

NX406 Phase 1 & Phase 2 Geoenvironmental Assessment Report for No 1 City Road East, Manchester, M15 4PN

Project No: NX406

Planning Application Reference: 128002/FO/2020



Client

MARSHALL

DOCUMENT VERIFICATION

Report Reference: NX406**Issue: Final****Date: 5th September 2023****Written by:**

Matthew Tomkinson
Senior Geoenvironmental Engineer
(For and on Behalf of NX Consulting Ltd)

Written & Approved by:

Mark Newton
Director
(For and on Behalf of NX Consulting Ltd)

Revision History

Revision	Date	Description	Reviewed by	Approved by
Issue	September 2023	Final		

Issued By:
Station House
Stamford New Road
Altrincham
WA14 1EP

Contact: Mark Newton
Email: marknewton@nxconsulting.org.uk
Telephone: 0161 929 6034

EXECUTIVE SUMMARY

Site Location	One City Road East, Manchester, M15 4PN.
Grid Reference	E383596, N397324
Site Area	0.55ha
Current Site Use	<p>The site is irregular in shape and consists of No. 1 City Road office development which comprises 4no. connected multi-storey commercial office buildings, located in the eastern site area.</p> <p>Site levels dip to the north/northeast and east from 33.6m in the north to 31.30 on the eastern boundary.</p> <p>The western site area comprises a car park. Raised landscaping beds are present along the site boundary. Trees are present within these areas in parts as shown on a topographical drawing provided within Appendix A.</p> <p>No visual and olfactory evidence of hydrocarbon/solvent contamination were observed during the site walkover. No ground floor plantrooms or chemical stores are thought to be present upon site. An electricity substation is present on the northern boundary. This is formed upon a raised concrete and brick bund and appeared to be well maintained during the site walkover.</p> <p>The site is located within a predominately commercial area, bounded by Medlock Street to the east, City Road E to the north, Shortcroft Street to the west and River Street to the south with a multi-storey hotel.</p>
Development Proposals	The site is currently developed with 4no. connected commercial office buildings which are proposed to be demolished and replaced with 2no. blocks of 11-14 storey commercial office buildings.
Geology Mapping	<p>Artificial Deposits</p> <ul style="list-style-type: none"> None Shown on mapping. <p>Drift</p> <ul style="list-style-type: none"> Alluvium Glaciofluvial Sheet Deposits (Devensian) (Sand and Gravel). Glacial Clay. <p>Bedrock</p> <ul style="list-style-type: none"> Chester Formation (Sandstone). <p>Faults</p> <ul style="list-style-type: none"> None indicated in the vicinity of the site.
Ground Conditions in BGS Boreholes & Arup Report	<p>The borehole data viewed on the BGS website identifies Made Ground comprising clay, sand and ballast to 6.71-7.01m bgl. This is directly underlain by sandstone bedrock proven to approximately 11.28m bgl.</p> <p>Arup carried out a ground investigation in February 1993. Up to 5.30m of made ground. Beneath the made ground, up to 2.25m of Alluvium was encountered. It consisted of soft to firm grey-brown clayey silt, sand silt, loose light grey sand with occasional soft silty clay, fine gravel, peat laminations and sand and gravel layers.</p> <p>Beneath the alluvium or the made ground (where the alluvium is absent) up to 2.3m of Glacial Sand and Gravel was encountered. In one trial pit the stratum was proved to 2.6m but was not fully penetrated. The stratum</p>

	<p>consisted of medium dense yellow-brown to brown silty fine to coarse sand with some fine to coarse angular to subrounded gravel and cobbles, clay - bound in parts.</p> <p>Beneath the Glacial Sand and Gravel or made ground (where the upper strata were absent) up to 2.10m of Glacial Till was recorded. The Till consisted of stiff to very stiff brown silty sandy clay with some fine to medium sand lenses and occasional fine to medium gravel. In places the clay was initially softened. In one borehole, the clay was replaced by a layer of very dense grey-brown silty fine sand, slightly clayey in parts, with some weakly cemented sandstone gravel.</p> <p>Very weak, becoming moderately weak red-brown fine to medium grained sandstone with occasional 'marly' mudstone layers and lenses up to 0.2m thick and fine to medium quartz gravel inclusions was recorded at depths circa 6.0m to 7.0m bgl. The rock was initially completely weathered and recovered as sand but became moderately weathered with depth.</p> <p>Groundwater was limited to seepages in in 4no boreholes at depths of between 2.3 and 6.8m depth with moderate flows recorded within two boreholes st depths of 4.8 and 7.1m.</p>
Hydrology	<p>The nearest surface watercourse to the site is the River Medlock, located 12m to the north of the site.</p> <p>The River Catchment (Lumb Brook to River Irwell) has an Overall EA rating of moderate. The Ecological rating is Moderate. The Chemical rating is Good.</p>
Hydrogeology	<p>Drift - Secondary A Aquifer (permeable layers capable of supporting water supplies at a local rather than strategic scale).</p> <p>Bedrock deposits – Chester Formation strata underlying the site are a Principal Aquifer (geology of high intergranular and/or fracture permeability, usually providing high levels of water storage).</p> <p>Several groundwater abstractions have been identified within 1000m. The closest abstractions are 506m south & 55m east.</p> <p>No surface water or potable abstractions are recorded within 1km of the site.</p> <p>The site does not lie within a currently defined Groundwater Source Protection Zone.</p>
Site History	<p>On-Site</p> <p>Historical mapping indicates that the site was development between 1841 and 1891 as a sawmill until the 1948 1950's and a timber yard until the early 1980's.</p> <p>1848 mapping shows the site to be occupied by a cluster of buildings in the central-eastern and southern site areas. The southern site area is divided by Glass Street running south-west to north-east.</p> <p>Around 1908, the site comprises a Sawmill across the majority of the site with multiple buildings.</p> <p>1948 mapping shows the southern site area to have been replaced by a Timber Yard. The Arup report highlights that 1953 photographs shows the</p>

	<p>addition of a 'factory' in the west with chimneys/incinerators in the north and south of the building respectively.</p> <p>C. 1986 The Sawmill buildings have been demolished and replaced by a car park. The is shown to be cleared c. 1990, and the current existing buildings are recorded c. 1992 with a car park in the west of the site.</p> <p>Offsite</p> <p>The site area is historically a predominately industrial area with 133no. historic industrial sites identified within 250m of the site vicinity. These include cotton mills, rubber works, gas works, chemical works, dye works, iron works, warehouses, tanks and depots/ yards.</p> <p>The former adjacent Gaythorne gas works was remediated as part of the Home developments by Ask Developments and Manchester City Council. It is understood that chemical stabilisation was applied to contaminated materials excavated from four gas holder bases, with in-situ stabilisation applied to materials in a fifth gas holder base and impacted soils in other areas of the site. Multi-phase extraction was also employed to remove mobile coal tars from the saturated zone.</p>
Utility Locations	<p>Underground services impact the site and the engineer should familiarise themselves with their presence and implications on the development.</p>
Landfill Sites, Permits, Radon & Ground Gases	<p>No current or former Environment Agency or Local Authority Registered landfill sites have been identified within 1km of the site.</p> <p>Historical scrap yards have been identified 45m north west and 70m west of the site. A former Gaythorne gas works was located 20m to the east of the site. A Waste Paper Works is historically recorded 360m east, and a recycling centre 400m north.</p> <p>The GroundSure report states that less than 1% of homes in the site vicinity were above the action level. Therefore, radon protection measures are <u>not</u> required in the construction of new dwellings or extensions.</p>
Unexploded Ordnance	<p>The regional unexploded bomb risk map from Zetica indicates that the site is in an area at moderate risk from possible Unexploded Ordnance (UXO) resulting from the Second World War. (Zetica, 2020).</p> <p>It is recommended that a detailed desk based UXO threat assessment is undertaken to establish if protection measures are required during demolition and construction.</p>
Geotechnical Assessment	<p>It is considered that the use of vibro replacement stone columns are suitable for lightly loaded foundations and floor slab. For the main building Contiguous Flight Augur or a bored piled foundations (socketed into the sandstone bedrock) are likely to be the most suitable solution for both foundation to reduce the risk of excessive total and differential settlement associated with Made Ground and drift deposits.</p> <p>A piling risk assessment will be required to establish the most suitable pile type and mitigate the risk of contamination to impact the underlying secondary A and Principal Aquifers.</p> <p>Based on information provided to date, a bored piled solution is likely to be</p>

A piling matt will be required in line with BRE470 Working Platforms for Tracked plant. This should be able to be developed from 'site won' crush which is likely to be a significant amount following site preparation and treatment.

Obstructions in the form of relic foundations, floor slabs, infilled cellars/basements, former chimney bases and roads/infrastructure should be anticipated across the site. Heavy plant and machinery may be required to break out existing slabs/retaining walls/ground beams and cellars/basement slabs.

These materials will require 'grubbing out' and treatment (screening/crushing/segregation and reused (where appropriate) on site to prevent deflection/obstruction of the piled foundations and services formation.

Surface treatment of surface hardstanding should be anticipated within all areas comprising excavation, crushing, screening with reuse and/or removal from site.

Existing piles and possibly oversize foundation bases are likely to be present upon site and during site preparation will need to be recorded /surveyed to enable foundations and infrastructure to the new development to be designed.

Trees may be within possible influencing distance of the site and some foundations and drainage heave/shrinkage protection measures in line with NHBC Standards guidance document Chapter 4.2 Building Near Trees.

Ground water and surface water should be control in accordance with CIRIA report 113 "Control of Ground Water to Temporary Works. A perched and discontinuous groundwater regime is likely to be present within granular soils within the upper 3m of strata. Excavations are unlikely to remain fully dry but should be able to be controlled by a screened sump pump techniques within the upper 3.00mbgl of strata. Below this depth, specialist protection measures may be required such as 'well point' systems. Advice from a qualified hydrogeologist to advise on specialist measures.

Arrangements should be made to prevent surface water ponding and water softening in any excavation and within formation level soils. The Contractor should ensure that ground levels are of sufficient gradient to enable the collection of surface water run-off in sumps or grips. Pumping from over excavated sumps may be required to maintain satisfactory working conditions.

Soakaway testing was undertaken within 2 locations broadly in accordance with BRE Digest No 365, to confirm the suitability of the Made Ground, Glacial Sand and Gravel, and Glacial Till. The depth of drainage and the proposed invert level and volume of the surface water ingress, will be critical; due to clayey nature of the Made Ground, Glacial Clay and interbedded and cohesive nature of the Glacial Sand and Gravel deposits. Further soakaway tests are recommended at planned locations if they are to be considered further.

