth (m)		H/Ho
Hours	Minutes	Seconds				
0	0	0	0	0	0	1.0000
0	1	0	60	0	60	1.0000
0	2	0	120	0	120	1.0000
0	3	0	180	0	180	1.0000
0	4	0	240	0	240	1.0000
0	5	0	300	0	300	1.0000
0	10	0	600	0	600	1.0000
0	20	0	1200	0	1200	1.0000
0	30	0	1800	0	1800	1.0000
0	60	0	3600	0	3600	1.0000



General Approach

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

k = permeability of soil
 F = Intake Factor (figures 6 & 7, BS5930:1999)
 H_1 = variable head measured at time t_1 after commencement of test
 H_2 = variable head measured at time t_2 after commencement of test
 A = Cross sectional area of borehole casing or standpipe as appropriate.

$H_1 =$	1	$t_1 =$	60
$H_2 =$	1	$t_2 =$	1800
		$F =$	3.93

$A = 0.00196349 \text{ m}^2$

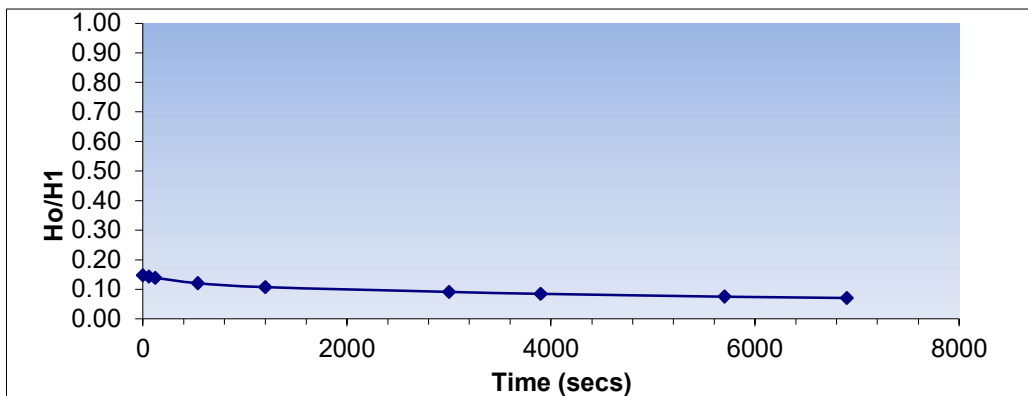
Coefficient of Permeability, $k = 7.81\text{E-}07 \text{ m/s}$

Falling Head Test

Borehole: **WS111** Test No: **1**

Contract No:	15-175	Casing Diameter: (m)	0.05
Contract Title:	Former Boddingtons Site	Height of Casing:	0
Date of Test:	19/10/2021	Depth of Borehole: (m)	4.40

Recorded Time			Total Time (secs)	Depth (m)		H/Ho
Hours	Minutes	Seconds				
0	0	0	0	3.75	0	0.1477
0	1	0	60	3.77	60	0.1432
0	2	0	120	3.79	120	0.1386
0	9	0	540	3.87	540	0.1205
0	20	0	1200	3.93	1200	0.1068
0	50	0	3000	4.00	3000	0.0909
0	65	0	3900	4.03	3900	0.0841
0	95	0	5700	4.07	5700	0.0750
0	115	0	6900	4.09	6900	0.0705



General Approach

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

k = permeability of soil
 F = Intake Factor (figures 6 & 7, BS5930:1999)
 H_1 = variable head measured at time t_1 after commencement of test
 H_2 = variable head measured at time t_2 after commencement of test
 A = Cross sectional area of borehole casing or standpipe as appropriate.

$H_1 =$	0.1432	$t_1 =$	60
$H_2 =$	0.075	$t_2 =$	5700
		$F =$	3.93

$A = 0.00196349 \text{ m}^2$

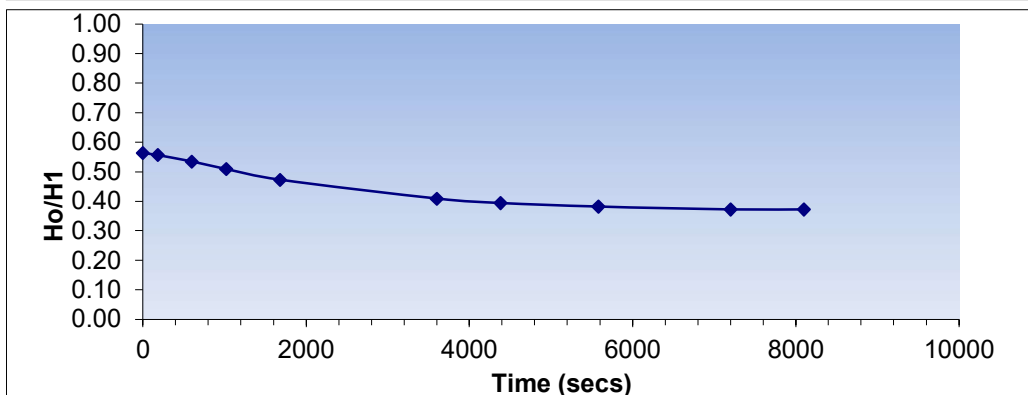
Coefficient of Permeability, $k = 4.6\text{E-}07 \text{ m/s}$

Falling Head Test

Borehole: **BH102** Test No: **1**

Contract No:	15-175	Casing Diameter: (m)	0.05
Contract Title:	Former Boddingtons Site	Height of Casing:	0
Date of Test:	19/10/2021	Depth of Borehole: (m)	5.50

Recorded Time			Total Time (secs)	Depth (m)		H/Ho
Hours	Minutes	Seconds				
0	0	0	0	2.40	0	0.5636
0	3	0	180	2.44	180	0.5564
0	10	0	600	2.56	600	0.5345
0	17	0	1020	2.70	1020	0.5091
0	28	0	1680	2.90	1680	0.4727
0	60	0	3600	3.25	3600	0.4091
0	73	0	4380	3.33	4380	0.3945
0	93	0	5580	3.40	5580	0.3818
0	120	0	7200	3.45	7200	0.3727
0	135	0	8100	3.45	8100	0.3727



General Approach

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

$$H_1 = 0.5564$$

$$H_2 = 0.3818$$

k = permeability of soil

F = Intake Factor (figures 6 & 7, BS5930:1999)

H₁ = variable head measured at time t₁ after commencement of test

H₂ = variable head measured at time t₂ after commencement of test

A = Cross sectional area of borehole casing or standpipe as appropriate.

$$t_1 = 180$$

$$t_2 = 5580$$

$$F = 2.86$$

$$A = 0.00196349 \text{ m}^2$$

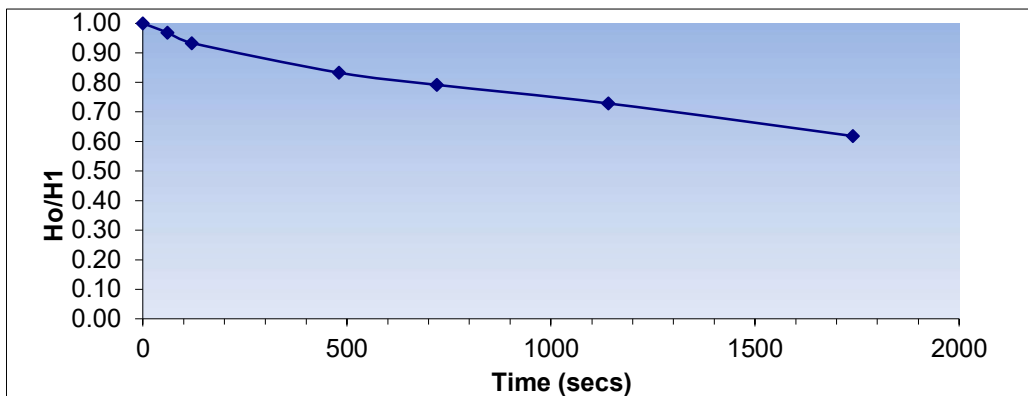
Coefficient of Permeability, k = 5.04E-07 m/s

Falling Head Test

Borehole: **BH103** Test No: **1**

Contract No:	15-175	Casing Diameter: (m)	0.05
Contract Title:	Former Boddingtons Site	Height of Casing:	0
Date of Test:	19/10/2021	Depth of Borehole: (m)	4.80

Recorded Time			Total Time (secs)	Depth (m)		H/Ho
Hours	Minutes	Seconds				
0	0	0	0	0	0	1.0000
0	1	0	60	0.15	60	0.9688
0	2	0	120	0.32	120	0.9333
0	8	0	480	0.80	480	0.8333
0	12	0	720	1.00	720	0.7917
0	19	0	1140	1.30	1140	0.7292
0	29	0	1740	1.83	1740	0.6188



General Approach

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

k = permeability of soil
 F = Intake Factor (figures 6 & 7, BS5930:1999)
 H_1 = variable head measured at time t_1 after commencement of test
 H_2 = variable head measured at time t_2 after commencement of test
 A = Cross sectional area of borehole casing or standpipe as appropriate.