Conceptual Model

A CBR value of 2% should be used for pavement construction within the Made Ground deposits. Where pavements intercept existing car parking sub base a CBR value of 5 to 15% may be achievable. CBR testing should be carried out to inform design.

Any large/high level retaining walls may need to be piled due to the depth and nature of made ground. Site reprofiling should take this into account.

The Site is not included on the list of sites designated as contaminated land. With respect to existing commercial development, the likelihood of action being taken under the Environmental Protection Act 1990 is considered to be low. We consider that the site can be considered suitable for the proposed commercial end use.

A preliminary and refined risk assessment, based upon the findings of the intrusive investigation, is presented in Appendix F the general findings of which are discussed below.

Outline remediation solutions for site development will involve further supplementary groundwater analysis around RBH01, where TPH concentrations of 1200ug/l have been recorded at 4.20m bgl. Depending on the findings of the supplementary works, possible quantitative groundwater modelling may be required to inform a suitable remediation solution.

In terms of risks from potential soil contamination, the majority of the site contaminants are likely to be isolated beneath buildings and areas of hardstanding. In areas of soft landscaping and P.O.S areas, to protect end users from isolated concentrations of contamination, a soil cover system (consisting of a minimum 600mm thick layer) is likely to be required over deposits of Made Ground.

Site workers involved in excavations for foundations, roads, sewers etc during the construction works may come into direct contact with the soils containing elevated concentrations of PAH's, or potentially other forms of contamination including asbestos. Mitigation measures for dealing with potential asbestos fibres are recommended.

In terms of other contamination, we recommend that simple precautionary measures be adopted during the construction phase i.e. good personal hygiene, provision of suitable welfare facilities and basic personnel protective equipment.

Any areas of proposed landscaping and public open space will require imported subsoil/topsoil materials which will require chemical validation to demonstrate that they are suitable for a commercial end use and taken to depths sufficient to provide a sufficient cover system for all proposed materials used which are capable to support root growth.

Risk to Controlled water are considered to be low upon completion of the development. Supplementary works are recommended around RBH01 and if contamination is found during construction works the associated risks should be reassessed.

A low to moderate risk of presence of hazardous ground gas associated with alluvial deposits near River Medlock and made ground present on site.

Gas protection measures should be installed in accordance with BS8485: 2015. Based on a Type C development and CS2 classification a gas protection score of 2.5 to will need to be achieved.

Prior to the adoption of any gas protection measures, agreement should be sought from the local authority environmental health department and building control.

Depending on the foundations and sub floor construction utilised, some or all of the following protective measures may be required.

- Reinforced cast in-situ floor slab (suspended or non-suspended) with a proprietary low permeability resistant membrane.
- Membrane to be sealed across whole building including cavity walls.
- Possibly ventilated subfloor void, depending on sub floor construction.
- All joints and penetrations to be sealed.

No radon protection measures are anticipated.

During the preliminary works, all arisings from the ground investigation were screened on-site for the presence of volatile organic compounds (VOC) using a MiniRae Photoionisation Detector (PID). No elevated concentrations were recorded. As part of any remediation options appraisal consideration should be given to incorporating vapour monitoring around RBH01, to establish the risks of potential volatilisation via indoor air migration pathways to adversely impact site occupiers.

Specialist potable water pipework will be required. This will need to be confirmed following completion of a UKWIR assessment with the Regulators and testing along the line of the proposed pipework once positions are known.

A CL:AIRE COP Materials Management Plan (MMP), remediation strategy and final validation reports are recommended and will be required prior to discharge of any outlying planning conditions.

Standard contaminated land planning conditions (requiring investigation, risk assessment, remediation strategy, implementation and validation) are likely to be applied to any planning consent and will require staged regulatory approval.

EXECUTIVE SUMMARY.....	2
1.0 INTRODUCTION	10
1.1 Instruction	10
1.2 Previous Assessments	10
1.3 Objectives & Scope of Work	11
1.4 Report Layout	12
1.5 Limitations	12
2.0 PHASE 1 ASSESSMENT SUMMARY	14
2.1 Site Location & Setting	14
2.2 Geology, Hydrology, Hydrogeology & Soil Properties	14
2.3 Mining Extraction and Natural Cavities	16
2.4 Site History	17
2.5 Environmental Information	18
2.6 Existing Ground Conditions and Possible UXO	19
2.7 UXO Risk	20
3.0 PRELIMINARY CONCEPTUAL MODEL	21
3.1 Risk Assessment	21
4.0 FIELDWORKS	28
4.1 General	28
4.2 Rotary Core Boreholes (RBH)	28
4.3 Window Sampler Boreholes (WS)	29
4.4 Cable Percussive Boreholes (CP)	29
4.5 Mechanically Excavated Trial Pits (TP)	30
4.6 Manually Excavated Hand Pits (HP)	30
4.7 Sample Collection and Analysis	30
5.0 GROUND CONDITIONS	31
5.1 General	31
5.2 Ground & Groundwater Conditions	31
5.3 Groundwater	36
5.4 Underground Service Plans & Relic Tank Features	36
5.5 Below ground obstructions	37
5.5 Contamination Observations	38
6.0 GEOTECHNICAL TESTING	39
6.1 Laboratory Analysis	39
7.0 GEOTECHNICAL ASSESSMENT	41
7.1 General	41
7.2 Geotechnical Parameters	41
7.3 General	43
7.4 Earthworks, Excavations and Groundwater	45
7.5 Soakaway Drainage	47
7.6 Shallow Mineworkings	48
8.0 GEOCHEMICAL GROUND AND GROUNDWATER ASSESSMENT	49
8.1 Introduction & Sampling Strategy	49
8.2 Rationale	50
8.3 Soil Guideline Values	51

8.4	LQM/CIEH Suitable 4 Use Levels (S4UL).....	51
8.5	Site Soils.....	52
8.5.1	<i>NX Consulting Investigation</i>	52
8.5.2	<i>Water Supply</i>	55
8.5.3	<i>Phytotoxicity</i>	56
8.5.4	<i>Controlled Waters</i>	56
8.5.5	<i>Discussion and Recommendations</i>	57
8.5.6	Waste Classification	60
8.6	Ground Gases	62
8.6.1	Asphyxiant, Noxious or Explosive Gases	62

9.0 PRE-REMEDATION CONSTRAINTS AND OUTLINE REMEDIATION STRATEGY

65

9.1	Invasive Plants.....	65
9.2	Services.....	65
9.3	Hardstanding & Surface Cover	65
9.4	Land Condition and Outline Remediation.....	65
APPENDICES		69
Appendix A – Drawings & Site Photographs.....		70
Appendix B – Groundsure Report & Historical Mapping		71
Appendix C – Exploratory Hole Logs.....		72
Appendix D - Geotechnical Laboratory Test Results		73
Appendix E – HazOnline Assessment & Chemical Test Results		74
Appendix F – Conceptual Models & Risk Assessments.....		75
Appendix G – Gas Monitoring Results		76

1.0 INTRODUCTION

1.1 Instruction

NX Consulting Limited have been commissioned by Marshall CDP (The Client) to complete a Phase 1 Geoenvironmental Desk Study & Preliminary Phase 2 Ground Investigation report on Land at One City Road, Manchester, M15 4PN.

It is understood that the site is currently developed with 4no. connected commercial office buildings which are proposed to be demolished and replaced with 2no. blocks of 11-14 storey commercial office buildings with associated car parking and limited landscaping areas.

1.2 Previous Assessments

Previous assessments conducted either on site or within the immediate surrounding area; which should be read in conjunction with this study; comprise the following:

- 'Phase 1 Geoenvironmental Desk Study on Land at One City Road, Manchester, M15 4PN' by NX Consulting. Reference Ref: NX406/R1, dated August 2020.
- 'Geotechnical report – No 1 City Road, Manchester' by Arup, reference Report 18693/CRL/KSC, dated February 1993.

The NX Consulting Phase 1 report will be summarised within section 2 of this report. The Arup report is summarised below.

NX Consulting have been provided with a former ground investigation report for the site, carried out in 1988.

The report was carried out by Ove Arup & Partners (Arup) on behalf of Inner-City Enterprises plc. The development comprised four interconnecting office blocks, between 2 and 4 storeys high, with an observation tower attached at one end and car parking across the remainder of the site.

A ground investigation consisted of trial pits and boreholes with associated in-situ soil testing and laboratory chemical and soil tests. The pits and boreholes encountered variable thicknesses of Made Ground, alluvium and glacial deposits overlying Bunter Sandstone bedrock at a depth of approximately 6.5m. Obstruction in the form of relic infrastructure such as foundations, basements, cobble setts were recorded.

Ground water was limited to seepages towards the base of the Made Ground or in isolated pockets in the alluvium.

Arup identified within historical mapping that the site experienced extensive bomb damage to the south of the site below River Street (1946). Terrance housing was flattened, but gas holders relating to Gaythorn Gas Works were left intact. Timber yards and sheds were also recorded within the south of the site. 1953 mapping indicated a two-storey factory on the west side with a large chimney in its northern end, and a new

shed with a chimney or incinerator was present within the eastern area of site. The site remained this way till 1984 where the present configuration appeared disused.

Arup stated that, on the whole, the site was uncontaminated, although a limited number of samples tested showed slight (or, in one case heavy) contamination and since the majority of the site was to be covered with buildings, roads and car parking areas, the contamination should not present any problems after construction. Although they did note that there is a slight risk to workers during construction from heavy metal contamination.

The report recommended that the office structures should be supported on bored and cast in-situ 450 and 600mm diameter piles founded beneath any weathered layers on the Bunter Sandstone at a depth of between 8 and 9m. In advance of the piling, the made ground was probed at each pile position to establish the presence or otherwise of obstructions; associated with the former sawmills, timber works and residential housing once occupying the site.

1.3 Objectives & Scope of Work

Guidance set out in LCRM¹, GPLC1-3² and the National Planning Policy Framework (NPPF)³ states that a Preliminary Risk Assessment with a site reconnaissance is required as a minimum to ascertain if there is a potential contamination risk. If contamination is a potential, then site investigation works are carried out to establish a viable pollutant linkage to assess the potential risks to human health and controlled water receptors.

1 EA (2020). "Land contamination risk management (LCRM).

2 EA (2010). "Guiding Principles for Land Contamination." GPLC1-3.

3 DCL (2012). "National Planning Policy Framework." Department of Communities and Local Government. March 2012.

The objectives of the NX Consulting preliminary geoenvironmental site assessment was as follows:

- To undertake a Phase I Desk Study for the site;
- To provide further information on ground conditions to facilitate design of site infra-structure for the proposed new buildings, landscaping and hardstanding;
- To conduct chemical analysis on collected soil and groundwater samples of Made Ground and natural soils and provide a semi-quantitative assessment of potential risks from contaminants to human health and/or controlled waters, comprising a further Refined Conceptual Model; and,
- Provide preliminary recommendations regarding any outline remedial measures necessary to mitigate any risks to human health or controlled waters resulting from contamination on the site; or recommendations for any further work.

The PRELIMINARY scope of the current work included the following:

- 10no. window sampler boreholes within external locations, with associated in-situ testing to maximum depths of up to 6.45m bgl;
- 2no. Rotary Core boreholes with associated in-situ testing to maximum depths of 22.50m bgl.
- 7no. machine excavated trial pits to maximum depths of 3.10m bgl to assess the nature of Made Ground deposits, and to undertake Soakaway testing.
- 2no. machine excavated trial pits to maximum depths of 2.00mbgl for the intent of BRE Infiltration Testing.
- 2no. core holes within internal locations, progressed as manually excavated hand pits to maximum depths of 1.20m bgl for the intent of investigating ground conditions within areas where window sampler rig access was restricted.
- On site environmental screening with a Photoionisation Detector (PID) PID.

The supplementary scope of the intrusive works included the following:

- 4no. Cable Tool boreholes with associated in-situ testing to maximum depths of 7.00m bgl.
- 7no. window sampler boreholes within internal locations, with associated in-situ testing to maximum depths of up to 4.45m bgl.

1.4 Report Layout

- Section 2 of this report provides a summary of Phase 1 information from the previous NX Phase 1 & Arup reports, Groundsure Report, including site description, history, published geology, Coal Mining Risk Assessment and environmental setting.
- Section 3 details the preliminary risk assessment and site investigation design.
- Section 4, 5, 6 & 7 details the intrusive investigation carried out to validate the foundation recommendations, geotechnical conditions identified by the investigation and makes recommendations in respect of foundations, pavement construction and soakaway drainage.
- Section 8 presents the records of the chemical analyses undertaken and gives the results of the qualitative risk assessment carried out using the results of the chemical analyses and taking account of the proposed end use of the site.
- Section 9 provides outlying remedial measures arising from this investigation.

1.5 Limitations

The accuracy of the data supplied by third parties should be considered in the context of any known site conditions for which NX Consulting Limited cannot be held liable.

The comments made in this report are based on the data available at the time of its completion. Any unusual or conflicting evidence discovered during any future site works

must be presented to NX Consulting as soon as possible so that any implications may be considered.

This report is provided for the benefit only of the party to whom it is addressed. NX Consulting does not extend responsibility to any third party for the whole or any part of the contents. Nx Consulting owes no duty of care in relation to this report to any third party. The investigation and reportage has been undertaken with all reasonable skill, care and due diligence. NX Consulting disclaims any responsibility to the client or others in respect of any matter(s) outside this agreed scope of the above works.

In addition to the above it should be noted that when investigating or developing land, sub-surface conditions might vary both spatially and over time. Whilst this investigation and subsequent interpretation has been undertaken to reasonably characterise current sub-surface conditions at the site within the scope of works and agreed budget, the absence of certain ground, contamination or groundwater conditions at the individual locations is not a guarantee that these conditions do not exist elsewhere on the site. Additional information, changes in legislation or revised practices may necessitate re-interpretation of part or all of this report.

© NX Consulting Limited

2.0 PHASE 1 ASSESSMENT SUMMARY

This section summarises pertinent information gained from reviewing the NX Consulting Phase I report (ref: NX406) dated August 2020.

2.1 Site Location & Setting

Table 2.1 – Site location and Setting

Site Location	No. 1 City Road East, Manchester, M15 4PN.
Grid Reference	E383596, N397324
Site Description	<p>The site is irregular in shape and comprises No. 1 City Road office development which comprises 4no. connected multi-storey commercial office buildings, located in the eastern site area.</p> <p>Site levels dip to the north/northeast and east from 33.6m in the north to 31.30 on the eastern boundary.</p> <p>The western site area comprises a car park. Raised landscaping beds are present along the site boundary. Trees are present within these areas in parts as shown on a topographical drawing provided within Appendix A.</p> <p>No visual and olfactory evidence of hydrocarbon/solvent contamination were observed during the site walkover. No ground floor plantrooms or chemical stores are thought to be present upon site. An electricity substation is present on the northern boundary. This is formed upon a raised concrete and brick bund and appeared to be well maintained during the site walkover.</p> <p>The site is located within a predominately commercial area, bounded by Medlock Street to the east, City Road E to the north, Shortcroft Street to the west and River Street to the south with a multi-storey hotel building beyond (Premier Inn).</p>

2.2 Geology, Hydrology, Hydrogeology & Soil Properties

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Made Ground	<p>On site: None recorded on plans.</p> <p>Surrounding area: Extensive Made Ground deposits recorded 20m north of the site.</p>
Drift Geology	<p>On site and surrounding area: Glaciofluvial Sheet Deposits (Devensian) (Sand and Gravel).</p>

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Solid Geology	<p>BGS sheet 85 'Manchester', Solid, 1:50,000 dated 2010 indicates that sandstone of the Chester Formation (Triassic in age) underlie the site.</p> <p>The Groundsure report indicates that there are a number of boreholes held by the BGS which are publicly available.</p> <p>The nearest available BGS borehole log is located approximately 29m to the north (ref SJ89NW118) and indicated sandstone to be present at depths of 7.01m bgl to a proven depth of 11.28m bgl.</p>
Faults	<p>None recorded within 250m of the site.</p>
Hydrology	<p>The nearest surface watercourse to the site is the River Medlock, located 12m to the north of the site.</p> <p>The River Catchment (Lumb Brook to River Irwell) has an overall EA rating of moderate. The ecological rating is Moderate. The chemical rating is Good.</p>
Hydrogeology	<p>Drift - Secondary A Aquifer (permeable layers capable of supporting water supplies at a local rather than strategic scale).</p> <p>Bedrock deposits – Chester Formation strata underlying the site are a Principal Aquifer (geology of high intergranular and/or fracture permeability, usually providing high levels of water storage).</p> <p>Groundwater was monitored at depths between 2.73m and 5.34m bgl during ground gas and groundwater monitoring.</p>
Water Abstractions	<p>Several groundwater abstractions have been identified within 1000m. The closest abstractions are summarised as follows:</p> <ul style="list-style-type: none"> • 2 no. licenses at Manchester Metropolitan University, 506m south. Licensed to abstract 274,115m³ per day for general use and heat pump. • 2 no. licenses at Lower Chatham Street, 55m east. Licensed to abstract 283,240m³ per day for general use and heat pump. <p>No surface water or potable abstractions are recorded within 1km of the site.</p>
Source Protection Zone	<p>The site does not lie within a currently defined Groundwater Source Protection Zone.</p>

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Flood Risk	<p>The site is not recorded to be located within a Zone 2 or Zone 3 floodplain. Risk of Flooding from Rivers and the Sea (RoFRaS) classification for the site is very low (<1:1000) chance of occurring in any given year.</p> <p>BGS data indicates a high risk for groundwater flooding (clearwater flooding) in the area.</p> <p>The project engineer should determine what further works are necessary if any, in relation to potential flooding.</p>
Shrink Swell Clays	Negligible risk.
Landslides	Very low risk.
Ground Dissolution of soluble Rocks	Negligible risk.
Compressible deposits	Very low risk.
Collapsible Deposits	Very low risk.
Running Sands	Very low risk.

2.3 Mining Extraction and Natural Cavities

Table 2.3 – Mining and Mineral Extraction

Coal Mining	The site lies within the Coal Authorities Coal Mining reporting Area. However, NX Consulting considers that the risk of underground coal mining to be low based upon the extensive cover of sandstone beneath the site.
Johnson Poole and Bloomer	The site is recorded as being in an area where Johnson Poole and Bloomer may hold information on mining.
Other mining	None within 250m.
Historic Ground Workings	Historical surface workings associated with the canal to the west are present in the vicinity. The closest of these is 17m north-west.

Railways and railway sidings are present 180m north of the site. A tunnel is recorded 245m north west of the site.

2.4 Site History

Historical maps of the site area have been obtained from Groundsure. Pertinent information determined from review of these maps within 250m of the site is set out in the following table; a full copy of the maps is presented in Appendix B.

Table 2.4 – Site History

Map Date	On Site Potentially Contaminative Past Uses	Off Site Potentially Contaminative Past Uses
1848	The site is occupied by clusters of buildings in the central-eastern and southern site areas. A small building is present in the west labelled 'Licensed for Divine Service'. The southern site area is divided by Glass Street running south-west to north-east.	The site is predominantly surrounded by industrial buildings within 100m including 4no. cotton mills, chemical works, 2 no. iron works, 2no. gasometers, 2no. reservoirs, dye works, manufacturing works, brewery and glass works.
1893	The southern site area remains the same. Buildings are recorded sporadically across the remainder of the site, with a large cluster recorded in the central-eastern area.	The adjacent land to the south of the site comprises residential units, and Gaythorn Gas Works is recorded 10m east of the site. To the north, a timber yard, finishing works, train station, cotton and dye mills are recorded. To the west, old warehouses, iron works, corporation yard and iron foundries are recorded.
1908	The site comprises a Saw Mill covering the majority of the site. The southern site area remains unchanged.	The majority of the surrounding industrial buildings are still recorded, with the addition of a printing works to the west of the site.
1948	<p>The buildings in the northernmost site area have been demolished. The structures in the southern site area have been demolished and replaced by a Timber Yard with one building recorded in the south western corner.</p> <p>The Arup report highlights that 1953 photographs shows the addition of a 'factory' in the west with chimneys/incinerators in the north and south of the building respectively.</p>	<p>The adjacent southern area has undergone significant demolition of the former residential units. The majority of the surrounding area is recorded as various works.</p> <p>The large gas works adjacent to the east of the site is now partially recorded as Dunlop Rubber Works with several tanks. Wire & cable mills, box works and joinery works are recorded to the west of the site.</p>

Table 2.4 – Site History

Map Date	On Site Potentially Contaminative Past Uses	Off Site Potentially Contaminative Past Uses
1969-1973	Several new buildings are recorded in the northern and southern parts of the site. The southern area is no longer labelled 'Timber Yard'.	The large gas and rubber works are still present to the east; while many works, depots and mills are present to the north west. A large printing works is recorded to the west of the site.
1986-1990	The Saw Mill buildings have been demolished and the site is recorded as a car park with 1no. large building in the west. The southern site area remains unchanged.	The majority of the gas and rubber works have been demolished to the east. Several of the former works to the north have been replaced by a large car park. A scrap yard is recorded north west of the site.
1990	The site has been cleared.	No significant change.
1992-1995	A series of buildings is recorded along the eastern site boundary, and a car park is recorded in the west. The site remains in this general configuration to the present day.	The majority of surrounding buildings are labelled as 'works' and warehouses. A laboratory is recorded south east of the site. A hotel is recorded to the south of the site c. 2003.