$H_1 =$	0.9688	$t_1 =$	60
$H_2 =$	0.7292	$t_2 =$	1140
		$F =$	1.28

$A = 0.00196349 \text{ m}^2$

Coefficient of Permeability, $k = 5.13\text{E-}06 \text{ m/s}$

APPENDIX X ROCK CORE PHOTOGRAPHS

PLATE 3 BH101 – 20.00 M – 23.00 M BGL



PLATE 4 BH101 – 23.00 M – 26.00 M BGL



PLATE 5 BH101 – 26.00 M – 29.00 M BGL



PLATE 6 BH102 – 7.50 M – 10.50 M BGL



PLATE 7 BH102 – 10.50 M – 13.50 M BGL



PLATE 8 BH102 – 13.50 M – 16.50 M



PLATE 9 BH103 – 7.50 M – 10.50 M BGL



PLATE 10 BH103 – 10.50 M – 13.50 M BGL



PLATE 11 BH103 – 16.50 M – 19.50 M BGL



PLATE 12 BH104 – 20.00 M – 23.00 M BGL



PLATE 13 BH104 – 23.00 M – 26.00 M BGL



PLATE 14 BH104 – 26.00 M – 29.00 M BGL



APPENDIX XI UKWIR PIPELINE RISK ASSESSMENT

Supplementary guidance for the selection of water pipes in land potentially affected by contamination

Introduction

In January 2011, UK Water Industry Research (UKWIR) published “Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites” (Ref 10/WM/03/21; the ‘UKWIR Guidance’). Its aim is to ensure that the correct materials are selected for water pipes and components to be used below ground in brownfield sites to protect the quality of drinking water whilst taking into account the service life of the water distribution system. It supersedes the Water Regulations Advisory Scheme (WRAS) Information and Guidance Note 9-04-03 “Laying Pipes in Contaminated Land” which has been withdrawn.

The UKWIR Guidance is for use by developers, self-lay organisations, water companies and consultants when planning, designing and constructing water mains and/or services in brownfield sites. It defines brownfield sites as “land or premises that have previously been used or developed. They may also be vacant or derelict. However, they are not necessarily contaminated.” The UKWIR Guidance states that it does not apply to greenfield sites; however, we consider this supplementary guidance and the relevant sections of the UKWIR guidance as being equally suitable for application to those greenfield sites considered to be potentially affected by contamination. Where greenfield sites are not affected by contamination a preliminary risk assessment (see below) will suffice.

The UKWIR Guidance also states that there should be no departure from its provisions “*except where formally approved by the Water Company, such departure being technically justifiable or representing advances in knowledge or product development*”.

We have adopted the UKWIR Guidance in principle and produced this company specific supplementary guidance (the ‘UUW Guidance’) which includes the Risk Assessment for Water Pipes (the ‘RA’).

This guidance does not cover operative safety, health exposure modelling or accidental pipe damage.

Risk Assessment for Water Pipes in Land Potentially Affected by Contamination

Any application for new water supplies to a development (construction of new properties, or renovation or conversion of existing buildings) in land potentially affected by contamination shall include a completed RA.

As a minimum a desk study (preliminary risk assessment) shall be provided with the RA in accordance with the framework in Environment Agency publication “Model Procedures for the Management of Land Contamination” (ref: CLR11) that sets out whether the land through

which the pipes are to be laid may be affected by contamination. The application of the source, pathway, receptor concept will be an integral part of any pipeline risk assessment. For each potential source (the contamination) and each potential receptor (the water pipe), consideration shall be given to whether a potential pathway between source and receptor exists, or may exist in the future, linking the two. There are normally only three pathways by which contamination may come into contact with water pipes. These are direct contact with the soil or backfill, an excessive vapour phase or a contaminated groundwater regime. If none of these conditions exist on site (adopting the source, pathway, receptor concept) then it is likely that extended and/or targeted soil testing will not be required and a simple risk assessment will suffice. For those sites where land may be affected by contamination appropriate testing shall be undertaken on the materials within which the pipes are to be laid, whether that be existing ground materials, remediated materials or imported capping materials. The testing requirements are as described in the following section.

The signatories of the Water Supply Application Form and the RA must ensure that all assessments of land condition have been carried out in accordance with applicable current standards and guidelines by or under the direction of a suitably qualified competent person.

We require the competent person to be a) a chartered member of an appropriate professional body (such as the Institution of Civil Engineers, the Geological Society of London or the Royal Institution of Chartered Surveyors) with relevant experience of investigating contaminated sites or b) a Specialist in Land Condition (SiLC) with appropriate geo-environmental experience.

How to contact us about the information in this leaflet



DeveloperServicesWater@uuplc.co.uk



0345 072 6067

Opening hours:
8am-5pm Mon to Thurs
8am-4.30pm Fri

Testing Requirements

The soil, rock and if appropriate groundwater tests that are required on all sites where the potential for organic contamination has been identified in the desk study and where water pipes are proposed to be laid must be accredited by United Kingdom Accreditation Service (UKAS) as a minimum and where commercially available the Environment Agency's Monitoring Certification Service (MCERTS). These accredited tests should be undertaken for:

Banded hydrocarbons EC5-EC10, EC10-EC16, EC16-EC40 (Total aliphatic and aromatic hydrocarbons for each banding may be summed). Aliphatic/aromatic fractionation and subsequent banding may be required should a more detailed site specific risk assessment be undertaken. The bandings have been amended to take into account readily available laboratory tests. The equivalent carbon number (EC) is used to assess petroleum hydrocarbon mixtures rather than the actual number of carbon atoms in the molecule in line with guidance issued by the Environment Agency (2005).

Volatile organic compounds (VOCs) (method by head space or purge & trap GCMS) with tentative identification of compounds greater than 20µg/kg. The method used should be capable of detecting a wide range of compounds listed in US EPA Method 8260C or similar. The method should include analysis of naphthalene.

BTEX (Benzene, toluene, ethyl benzene and xylenes) plus MTBE (Methyl-tertiary butyl ether) (by head space GCMS)

Semi-Volatile Organic Compounds (SVOCs) (method by GCMS) with tentative identification of compounds greater than 20µg/kg The method used should be capable of detecting the compounds listed in US EPA Method 8270D or similar. The total concentration of SVOCs excludes polycyclic aromatic hydrocarbons, ethers, nitrobenzene, ketones, aldehydes, phenols, cresols and chlorinated phenols. Phenols, cresols and chlorinated phenols which are detected by the SVOC analysis are given their own assessment criteria.

We do not consider Table G1 and Table 3.1 of the UKWIR Guidance to be a definitive guide for assessing total concentrations. Table 1 in the RA below replaces Table 3.1 of the UKWIR Guidance.

Where previous site uses include the use, storage, treatment, disposal or manufacture of any of the following, appropriate testing for these substances will be required:

- Ethers, nitrobenzene, ketones, aldehydes and amines. Note that the presence of amines on any site at the proposed pipe depth +/- 1.0m precludes the use of polyethylene. The methods of analysis and method of calculation of total concentrations of these compounds will need to be agreed with UUW.

To comply with the testing requirements, the suites of tests that are required on all brownfield sites where wrapped steel, wrapped ductile iron or copper pipes are to be laid as minimum must include:

- pH, Conductivity and redox potential

Sufficiency of Testing

Water pipes are normally laid at between 0.75 and 1.35m from finished ground level to crown of pipe. Samples taken and tested must represent both a) the soil in which the water pipes are to be laid and b) the soil down to at least 500mm below the underside of the proposed pipe. Where the proposed depth of the pipes is unknown at the time of application, soil samples representative of the ground condition between surface level and 1.5m below finished ground level shall be taken as a minimum. Where appropriate (see UKWIR Guidance) groundwater sampling and groundwater monitoring will also be necessary. Photo-ionisation detection (PID) monitoring along the proposed route of the pipeline may be employed, though this does not provide a definitive guide to the suitability of water pipe materials.

Where required a sufficient number of test results should be obtained from the material in which the pipes are to be laid. CLAIRE/CIEH 2008 "Guidance on comparing soil contamination data with a critical concentration" may be used, where appropriate, to justify the number of soil samples tested; however, this statistical model should not be used on heterogeneous materials or used to average test results from different types of materials.