2.5 Environmental Information

Table 2.5 – Environmental Information

Environmental permits, incidents and registers	<p>Several radioactive substance authorisations are held 450m east by Manchester Metropolitan University relating to the disposal of radioactive waste and the keeping and use of radioactive materials.</p> <p>3no. part A(2) or Part B processed within 500m. These are 78m south east, 250m east and 250m west, relating to coating processes, rubber and respraying of road vehicles.</p> <p>One recorded pollution incident within 500m. This was 497m east. This was Category 4 (minor). The pollutant was oils and fuel/ diesel.</p> <p>No sites determined as contaminated land under the Environmental Protection Act (1990) have been identified within 500m.</p>
Landfill Sites and Other Waste Disposal Facilities	<p>No current or former Environment Agency or Local Authority Registered landfill sites have been identified within 1km of the site.</p> <p>One licensed waste site has been identified 360m east of the site registered to Terra Vac Ltd. No other information is available.</p>

	<p>Historical scrap yards have been identified 45m north west and 70m west of the site. A Waste Paper Works is historically recorded 360m east, and a recycling centre 400m north.</p>
Potentially contaminative land uses	<p>30no. industrial uses have been identified within 250m of the site. These include engineering services, industrial products, transport storage and delivery, repairs and servicing and public transport infrastructure. The closest industrial features on site are an electricity sub station and office and shop equipment.</p> <p>2no. obsolete petrol or fuel sites are identified 315m west and 480m east.</p> <p>133no. historic industrial sites have been identified within 250m of the site vicinity. These include cotton mills, rubber works, gas works, chemical works, dye works, iron works, warehouses, tanks and depots/ yards.</p> <p>Historical tanks have been identified, the closest of which are 9m east. 27no. tanks have been identified within 50m of the site, most associated with the adjacent gas works.</p> <p>The closest electricity substation identified is on site.</p> <p>17no. historical garages have been identified, the closest of which is 18m northeast.</p>
Ecological Setting	<p>The site is located within an urban area.</p>
Radon	<p>The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.</p>

2.6 Existing Ground Conditions and Possible UXO

The following British Geological Survey scanned borehole records have been examined in the vicinity of the site:

SJ89NW118

This borehole is located approximately 29m north of the site and was sunk for Manchester Corporation B Sewer. This encountered Made Ground of clay, sand and ballast to 7.01mbgl, overlying sandstone to the base of the hole at 11.28mbgl.

SJ89NW117

This is located approximately 11m north-west of the site and was sunk for Manchester Corporation B Sewer. This encountered Made Ground of clay, sand and ballast to 7.01mbgl, overlying sandstone to the base of the hole at 11.28mbgl.

SJ89NW116

This borehole is located approximately 16m south west of the site which was sunk for Manchester Corporation B Sewer. This encountered Made Ground of clay, sand and ballast to 6.71mbgl, overlying sandstone to the base of the hole at 11.28mbgl.

2.7 UXO Risk

The regional unexploded bomb risk map from Zetica indicates that the site is in an area at moderate risk from possible Unexploded Ordnance (UXO) resulting from the Second World War. (Zetica, 2020). Areas noted as at high risk from possible Unexploded Ordnance are noted approximately 700m to the north and west of the site.

The site is noted to be in an area of Luftwaffe Targets and a UXO find.

It is recommended that a detailed desk based UXO threat assessment is undertaken.

3.0 PRELIMINARY CONCEPTUAL MODEL

The site characterisation attempts to identify potential previous and existing site sources of contamination. The conceptual model links the identified sources likely to cause significant possibility of significant harm via pathways to identified critical receptors. The conceptual model is therefore based on a number of identified source-pathway-receptor scenarios. For land to be classified as contaminated a significant pollutant linkage will need to be identified which will include each component of the conceptual model. The absence or removal of a source or interception of a pathway will 'break' the pollutant linkage.

The conceptual model is characterised by identification of the following:

- On-site sources, which may impact on-site receptors via plausible pathways.
- On-site source, which may impact off-site receptors via plausible pathways.
- Off-site sources, which may impact on-site receptors via plausible pathways.

The change of land use will require assessment of the new site development layout within the context of introducing new exposure pathways. The planning regime will require assessment of the site to ensure the new development will not be classed as contaminated land as defined in the Contaminated Land (Scotland) Regulations 2000.

3.1 Risk Assessment

Section 6.3 of the CIRIA Report "Contaminated Land Risk Assessment: A Guide to Good Practice" (CIRIA Report C552) describes in detail the concepts underlying the risk-based approach to assessing potentially contaminated land, introduce the roles of key legislation and describe the qualitative methodology adopted for evaluating and characterising risk.

Current best practice in the UK promotes a risk-based approach to dealing with both soil and groundwater contamination. The principal aim of the approach is to ensure protection of human health and the environment in a thorough, transparent and cost-effective manner.

Fundamental to the risk-based approach is the concept that for 'Contaminated Land' to be designated, as a consequence of historic activities, a pathway for contamination must be shown to exist between a source of contamination and a receptor. The combined presence of a source, pathway and a receptor is described as a 'pollutant linkage'.

The concepts associated with a contaminant source, pathway and receptor are defined in DETR Circular 02/2000 'Contaminated Land Environmental Protection Act 1990: Part II A'. A **source** of contamination may be considered as a 'substance which is in, on or under land that has the potential to cause harm or to cause pollution of controlled waters'. A **receptor** can be considered as either 'a living organism, a group of living organisms, an ecological system or a piece of property which is being, or could be

harmed, by a contaminant or controlled waters which are being, or could be, polluted by a contaminant'. A **pathway** may be considered as one or more routes by, or through, which a receptor is being, or could be, exposed to or affected by a contaminant. Typical pathways may include migration in groundwater, surface water run-off or infiltration, inhalation, dermal contact and ingestion.

The risks posed by an identified pollutant linkage can often be mitigated by removing the source of contamination, treating the source of contamination, blocking the relevant pathway(s) or by protecting the receptor.

PRINCIPLES OF RISK EVALUATION

The risk evaluation methodology presented below is qualitative in nature, and is therefore a subjective method. It is based upon guidance presented in CIRIA publication referenced C552, 'Contaminated land risk assessment ~ A guide to good practice', 2001 and involves the classification of the following:

The magnitude of the potential **consequence** (severity) of risk occurring (Table C 1).

The magnitude of the **probability** (likelihood) of the risk occurring (Table C 2).

These are then considered in conjunction to give a risk matrix (Table C 3)

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in 'significant harm' as defined by the Environmental Protection Act 1990, Part II A. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health ('significant harm' as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (Note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000).	Concentrations of a contaminant from site exceed the generic, or site-specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in the <i>Draft Circular on Contaminated Land</i> , DETR, 2000). Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discolouration of concrete.

Table C 1: Classification of Consequence

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table C 2: Classification of Probability

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table C3: Comparison of Consequence Against Probability

Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

Table C 4: Description of the classified risks and likely action required

Table 1.0. Phase 1 Conceptual Site Model (CSM) and Preliminary Risk Assessment (Proposed Commercial End Use)

SOURCE -PATHWAY -RECEPTOR LINKAGE				QUALITATIVE RISK ASSESSMENT		
Potential Contaminant Source	Location	Receptors	Pathways to Receptors	Associated Hazard (Potential Severity)	Likelihood of Occurrence	Risk*
<p>Potential contaminants may be present beneath the site</p> <ul style="list-style-type: none"> - Ash and clinker used for levelling / drainage: heavy metals, sulphates and PAHs. - Hydrocarbons - Asbestos Containing Material (ACM),. 	Possibly within sub surface strata & Groundwater.	Ground water (Secondary A & Principal Aquifer)	Vertical percolation to groundwater	Groundwater (Medium – pollution of sensitive water resource)	<p>Likely</p> <p>BGS boreholes indicate shallow drift deposits, which would not offer significant protection to the underlying aquifer. However, presence of buildings and hardstanding would limit infiltration.</p>	Moderate Site investigation works required
		Surface Water / River Medlock	Lateral percolation & Surface Run-off to surface water	Groundwater (Medium – pollution of sensitive water resource)	<p>Likely</p> <p>The River Medlock is 12m north of the site, and due to the site's industrial history mobile contaminants may be present on site.</p>	Moderate Site investigation works required
		End users of site.	Direct contact, Ingestion, Inhalation (Dust and Vapours)	Human Health (Severe).	<p>Low Likelihood</p> <p>Potential pathway to receptors will be restricted via building cover and hardstanding. ACM contamination likely to be relatively localised to areas of infilled ground and former buildings. Recommend intrusive investigation prior to redevelopment of site.</p>	Low/Moderate Site investigation works required
		Site workers, construction staff,	Direct contact, Ingestion, Inhalation (Dust and Vapours)	Human Health (Minor – providing suitable PPE equipment is worn)	<p>Low Likelihood</p> <p>ACM contamination likely to be relatively localised to area of infilled ground and former buildings. Recommend intrusive investigation prior to redevelopment of site and use of appropriate PPE.</p>	Low/Moderate Site investigation works required

* Risk refers to the potential risk that the Source, Pathway, Receptor linkage is complete and is used to determine if any further investigation/measures are required. It does not indicate immediate emergency risk to any individual or feature present on the site unless specifically noted.

Table and Summary of Potential Risks, Sheet 2

SOURCE -PATHWAY -RECEPTOR LINKAGE				QUALITATIVE RISK ASSESSMENT		
Contaminant	Location	Receptors	Pathways to Receptors	Associated Hazard (Potential Severity)	Likelihood of Occurrence	Risk*
Mobile/volatile contaminants from off site sources.	Possibly within sub surface strata & Groundwater.	End user of site	Direct contact, Ingestion, Inhalation (Dust and Vapours)	Human Health (Medium)	Likely Significant former factories/works/gas works in the vicinity. Intrusive investigation recommended prior to redevelopment.	Moderate Site investigation works required
		Construction workers if applicable	Direct contact, Ingestion, Inhalation (Dust and Vapours)	Human Health (Minor – Providing suitable PPE equipment is worn)	Low likelihood with appropriate PPE Significant former factories/works in the vicinity. Intrusive investigation recommended prior to redevelopment.	Low / Moderate Site investigation works required
Hazardous Ground Gas associated with potential Made Ground and adjacent former infilled reservoirs.	Possibly within strata beneath the site/surrounding area	End user of site (Staff and patrons)	Migration through strata and accumulation under buildings of explosive and asphyxiating gases.	Human Health (Severe)	Low Likelihood. No recorded landfills nearby. Potential for some gas generation within the Made Ground and adjacent infilled historic reservoirs/gas works.	Low / Moderate Site investigation works required
		Buildings & Infrastructure	Migration through strata and accumulation under buildings of explosive and asphyxiating gases.	Buildings & Infrastructure (Severe)	Unlikely. No landfills nearby. Potential for some gas generation within the Made Ground and adjacent infilled historic reservoirs.	Low / Moderate Site investigation works required

* Risk refers to the potential risk that the Source, Pathway, Receptor linkage is complete and is used to determine if any further investigation/measures are required. It does not indicate immediate emergency risk to any individual or feature present on the site unless specifically noted.

4.0 FIELDWORKS

4.1 General

The preliminary phase of fieldworks were undertaken between 11th July 2023 and 17th July 2023.

The first phase of supplementary works were carried out on 25th & 27th July 2023. These works were designed to further investigate the drift deposits using Cable Percussive Drilling, specially relating to the Glacial Sand and Gravel.

Due to limitations with access and stabilizing the WS rig within internal areas of site, not all works were able to be completed during the first phase of works. Therefore, a second phase of supplementary works were carried out on 3rd & 4th August 2023. These works comprised 5No. WS boreholes within the internal areas of the site.

For the simplicity of this report and due to all phases of works being completed within close proximity, the works will be summarised as a collective.

All arisings from the preliminary site investigation were screened on-site for the presence of volatile organic compounds (VOC) using a MiniRae Photoionisation Detector (PID). No significant readings above 0.0ppm were identified across all the exploratory boreholes.

A plan showing all the exploratory hole locations is presented in Appendix A. All locations were checked for services against available service plans, scanned with a cable avoidance tool (CAT), and hand dug trial pits formed to a depth of 1.20metres below ground level (mbgl) prior to the intrusive investigation.

4.2 Rotary Core Boreholes (RBH)

2no. dynamic sampler/rotary core boreholes were undertaken across the site to maximum depths of 22.50mbgl.

The exploratory holes retrieved continuous soil samples; these were then logged by an on-site engineer and representative samples were taken for geotechnical and chemical analysis.

Groundwater and gas monitoring wells were placed in all 2no. of the boreholes on completion. Table 4.2.1 below provides boreholes installations placed, depths and response zones of strata types.

Table 4.2.1 – Borehole Installation Details

Borehole & Installation Depth (mbgl)	Response Zone (mbgl)	Strata Type
RBH01 – 6.00	0.50 to 6.00	Made Ground, Sand, Glacial Sand and Gravel
RBH02 – 6.00	0.50 to 6.00	Made Ground, Clay, Glacial Sand and Gravel

***Note: RBH02 monitoring installation was found to be damaged on return and unable to purge and obtain groundwater samples.**

Detailed log sheets are included in Appendix C.

4.3 Window Sampler Boreholes (WS)

17no. window sample boreholes were advanced across all areas of the site, to depths of between 0.20mbgl and 6.00mbgl. Representative samples were taken for geotechnical and chemical analysis. Obstructions were recorded within 3no. boreholes (WS09, WS14 and WS15). These boreholes were relocated and renamed WS09a, WS14 & WS15a). WS03 and WS04 were not drilled due to access restrictions.

All WS boreholes were drilled within external areas.

WS02 and WS12 to WS16 were drilled within internal locations of the existing No 1 City Road East building.

Standard Penetration Tests (SPTs) were undertaken at 1m intervals within the WS boreholes. Groundwater as gas monitoring wells were placed within 9no. WS boreholes (3no. internal/6no.external) on completion.

Table 4.3.1 below provides details of boreholes installations highlighting depths and response zones.

Table 4.3.1 – Window Sample Installation Details

Borehole & Installation Depth (mbgl)	Response Zone (mbgl)	Strata Type
WS01 – 5.00	0.50 to 5.00	Made Ground, Sand & Clay
WS05 – 5.00	0.50 to 5.00	Made Ground, Clay/Alluvium
WS06 – 3.00	0.50 to 3.00	Made Ground, Glacial Sand and Gravel
WS07 – 3.00	0.50 to 3.00	Made Ground, Clay
WS08 – 4.00	0.50 to 4.00	Made Ground, Clay
WS10 – 3.50	0.50 to 3.50	Made Ground, Glacial Sand and Gravel, Clay
WS12 – 3.00	0.50 to 3.00	Made Ground, Clay
WS14a – 2.00	0.50 to 2.00	Made Ground, Sand and Gravel
WS15a – 3.00	0.50 to 3.00	Made Ground, Clay

Detailed window sample log sheets are included in Appendix C.

4.4 Cable Percussive Boreholes (CP)

4no. Cable Percussive boreholes were advanced across the site to depths of between 5.26mbgl. and 7.00mbgl. Representative samples were taken for geotechnical and chemical analysis.

All Cable Percussive boreholes were completed with a Dando CP rig with 4no. boreholes drilled within the external areas of the site. All boreholes were drilled to their intended depths. Obstructions were encountered during the drilling works in BH04 at depths circa 2.40m.

Standard Penetration Tests (SPTs) were undertaken at 1m intervals within select CP boreholes. Groundwater as gas monitoring wells were not placed within any CP boreholes on completion.

Detailed window sample log sheets are included in Appendix C.

4.5 Mechanically Excavated Trial Pits (TP)

7no. mechanically excavated trial pits were advanced across the site to depths of between 2.00mbgl. and 3.10mbgl. Representative samples were taken for geotechnical and chemical analysis.

TP02 and TP05 were terminated at shallower depths (2.00mbgl) to allow for Soakaway testing, in line with BRE Digest 365 Soakaway Design.

Trial pit record sheets are presented in Appendix C.

4.6 Manually Excavated Hand Pits (HP)

2no. manually excavated hand pits were advanced within the building to establish slab thicknesses and obtain shallow samples within the upper 1.00mbgl. and 1.20mbgl. Representative samples were taken for geotechnical and chemical analysis.

Hand pit record sheets are presented in Appendix C.

4.7 Sample Collection and Analysis

Environmental sample collection was carried out in accordance with BS EN ISO 22475-1:2006. All soil and groundwater samples were collected using either clean stainless steel utensils or clean disposable gloves and placed directly into clean containers provided by the laboratory. Samples obtained during the investigation were subjected to a range of geochemical testing at appropriate UKAS accredited laboratories. Testing was carried out in accordance with the procedures outlined in BS EN ISO14688-1:2002, 14688-2:2004, and 14689-1:2003.

5.0 GROUND CONDITIONS

5.1 General

The ground conditions recorded confirmed the published geology discussed within the NX Phase 1 section of this report. In general, the ground conditions were found to comprise a surface cover of majority hard standing and building cover with limited landscaping on the site boundary, within purpose-built beds. Concrete floor slab covers the entire building ground floor footprint, and the car park is laid to tarmacadam and brick paving.

5.2 Ground & Groundwater Conditions

A summary of ground condition depths and respective water strikes, from exploratory holes are provided within the Table 5.2.1 below.

Table 5.2.1. Ground Conditions Summary

M – Denotes metres below ground level

	Made Ground	Glacial Sand/Sand and Gravel Deposits	Glacial Clay	Alluvium	SANDSTONE BEDROCK	Groundwater Strike
RBH01	0.0 – 4.9m	4.9 – 5.3m	-	-	5.3-7.5m*, 7.5 - 22.5m+	NR
RBH02	0.0 – 3.0m	-	3.0 – 4.5m	-	6.0 - 21.0m+	NR
WS01	0.0 – 2.9m	2.9 – 4.7m, 5.1 – 5.8m	4.7 - 5.1m, 5.8 - 6.0m+	-	-	NR
WS02	0.0 – 1.9m	1.9 – 2.9m	2.9 - 4.0m+	-	-	NR
WS05	0.0 - 3.65m	-	-	3.65 - 6.00m+	-	3.5m
WS06	0.0 – 2.8m	2.8 – 4.0m+	-	-	-	NR
WS07	0.0 – 2.8m	-	2.8 – 3.7m+	-	-	NR
WS08	0.0 – 2.95m	-	2.95 – 4.5m+	-	-	NR
WS09	0.0 - 0.95m+	-	-	-	-	NR
WS09a	0.0 – 1.90m	1.90 – 3.0m, 3.8 – 4.0m+	3.0 - 3.8m	-	-	NR
WS10	0.0 - 0.25m	0.25 – 3.2m	3.2 - 4.0m+	-	-	NR
WS11	0.0 – 1.95m	1.95 – 3.2m	-	3.2 – 5.0m+	-	NR
WS12	0.0 - 2.3m	-	2.3 – 3.0m+	-	-	NR
WS13	0.0 – 2.9m+	-	-	-	-	NR
WS14	0.0 - 0.4m+	-	-	-	-	NR

WS14a	0.0 - 1.5m	1.5m – 3.00m+	-	-	-	NR
WS15	0.0 - 0.2m+	-	-	-	-	NR
WS15a	0.0 - 2.75m	-	2.75 - 3.8m+	-	-	NR
WS16	0.0 - 2.8m	-	2.8 - 4.0m+	-	-	3.0
CP01	0.0 – 3.6m	-	-	3.6 – 6.5m	6.5 – 7.0m+	NR
CP02	0.0 - 3.1m	-	3.1 – 5.7m	-	5.7 – 6.15m+	NR
CP03	0.0 – 2.8m	-	2.8 - 5.6m	-	5.6 – 6.14m+	NR
CP04	0.0 - 2.6m	2.6 – 3.0m	3.0 - 5.0m+	-	5.0 – 5.26m	NR
HP01	0.0 - 1.2m+	-	-	-	-	NR
HP02	0.0 - 1.0m+	-	-	-	-	NR
TP01	0.0 - 3.1m+	-	-	-	-	NR
TP02	0.0 – 0.9m	0.9 – 2.0m+	-	-	-	NR
TP03	0.0 – 3.1m+	-	-	-	-	NR
TP04	0.0 – 2.7m	2.7 – 3.1m+	-	-	-	NR
TP05	0.0 - 1.8m	-	1.8 - 2.0m+	-	-	NR
TP06	0.0 – 1.2m	1.2 – 2.9m+	-	-	-	NR
TP07	0.0 – 2.6m	2.6 – 2.9m+	-	-	-	NR

***Tentatively proven as described by drillers logs**

Sandstone Bedrock encountered within CP Boreholes recovered as Weathered/Highly Weathered Sandstone sand/sandy gravel.