Further guidance on representative sampling is contained within BS10175:2011 Code of Practice for the Investigation of Potentially Contaminated Sites, the Department of the Environment's Contaminated Land Research Report "Sampling strategies for contaminated land" prepared by The Centre for Research into the Built Environment, Nottingham Trent University (Ref: CLR 4; 1994) and the Environment Agency's "Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination" (ref: R&D Technical Report P5-066/TR; 2000).

Where remediation has been carried out on the site, the test results obtained from validation samples will be used in the assessment. Where a horizontal capping system has been or will be employed using materials spread across a site, sufficient samples will need to be taken to characterise the capping material used and the results presented to UUW. However, the sufficiency of sampling on the horizontal capping system, in which the pipeline will be placed, may be assessed on the basis of the source, quantity and type of materials used.

Detection Limits

Only positive concentrations, ie those above the limit of detection should be used in summation of VOC and SVOC (or other test groups of compounds ie phenols, cresols and chlorinated phenols). Laboratory methods shall provide a minimum limit of detection of 10µg/kg for each individual VOC or SVOC (or other test groups of compounds) quantitatively detected in accordance with the methods described above. For tentatively identified compounds (TICs), only those compounds with a concentration of 20µg/kg or greater shall be used in the summation of VOC and SVOC (or other test groups of compounds).

Protective Measures

Where polyethylene, ductile iron, steel or copper pipes are to be laid on a brownfield site or other land potentially affected by contamination (whether or not it has been remediated) and where the concentrations exceed the generic guideline values set out in Table 1 of the RA, the developer shall provide either:

- a) a robust risk assessment to show how any contaminants will not significantly impact on proposed water supplies or buried assets over the lifetime of the assets; or
- b) more suitable pipe materials; or
- c) an engineering solution to protect the pipe work backed up by an adequate assessment of the risk.

Liquid free phase product (e.g. oil or free solvent layers) shall not remain in the ground or groundwater in the vicinity of water pipes, whether barrier pipe or any other pipe materials are used.

When designing pipe routes on land potentially affected by contamination, new preferential contamination pathways along the route of new water pipes shall not be created. Particular measures may be required to prevent the possible migration of contamination through pipe bedding and into controlled waters.

References

BS10175: 2011

"Investigation of Potentially Contaminated Sites Code of Practice"

CLAIRE/CIEH

"Guidance on comparing soil contamination data with a critical concentration" 2008

Department of the Environment Contaminated Land Research Report

"Sampling strategies for contaminated land"
prepared by The Centre for Research into the Built Environment, Nottingham Trent University (Ref: CLR 4) 1994

Environment Agency

"Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination"
(ref: R&D Technical Report P5-066/TR) 2000

Environment Agency

"Model Procedures for the Management of Land Contamination" (ref: CLR11), 2004

Environment Agency P5-080/TR3

"The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils", 2005

UK Water Industry Research (UKWIR)

"Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites" (Ref 10/WM/03/21) January 2011

Water Regulations Advisory Scheme (WRAS)

Information and Guidance Note 9-04-03

"Laying Pipes in Contaminated Land" 2002

Frequently asked questions

Why has UUW published supplementary guidance to the 'UKWIR Guidance for the Selection of Water Pipes to be used in Brownfield Sites'?

UUW agrees with the UKWIR Guidance in principle; we have published supplementary guidance to clarify some of the areas in which it will operate.

Does the UKWIR Guidance only apply to 'brownfield sites'?

Yes, the UKWIR Guidance does apply to brownfield sites; in addition United Utilities Water will apply this guidance and the UUW supplementary guidance to any greenfield sites which are potentially affected by contamination.

Who is responsible for completing/ signing the Risk Assessment for Water Pipes (RA)?

This may be the Developer, the Developers representative, or the competent person directing the land assessment. The signatory of the Risk Assessment for Water Pipes (RA) must ensure that all land assessments have been carried out in accordance with current standards and guidelines by or under the direction of a suitably qualified competent person. For water supply applications on land potentially affected by contamination, UUW requires the competent person to be either a chartered member of an appropriate professional body (such as the Institution of Civil Engineers, the Geological Society of London or the Royal Institution of Chartered Surveyors) with relevant experience of investigating contaminated sites or a Specialist in Land Condition (SiLC). This level of competency is intended to promote good practice and high professional standards and is no greater than that required for planning purposes by Local Authorities.