Made Ground

Made Ground was encountered across the site within all exploratory holes, to maximum depths of up to 4.90m bgl (RBH01). An average thickness of approximately 2.50m has been recorded within NX boreholes.

For purposes of identification, we have attempted to classify the Made Ground, with a few exceptions, into the following six distinct soil types;

- Concrete floor slab (surface). All internal exploratory holes.
- Brick paving and tarmacadam surfacing within all external areas to depths circa 0.10m thick.
- Uncompact & compact brown silty sandy gravel of limestone with brick, and concrete gravel (MOT Type subbase material) – maximum depth of 1.2mbgl (TP06).
- Soft black/dark brown/brown/grey ashy sandy clay/clayey sand/sand and gravel of mixed lithology, brick, sandstone, coal, concrete, slate, timber, ash and clinker. These soils were recorded to a maximum depth of 4.90m bgl in RBH01.

- Relic demolition arisings comprising uncompact black ashy gravelly sand/ashy sandy gravel and cobbles of brick, concrete, cement, timber were recorded to a maximum depth of 2.7mbgl (TP04). Within these deposits insitu relic brick walls/footing were observed with frequent cobbles and occasional boulders of brick, concrete and rare timber typically beneath former buildings.
- Uncompact brown (rarely slightly organic) slightly clayey sand with some gravel of brick, ash, clinker, concrete, limestone and coal - maximum depth of 2.8mbgl (WS06 & WS07).
- Loose reddish brown fine to coarse ashy sand (occasionally with rare gravel of brick), often found above gravelly demolition arising style Made Ground. Possible reworked sand - maximum depth of 2.9mbgl (WS01).

Made Ground was encountered across the site within all exploratory holes, from surface levels to depths ranging between 0.25m bgl (WS10 – area of highest elevation on site) to 4.90m bgl (RBH01 – centre of the site).

Made Ground – External Areas

Within external areas, Made Ground typically comprised an initial layer of tarmacadam, brick paving or paving slabs, underlain by compact ashy gravelly sand/sandy fine to coarse angular gravel (subbase material). Subbase material was encountered within all external boreholes between 0.10m and 1.20m bgl (TP06). Where brick paving was encountered the subbase was occasionally found below a thin layer of blinding sand. Natural strata (GLACIAL SAND AND GRAVEL) was encountered directly beneath the subbase in TP06 and WS10 (at 1.20m bgl and 0.25m bgl, respectively).

Below the subbase and observed in all exploratory holes with the exception TP06 & WS10. These soils comprised a mixture of made ground interspersed with Glacial sand and gravel and alluvium was recorded. These materials comprised of soft black/dark brown/brown/grey ashy sandy clay/clayey sand/sand and gravel of mixed lithology, brick, sandstone, coal, concrete, slate, timber, ash and clinker. These soils were recorded to a maximum depth of 4.90m bgl in RBH01 and to average depths of approximately 2.60m. Concrete and brick cobbles and boulders were recorded within TP01, TP02, TP03, TP04, TP07, WS06, WS13 and WS14a. This made ground material was recorded to be slightly organic within WS06 & WS07. Decomposing timber, roots, rootlets (with an organic odour), and other organic material were occasionally observed within this strata. Due to poor stability during excavation the final depth of this Made Ground was not proven within TP01 and the exploratory hole was terminated at 3.1mbgl.

Loose reddish brown fine to coarse sand (occasionally with rare gravel of brick) was recorded to a maximum depth of 1.8mbgl (RBH01).

A layer of loose sandy gravel with a black ashy sandy gravel/gravelly ashy sand was identified within 3no. WS boreholes, placed in the north of the site. The Made Ground was found in thin layers (0.05 to 0.1m in thickness) within the following depths:

- WS01 (external borehole) – 2.75m to 2.8m bgl.
- WS05 (external borehole) – 2.6m to 2.7m bgl.
- WS12 (internal borehole) – 1.8m to 1.9m bgl.

Made Ground – Internal Area

All exploratory positions within the internal areas comprised a surface cover of raised temporary tile floor, besides WS02. This flooring was removed around each exploratory position and the drilling rig was stabilised upon the surface of the concrete slab.

All internal exploratory holes (besides WS02) were drilled within the main room of the existing building. WS02 was drilled within a lobby area within the center of the building, accessed through a doorway leading to the external areas of the site.

Recorded Made Ground typically comprised an initial layer of reinforced concrete to depths of 0.20m to 0.32m (WS2). A possible concrete footing/ground beam was possibly observed within WS14 where a coring was terminated at 0.40m+ bgl. Porcelain floor tile and screed were found over concrete within WS02. The concrete was typically found to be reinforced with 1cm diameter metal rebar present at depths of 0.1m and 0.2mbgl.

A blue geotextile membrane was found at 0.25mbgl beneath the reinforced concrete within both WS12 and WS13. Subbase was found beneath the concrete within boreholes WS13, WS15a & WS16 (to a maximum depth of 0.45mbgl in WS15a and WS16).

Made Ground recorded below the concrete floor slab (and subbase where identified) to typically comprise of uncompact fine to coarse ashy slightly silty clayey ashy sand with rare gravel and interspersed with pockets and layers of ashy sandy gravelly clay. Where gravel is present it comprises of fine to coarse angular to subrounded brick, concrete, limestone, sandstone, ash, clinker, slate and other mixed lithology.

Cobbles of brick and sandstone were also recorded within WS13, WS14a, deflecting the drilling shoe. Slow progression was made within HP02 due to the volume of cobbles between 0.65m to 1.0mbgl. This strata was found to a maximum depth of 3.00mbgl+ within WS13. The final depth of Made Ground was not proven at this location due to an obstruction encountered at 2.90mbgl. Where a final depth of Made Ground was proven, this material was present until natural strata was encountered within all internal exploratory hole locations besides WS02 and WS16.

Loose reddish brown fine to coarse clayey sand was found between 1.70m and 1.90m of WS02. This material was similar to possible reworked sand encountered within the external exploratory holes. Soft black slightly organic ashy clay with rare gravel of brick and sandstone was found between 1.90m to 2.90m, and 1.95m to 2.80mbgl, within WS02 and WS16, respectively. A slightly organic odour was identified between 2.0m and 2.5mbgl within WS16.

Superficial Deposits

Superficial deposits were encountered within the majority of exploratory holes between depths of 0.25m to 7.50m bgl (WS10 to RBH01), with the exception of HP01, TP01, TP03, WS09, WS13, WS14 and WS15 where the Made Ground was not able to be fully penetrated.

Superficial deposits were noted to typically comprise an initial layer of Glacial Sand and Gravel was typically loose to medium dense light brown (occasionally yellow brown), subrounded to rounded gravel of mixed lithology to recorded maximum depths of 4.70mbgl. The gravel content within this stratum predominantly consisted of angular to subrounded mudstone, sandstone, and a variety of other mixed lithologies.

Beneath the Glacial Sand and Gravel in all exploratory holes (and beneath the Made Ground where Glacial Sand and Gravel was not encountered), Glacial Till was present. Glacial Till was

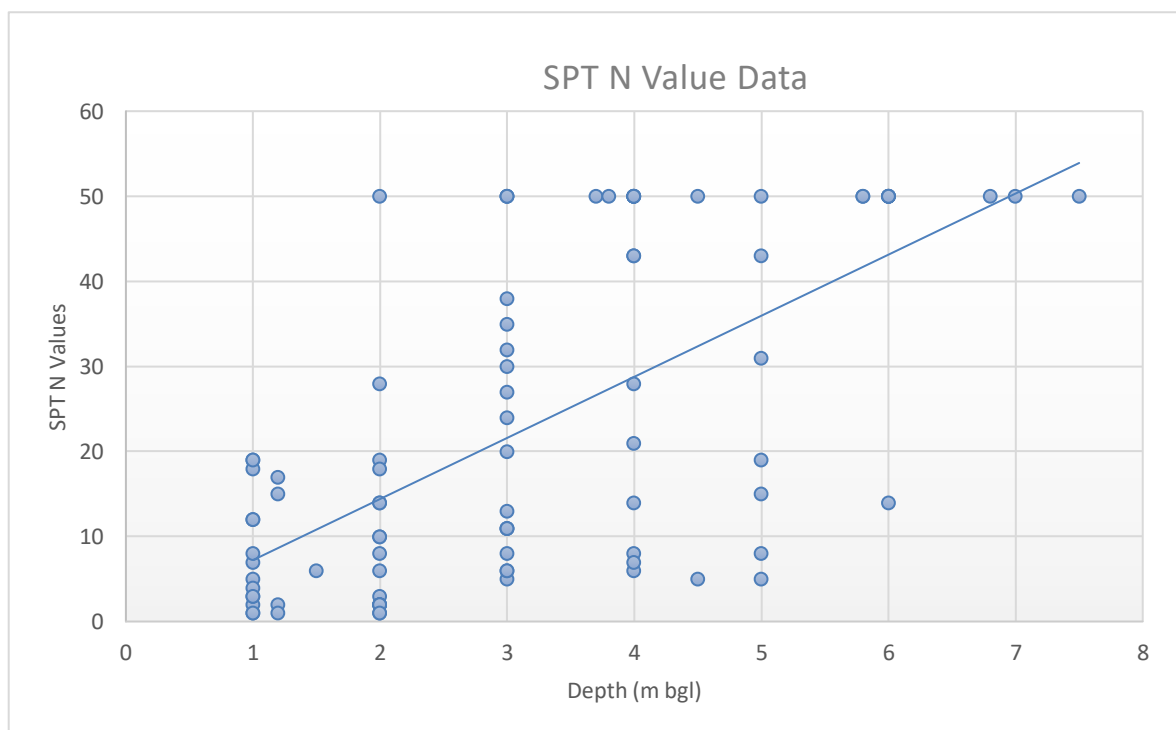
encountered within the majority of exploratory boreholes and was proven to a maximum depth of 6.0mbgl (WS01). The Glacial Till comprised brown typically firm to stiff clay (locally soft to firm), exhibiting a consistent trend of increasing stiffness with depth, and was frequently found to be stiff to very stiff between 3.00mbgl to 4.00mbgl.