Do we need to agree the number and location of soil samples with the Water Company as indicated by the UKWIR guidance following the Preliminary Risk Assessment (PRA)?

Where a preliminary risk assessment (PRA) highlights the need for a site investigation UUW considers it is a responsibility of the qualified competent person directing the land assessment to determine the location and frequency of sampling. UUW's role would be to confirm that the appropriate

choice of pipe material has been made on the basis of the information provided.

What do we do if the pipe route is not known when the Site Investigation report is commissioned?

Where the route of the pipe is not known at the site investigation stage, then any resultant pipe selection needs to take account of any contamination found on the site. Consideration should be given to identifying the route and depth of the pipeline at the site investigation stage to avoid unnecessary testing.

Is it acceptable not to undertake a site investigation and specify the use of barrier pipe which seems to be suitable for all conditions?

Not all brownfield land is contaminated, and because of that a default to barrier pipe is not an acceptable approach to UUW, due to the possibility of higher installation and future maintenance costs. The approach as to whether a site investigation is needed should be risk based. For those sites where land may be affected by contamination appropriate testing shall be undertaken on the ground materials within which the pipes are to be laid, whether that be existing ground materials, remediated materials or imported capping materials.

Examples where defaulting to barrier pipe would not be acceptable:

- Where a capping layer (non-contaminated) is introduced within which the pipes will be installed.
- Sites with a potential low risk for contamination.
- Where liquid free phase product (e.g. oil or free solvent layers) is in the ground or groundwater in the vicinity of water pipes.
- Where the route of the pipe could be diverted to another suitable location free from contamination.

Are UUW employees who will assess the Design Proposals for contaminated sites suitably qualified?

It is the role of the Developer's suitably qualified competent person to deal with or direct the assessment of land. UUW's role is to assess the Risk Assessment for Water

Pipes and supporting Site Assessment Report (SAR) which is provided with any new water supply application (ie. it has been provided in the correct format, proposals for pipe selection are included, the methodology is in line with the UKWIR Guidance and UUW Supplementary Guidance, it has been directed by a suitably qualified competent person etc.). If UUW do need to provide assistance or information in deciding pipe materials then the assessment would be carried out under the direction of a suitably qualified competent person.

What happens to existing PE that is in the ground under the "old" guidelines?

The latest UKWIR guidance and UUW's supplementary guidance are intended to be used to decide what pipe materials will be used for new water mains and services. It will have no effect for developers with regard to any parts of UUW's existing network.

Will the Developer be required to submit a fully completed Risk Assessment for Water Pipes (RA) and supporting Site Assessment Report (SAR), including pipe material recommendation, for both the option of a mains requisition application and the option of a self-lay application?

Yes, UUW expect the 'Developer', as defined in UUW Supplementary Guidance, to submit a Risk Assessment for Water Pipes (RA) and supporting Site Assessment Report (SAR), including pipe material recommendation, in respect of any water pipes being installed on the development irrespective of who is to install them.

Does Table 1 in UUW's Risk Assessment for Water Pipes (RA) replace any of the tables to be completed in the Site Assessment Report (SAR) as required in the UKWIR Guidance?

UUW does not consider Table G1 and Table 3.1 of the UKWIR Guidance to be a definitive guide for assessing total concentrations. Table 1 in UUW's RA replaces Table 3.1 of the UKWIR Guidance.

Have any other Water Companies adopted the UKWIR Guidance yet?

You will need to contact the water company concerned if you are intending to install water pipes outside UUW's licensed area.

About us

United Utilities is the North West's water company. We keep the taps flowing and toilets flushing for seven million customers every day. From Crewe to Carlisle, we work hard behind the scenes to help your life flow smoothly.

Risk assessment for water pipes (RA)

The risk assessment for water pipes will help you choose appropriate materials for your development. We are happy to deal with a risk assessment for water pipes in advance of any formal application for a new water supply.

If you need any help completing the form please call us on **0345 072 6067**.