Alluvial deposits were found in WS05 (3.65m – 5.0mbgl), WS11 (3.20m – 5.00m bgl), and BH01 (3.60m bgl to 6.50m bgl). These deposits included soft to firm grey-brown clayey silt and/or loose to medium dense light grey silty clayey sand. Some areas also contained soft silty clay, fine gravel, peat laminations and layers of with sand and gravel.

Probable Glaciofluvial drift deposits comprising dense red/brown SAND AND GRAVEL (drillers description) was found beneath clay within all rotary boreholes, between 4.5mbgl and 7.5mbgl. Gravel content within this strata typically comprised angular to subrounded mudstone, sandstone and other mixed lithology. Similar strata was recovered within the Cable Tool boreholes and was logged as HIGHLY WEATHERED SANDSTONE and WEATHERED SANDSTONE; recovered as dense to very dense gravelly sand/sandy gravel within CP01 to CP04 between 5.0m to 7.0mbgl.

The rotary core boreholes were progressed as cored drillholes once competent bedrock was encountered, 6.00m bgl and 7.50m bgl within RBH02 and RBH01, respectively.

Uncorrected SPT 'N' values ranged from 1-50, with an average 'N' value of 22.6 and generally increased with depth, as the strong positive correlation shows on the line of best fit within Graph 5.1.1 below. The standard deviation for the data is 18.62.



Graph 5.1.1 – SPT N Value Data.

SPT refusal was also common in the drift deposits as window sampler boreholes were occasionally recorded to terminate prematurely via SPT refusal between 3.7mbgl and 4.50mbgl (WS02, WS06, WS07, WS08, WS09a, WS10, WS12, WS15a and WS16). Softer

strata was encountered in the northern areas of the site, with boreholes WS01 and WS05 were able to progress to greater depths of 6.0mbgl.

SPT refusal frequently occurred within very stiff to hard CLAY, and dense reddish/brown/red (sometimes slightly clayey) SAND.

Handheld Shear Vane Tests

Shear vane values taken within the upper 6m the Glacial Clay deposits ranged from 22 to >130KPa, indicating that the clays generally range from soft to firm to very stiff.

Solid Geology

Suspected solid geology was encountered within all of the rotary core boreholes at depths between 5.00-22.50mbgl and comprised weak to medium strong reddish brown fine to coarse grained SANDSTONE with rare mineral inclusions and intraclasts. Subhorizontal bedding fractures, thinly spaced, planar, smooth to slightly rough were also noted upon recovered core runs. Recovery was often poor within 5.00m and 7.00m were the rock being poorly cemented. This generally improved as drilling progressed. Irregular bands of marl were observed between 7.00m and 9.00mbgl within RBH02, and at 13.50mbgl within RBH01. The marl appeared medium brown in colour. The colour of the sandstone generally remained reddish brown throughout, with some areas appearing light brown in colour.

Natural fractures in the bedrock were documented within the core samples, whereas fractures resulting from the drilling process (drilling induced fractures) were excluded from the calculations for the fracture index.

5.3 Groundwater

Groundwater strikes were recorded within 2No. window sampler borehole (WS05 and WS16) at depths of between 3.00 and 3.50mbgl. It should be noted that water added to aid rotary drilling, within deeper granular strata may have masked the presence of groundwater within these deposits.

No strikes were recorded within the sandstone strata.

Table 5.3.1 below highlights groundwater ingress noted in 2No. exploratory holes.

Table 5.3.1 – Groundwater Observations

Location	Depth (m)	Strata	Comments
WS05	3.5	MG	Moderate ground water ingress within MADE GROUND.
WS16	3.0	CLAY	Low ground water ingress perched above natural CLAY deposits.

The shallow groundwater deposits within the Made Ground deposits appears to be discontinued and perched upon the Alluvium/Glacial Clay. An absence of groundwater strikes and limited available nearby borehole logs has restricted regional groundwater flow calculations. It is anticipated to flow to the west/northwest towards the River Medlock.

5.4 Underground Service Plans & Relic Tank Features

The following utilities are present across the site:

- Electricity cables routed through the site.
- Drainage systems routed through the site.

The design team and Client should familiarise themselves with the presence of these underground services and potential structures.

No above ground or below ground fuel tanks were observed during the site walkover or site investigation works. However, this cannot discount their potential presence. Particularly in the former industrial buildings across the site.

5.5 Below ground obstructions

Several exploratory holes noted the presence of concrete and brick cobbles and boulder obstructions within Made Ground. Namely: TP01, TP02, TP03, TP04, TP07, WS06, WS13 and WS14a. Historical mapping indicates that demolition rubble associated with former developments, slabs/cellars and slabs are likely to be present upon site within the upper 3.0m bgl. Arisings/findings within TP02, TP04 and TP07 coincide with these indications.

External Boreholes

WS09 was excavated to 0.95mbgl where a solid obstruction was identified at the base of the hand pit. The hole was relocated to WS09a and no further obstructions were encountered.

TP02, TP04 and TP07 uncovered relic in-situ brick walls beneath the subbase during their excavation.

Within TP02, a brick wall was observed along the western and southern walls of the trial pit between 0.3m to 0.7mbgl. A possible former brick footing was identified at 0.7mbgl within the southern half of the of TP02 which prevented progression. The pit was expanded to allow progression where no more obstructions were encountered to the final depth of the trial pit (to 2.0mbgl).

A partially intact brick wall was observed within TP04 and TP07 between 0.5m to 2.0mbgl. Frequent cobbles of brick (including full intact bricks) and rare boulders of cemented brick and sandstone were recovered between 0.7m to 1.8mbgl (TP04) and 0.4m to 2.6mbgl (TP07). Metal rebar was also recorded within the shallow Made Ground of TP07 (0.4mbgl).

Obstructions were not encountered within other areas but should be anticipated considering established ground conditions and the historical uses of the site.

Internal Boreholes

Obstructions within internal exploratory holes were recorded within HP02, WS13, WS14 & WS15.

HP02 was not excavated to its intended depths of 1.20mbgl due to solid obstructions encountered within the base of the hand pit (at 1.0mbgl). Slow progression was recorded throughout these depths within compact cobbly Made Ground (between 0.65m to 1.0mbgl). WS14a was drilled through HP02 and frequent cobbles were encountered to 1.30mbgl. No further obstructions were encountered below this depth.

WS13 was not drilled to its intended depth due to an obstruction within the Made Ground. An obstruction recorded at 2.00mbgl was causing the drilling equipment (casing and the drilling rods) to bend.

WS14 and WS15 were not drilled to their intended depths due to solid obstructions encountered while coring through the reinforced concrete. The concrete corer was unable

to progress through the reinforced concrete present in WS14 and was terminated at 0.45mbgl. A solid obstruction was encountered within WS15 at 0.2mbgl which prevented the corer progressing. Both boreholes were relocated to a nearby position and renamed WS14A and WS15A. No further obstructions were encountered.

No redundant pipes or wires were identified within the internal boreholes.

5.5 Contamination Observations

No hydrocarbon contamination observations were recorded during the site investigation. All arisings from the first phase of the Ground Investigation were screened on-site for the presence of volatile organic compounds (VOC) using a MiniRae Photoionisation Detector (PID). No elevated concentrations (above 0.1ppm) were recorded.

6.0 GEOTECHNICAL TESTING

6.1 Laboratory Analysis

A programme of laboratory testing was undertaken in accordance with BS 1377 (1990) "Methods of Test for Soils for Civil Engineering Purposes". The results are presented in Appendix D and are summarised below.

BS Test Number	Description
Part 2:3	Moisture Content
Part 2:5	Plasticity index
Part 2:9	Particle Size Distribution
Part 3:5,9	pH and Sulphate
Part 4:1	Dry Density/Moisture Content Relationship

Moisture Content

23no. samples of clay were tested for natural moisture content from drift deposits The results are summarised below:

Strata	Range	Mean
Drift Deposits	7.5 - 38	14.02
Clay	10 - 23	14.63
Alluvium	12 - 38	25
Glacial Sand and Gravel	7.5 - 15	10.86

Plasticity Index

23no. samples of natural cohesive strata from natural cohesive strata from drift deposits and Made Ground, were analysed for plasticity index and hence shrinkage/swelling potential. The results are summarised below:

Strata	Plasticity	Plasticity Range	Amended Plasticity Range	Volume Change Potential
Drift Deposits	Low-Medium	7.0 - 27.0%	6.48 - 27.00%	Low-Medium
Clay	Low-Medium	14.0 - 27.0%	13.44 - 27.00%	Low-Medium
Alluvium	Low-Medium	9.0 - 12.0%	6.48 – 11.88%	Low-Medium
Glacial Sand and Gravel	N/A	7.0 - 13.0%	6.86 – 12.09%	Low

Particle size distribution

29No. samples were selected for the determination of particle size distribution. The resultant grading curves have been included in Appendix D.

Sulphate and pH

Samples were analysed for pH and soluble sulphate:

Property	Range
Sulphate as SO ₄ (g/l)	0.01 - 0.31
Sulphate as SO ₄ (mg/kg)	100 - 2920
pH	7.0 – 10.6

Point Load Testing and Uniaxial Compressive Strength Testing

24no. samples of sandstone were selected for the determination of Point Load compressive testing.

Property	IS(50) Range (MPa)	Mean	Approximate UCS (MPa)*
Point Load	0.13 to 0.52	0.31	3.12 to 12.84

*Refer: Carter and Sneddon 1977 (from "Using the Point Load Test to determine the UCS of Coal Measure Rock" by Rousiak and Mark.