Section 1: Development details	
Development name (if it has one)	
Development address	Former Boddingtons Site Great Ducie Street, Cheetham Hill, Manchester, M3 1PT
OS Grid reference (mid point)	SJ 83789 99268
Developer's name	Latimer Developments Ltd
UUW reference number (for UU use only)	
Please provide details below of the current and historical use of the site and adjacent sites. If your supporting information has details of the current and historical site use, please reference below the relevant sections of your report.	
The site currently forms an area of surface level car parking off Francis Street, Cheetham Hill. The majority of the site comprises hardstanding including asphalt and concrete. The subject site comprised buildings associated with print works along with Briddon Street and Nightingale Street in earliest mapping from 1848. By 1850 the site was named Strangeways Calico Print Works with several buildings, boilers and tanks on-site; terraced housing was present in the west of the site. In 1892 the site was named Strangeways Finishing Works with Albion Works present on the north-eastern boundary. Mapping from 1933 identified several industries on the site including boot repairs, rag and cotton warehouse, plumber, dentist, hotel, waterproof clothing factory, cotton goods warehouse, mortar mill, garage, quilt and clothing factory and an oil store. Terrace housing in the west of the site was demolished and replaced with a warehouse circa 1949-1951; by this time the site was part of Strangeways Brewery. Mapping dated 1978-1989 notes that Briddon Street and Nightingale Street were no longer present with large areas of the site cleared or demolished. The site then comprised the brewery and areas of hardstanding up until some point between 2006 and 2009 where the site was demolished and was subsequently utilised as a car park, which is still its current use.	
Section 2: Preliminary risk assessment	
Has your desk study and site walkover identified any land potentially affected by contamination?	☒ Yes ☐ No
If the site is potentially affected by contamination but you have not completed any intrusive site investigation please provide details below of the rationale behind the intended pipe selection. If your supporting information has details of the rationale behind the intended pipe selection, please reference below the relevant sections of your report.	
N/A	

Section 3: Intrusive site investigation																																	
Have you completed any intrusive site investigation?						☒ Yes ☐ No																											
Have you completed any none intrusive site investigation?						☒ Yes ☐ No																											
Date(s) when the site investigation(s) undertaken						<table border="1"> <tr> <td>2</td><td>7</td><td>0</td><td>9</td><td>2</td><td>0</td><td>2</td><td>1</td> </tr> <tr> <td>D</td><td>D</td><td>M</td><td>M</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td> </tr> <tr> <td>D</td><td>D</td><td>M</td><td>M</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td> </tr> </table>				2	7	0	9	2	0	2	1	D	D	M	M	Y	Y	Y	Y	D	D	M	M	Y	Y	Y	Y
2	7	0	9	2	0	2	1																										
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At what level has groundwater been encountered?						0.80-4.80 metres below ground level or ☐ Not encountered																											
Table 1 (Pipeline Selection Risk Assessment Summary (PSRAS)) below classifies testing required where the preliminary risk assessment has identified land potentially affected by contamination. Please provide details below of any test groups which have not been tested and the rationale for not testing. <i>If your supporting information has details of the rationale behind not testing any particular test groups, please reference below the relevant sections of your report.</i>																																	
Testing for Ethers, Nitrobenzene, Ketones, Aldehydes and Amines was completed as no potential source was identified.																																	
If the intrusive site investigation has identified concentrations above the PE threshold (see PSRAS) and your intended pipe selection is PE. Please provide details below of the rationale behind the intended pipe selection. <i>If your supporting information has details of the rationale behind the intended pipe selection, please reference below the relevant sections of your report.</i>																																	
N/A																																	
Section 4: Site remediation																																	
Please provide details below of any site remediation (which may include a change in site levels) already completed. <i>If your supporting information has details of the site remediation already completed, please reference below the relevant sections of your report.</i>																																	
N/A																																	
Has the PSRAS (Table 1) been completed using appropriate data after remediation?								☐ Yes ☒ No ☐ N/A																									
Please provide details below of any proposed site remediation and an analysis of whether this will affect your intended pipe selection. <i>If your supporting information has details of any proposed site remediation and whether this will affect your intended pipe selection, please reference below the relevant sections of your report.</i>																																	
Localised heavy end TPH and PAH impact has been identified within shallow Made Ground deposits (0.80 m bgl) on site within proposed pipeline depth. Made Ground soils will be lifted, sorted and screened and placed according to the engineering specification. Further assessment is likely to be required following remediation works.																																	

Section 5: Final use of site

Please provide details below of any chemicals (including fuel) to be stored on site and any other future contamination risks which may affect your intended pipe selection.

If your supporting information has details of potential contamination risks which may affect your intended pipe selection, please reference below the relevant sections of your report.

None - The proposal is to redevelop the site for future residential end use. The development scheme comprises the construction of a car-free development comprising 461 homes and commercial spaces.

What water pipe materials are intended to be used on site?

☐ PE ☐ PE Barrier Pipe Type A ☒ PE Barrier Pipe Type B
Other (please specify): x

Section 6: Additional information

Please use the section below to provide any additional details to support your intended pipe selection.

N/A

Section 7: Risk assessor

Name and relevant qualifications of person directing the risk assessment for water pipes

Andrew Edgar BSc, MSc, MEnvSc, CEnv

Name and address of risk assessor's company

E3P
Taylor Road, Urmston
Manchester
M41 7JQ

Date risk assessment performed

2 0 1 1 2 0 2 1

Section 8: Declaration

I confirm I have completed this form and provided supporting information in accordance with 'UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' and UUW's Supplementary Guidance. I also confirm that if any further site investigation is needed and carried out, I will be required to submit an additional Risk Assessment for Water Pipes with the relevant supporting information. I understand that failure to supply any of the required information may delay my application being processed.

Name

Andrew Edgar

Company

E3P

Telephone

0161 707 9612

Date

2 0 M M Y Y Y Y

Please email the completed form and supporting information to DeveloperServicesWater@uuplc.co.uk or post to us at United Utilities Water, Developer Services, Second floor Grasmere House, Lingley Mere, Warrington WA5 3LP.



About us

United Utilities is the North West's water company. We keep the taps flowing and toilets flushing for seven million customers every day. From Crewe to Carlisle, we work hard behind the scenes to help your life flow smoothly.

United Utilities Water Limited, Haweswater House, Lingley Mere Business Park, Lingley Green Avenue, Warrington WA5 3LP.
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Table 1 - Pipe selection risk assessment summary (PSRAS)

1. Testing must be undertaken on the materials within which the pipes are to be laid, whether that be existing ground materials, remediated materials or imported capping materials. Please use the appropriate testing data to complete Table 1 below.

2. If more than one pipe selection is being made, for example, for pipes in different areas of a large site, a completed PSRAS is required for each selection.

What materials have been tested to populate Table 1 below? ☒ Existing ground materials ☐ Remediated materials ☐ Imported capping materials

All concentrations in mg/kg								
Test Group	Testing Required?	PE threshold	Metal Pipes/ Barrier Pipe	Laboratory Detection Limit	Testing UKAS accredited Y/N	Maximum concentration at proposed pipeline depth See Note [2]	Maximum site concentration See Note [3]	Locations and depths where concentrations exceed proposed pipeline threshold
Total VOCs	Where Preliminary Risk Assessment (PRA) has identified land potentially affected by contamination	0.5	Pass	1.0	Y	<1.0	<1.0	N/A
Total BTEX & MTBE		0.1	Pass	1.0	Y	<1.0	<1.0	N/A
Total SVOCs (excluding PAHs and those substances marked with an *)		2	Pass	0.05 - 0.3	Y	2.9	2.9	WS111 - 0.80 m bgl
EC5-EC10 aliphatic and aromatic hydrocarbons		2	Pass	0.1 - 10	Y	<2.0	<2.0	N.A
EC10-EC16 aliphatic and aromatic hydrocarbons		10	Pass	2.0 - 4.0	Y	17	30	WS106 - 1.20m, WS108 - 6.60m
EC16-EC40 aliphatic and aromatic hydrocarbons		500	Pass	1.0 - 10	Y	1673	3590	WS101 - 0.80m, WS108 - 6.60 m
Phenols* (from SVOC analysis)		2	Pass	1.0	Y	<1.0	<1.0	N/A
Cresols and chlorinated phenols* (from SVOC analysis)		2	Pass	-	-	-	-	-
Ethers*	Only where identified	0.5	Pass	-	-	-	-	-
Nitrobenzene*		0.5	Pass	-	-	-	-	-
Ketones*		0.5	Pass	-	-	-	-	-
Aldehydes*		0.5	Pass	-	-	-	-	-
Amines		Fail	Pass	-	-	-	-	-
Corrosive	Conductivity, Redox and pH	Pass	See Note [1]	-	-	pH 8.2 - 11.1	-	-

Note [1] Threshold: For wrapped steel, corrosive if pH<7 and conductivity > 400µS/cm. For wrapped ductile iron corrosive if pH<5, Eh not neutral and conductivity > 400µS/cm. For copper, corrosive if pH<5 or >8 and Eh positive.

Note [2] Water pipes are normally laid at 0.75-1.35m below finished ground level.

Note [3] Also state if liquid free product is present in soil or groundwater.