Compaction Testing

Dry density/moisture content tests were carried out on 4no samples of Made Ground materials. Maximum dry densities and optimum moisture contents ranged from 1.79Mg/m³ to 1.98Mg/m³ and 10% to 16% respectively.

Natural moisture contents were in the range 7.8-38% and the results indicate that the materials to be variable, noted to be 'wet' and 'dry' of its optimum moisture content and a degree of site treatment may be required to achieve acceptable compaction criteria.

The Made Ground is unlikely to be suitable as a structural fill for foundations and pavements in its current state and treatment (sorting, segregation, screening and lime/cement stabilisation) would be required to enable some of the materials to be re-used on parts of the site.

The Made Ground is likely to be suitable as 'bulk' fill following a degree of treatment.

7.0 GEOTECHNICAL ASSESSMENT

7.1 General

It is understood the site is currently developed with 4no. connected commercial office buildings which are proposed to be demolished and replaced with 2no. blocks of 11-14 storey commercial office buildings.

No building loads have been provided to NX Consulting at the time of drafting this document.

Ground conditions encountered across the site (during the NX investigation) comprise a surface cover of tarmacadam, brick/slab paving and concrete slab. Made Ground was recorded to possible maximum depths in excess of 4.90mbgl with associated localised below ground obstructions overlying Glacial sand and gravel typically consisting of loose to dense light brown (occasionally yellow brown) Sand and Gravel/gravelly Sand, predominantly firm to stiff (becoming very stiff) cohesive clay. Alluvial deposits were identified in 3no. to 4no. of the NX exploratory holes, which comprised soft to firm grey-brown clayey silt and/or loose to medium dense light grey silty clayey organic sand. Sandstone bedrock has been encountered at depths between 6.00-22.50mbgl+ (RBH01 & 02) and noted to comprise a weak to medium strong reddish brown initially poorly cemented fine to coarse grained SANDSTONE with rare mineral inclusions and intraclasts.

SPT N values within the drift deposits recorded values of 1-50 between depths of 1.20 – 6.45mbgl, with an average 'N' value of 22.6 and generally increased with depth.

SPT refusal was also common in the drift deposits as window sampler boreholes were occasionally recorded to terminate prematurely via SPT refusal between 3.7mbgl and 4.50mbgl (WS02, WS06, WS07, WS08, WS09a, WS10, WS12, WS15a and WS16). Softer strata was encountered in the northern areas of the site, with boreholes WS01 and WS05 were able to progress to greater depths of 6.0mbgl.

7.2 Geotechnical Parameters

The following parameters are recommended for engineering design based on laboratory test results obtained to date and literature values:

Table 7.2.1: Glacial Clay		
Parameter	Typical data range	Suggested Design
Moisture Content (%)		
Clay	10.0 – 23.1	23.1
Alluvium	12.0 – 38.0	38.0
Amended Plasticity Index (%)		
Clay	13.44 - 27.0	27.0
Alluvium	6.48 – 11.8	30.00 (Conservative)
Bulk Density (Mg/m ³)	2.14 - 2.31	2.20
SPT N-value	1 - 50	5 – 1.00-3.00m bgl 20 – 4.0m to 6.0mbgl
Undrained Shear Strength (kN/m ²) (SV)	22 - 130	22 – 2.6m bgl 100 – 3.60m bgl (Where stiff)

Effective Cohesion (kN/m ²)	-	0
Coefficient of compressibility (m _z /MN)	-	10/Cu
Angle of Friction (phi°)	-	26 (localised granular GT also applied – conservative)
Permeability (m/sec)	-	10 ⁻⁸
ACEC	DS1	AC1s

Table 7.2.2 –Glacial Sand & Gravel

Parameter	Typical data range	Recommended Design
Moisture Content (%)	-	-
Plasticity Index (%)	-	-
Bulk Density (Mg/m ³)	-	2.0
SPT N-value	1 to 32	1-32
Net Allowable Bearing Capacity kN/m ² (Foundation 1m width)	<10 to 320	100
Undrained Shear Strength (kN/m ²)	-	-
Effective Cohesion (kN/m ²)	-	0
Angle of Friction (phi°)	-	38
Coefficient of compressibility (m _z /MN)	-	-
Infiltration Rate (m/sec)	5 x 10 ⁻⁶	5 x 10 ⁻⁶
ACEC	DS-1	DS-1

Table 7.2.3 – Sandstone Bedrock	
Parameter	Recommended Design
SPT N-value	50 to 50/52mm
Highly weathered SANDSTONE recovered as sand and gravel	Angle of shearing resistance = 36°
SANDSTONE	Friction Angles for clean fractures in rock of 30° (Tomlinson 2001)
UCS (MPa)	3.12 (conservative) to 12.48
Bulk Density (Mg/m ³)	2.1

7.3 General

It is likely that a post-development foundation system cannot fully be confirmed until final building levels and any 'Build Near' restrictions are established. It is understood that the upper 1.0 to 2.0m of strata is to be grubbed up, screened, crushed and replaced to create a stable working platform, free from obstructions to detrimentally impact pile formation.

A degree of surface treatment comprising screening, crushing, excavation and re-compaction will need to be carried out beneath former buildings and infrastructure prior to the formation of foundations.

The Made Ground deposits and drift deposits are considered unsuitable as an adequate founding stratum due to the proposed loads and the possible risks of unacceptable total and differential settlements occurring.

Lightly Loaded Foundations and Floorslab

Given the heavy nature of the proposed building loads Vibro Stone Column (VSC) are not considered suitable for the main building. For ancillary and lighter loaded buildings, retaining walls and floor slabs, VSC can be considered.

It is normal for the specialist contractor to give assurances on the subsequent engineering performance of the treated ground. Notwithstanding the above it is considered that following thorough treatment by vibro compaction allowable bearing capacities in the order of 100 to 150kN/m² to allow for reinforced concrete spread foundations and 30 to 50kN/m² for the floor slab are likely to be achievable. Any adopted vibro-treatment design should take into account any long-term deeper settlements. It is strongly recommended that, prior to the adoption of this proposal, vibro contractors are provided with a copy of this report and attend site to form trial pits, to confirm the suitability of their proprietary systems on site. It is important to note however, that the success of vibro treatment on this site would depend achieving proposed loading scenarios for the floorslabs. Any unsuitable materials may be required to be removed and replaced within more suitable granular fill.

Options would need to consider the effects of noise and vibration on nearby structures and the presence of below ground obstructions recorded during this assessment.

The advice of specialist vibro compaction contractors should be sought on the suitability and load carrying capacity of their proprietary system for the use at the site and their attention brought to the nature and composition of the Made Ground, obstructions, below ground services and Glacial Till and in particular low strength alluvium.

If treatment of the upper 2m of ground is not carried out, pre-auguring and/or excavation will be required at vibro column locations to establish the potential presence and any required removal of obstructions present within the upper 1.50m+ of made ground.

Main Building Foundations

Piles

Given the likely heavy building loads, presence of a potentially significant thicknesses of Made Ground to possible depths of c.4.90m bgl+, piled foundation are likely to be the most suitable foundation solution.

Soil and rock properties are presented in Table 7.3.1 below are recommended for 'preliminary' pile based on log description and in-situ testing results, as well as published geotechnical data of soil and rock properties. Point load analysis indicates that the bedrock is poorly cemented and are generally very weak to weak. Therefore, the UCS of lower bound of very weak should be adopted as a conservative approach.

If adopted, piled foundation options would need to consider the effects of noise and vibration on nearby structures and the presence of below ground obstructions and very shallow bedrock recorded during this assessment. Access for piling rigs with sufficient capacity to penetrate moderately strong to strong sandstone should also be considered.

The advice of specialist piling contractors should be sought on the suitability and load carrying capacity of their proprietary system for the use at the site and their attention brought to the nature and composition of the Made Ground, obstructions, below ground services, Glacial Till and sand and gravel deposits.

Again, if treatment of the upper made ground strata is not carried out, pre-auguring and/or excavation will be required at pile locations to establish the potential presence and any required removal of obstructions present within the upper 2.0m+ of made ground.

Following treatment, in-situ load tests should be carried out on the compacted ground to verify performance and foundation and slab design.

A number of trees are present which are within possible influencing distance of the site. Foundations and drainage should be designed in line with NHBC Standards guidance document Chapter 4.2 Building Near Trees.

Floor Slabs

Suspended floor slabs or ground bearing slabs onto pre-treated ground are recommended due to the depth of Made Ground and variability of strata encountered. Adequate support and reinforcement should be adopted to reduce slab deflections in line with structural standards.

Table 7.3.1 –Soil Properties adopted in the Preliminary Pile Design

Stratum	Soil Properties	Remark
Made Ground/ Fill	Bulk Density = 18 kN/m ³	Contribution of shaft resistance being ignored.
Glacial Till	Bulk Density = 18 kN/m ³ Angle of shearing resistance = 26°	
Sand and gravel	Bulk Density = 18 kN/m ³ Angle of shearing resistance = 38°	Based on medium dense granular materials with recorded lowest SPT N = 42.
Highly weathered SANDSTONE recovered as sand and gravel	Bulk Density = 18 kN/m ³ Angle of shearing resistance = 36°	Based on the lower bound of dense granular materials as recorded as sandstone sand and gravel

Very weak SANDSTONE	Bulk Density = 21 kN/m ³ UCS = 3.12 MPa RQD < 30% Angle of shearing resistance = 30°	Based on worst case point load and description of predominantly described very weak to moderately strong
------------------------	--	--

7.4 Earthworks, Excavations and Groundwater

All projects involving earthworks come under the requirements of the Construction (Design and Management) Regulations 2007 (CDM). The creation and maintenance of a project risk register is seen as good practice and is a requirement under CDM. All risks identified by those involved in the design of earthworks should be filed into the project risk register. Where a project includes geotechnical design, a geotechnical risk register should be developed to support and enhance the project risk register.

Site preparation prior to upfilling should include removal of all vegetation, topsoil and any uncontrolled filling/Made Ground. Earthworks materials should be classified in accordance with Table 6/1 of Department of Transport Specification for Highways Works (Series 600 SHW); summarised below.

Table 7.3.1 – Classes of Earthworks Materials Permitted for Incorporation into the Works

Use	Permitted Class(es)
General fill – granular (and granular improvement layer, where required)	1A, 1B, 1C
General fill – cohesive	2A, 2B
Fill to landscape areas	4
Topsoil	5A, 5B
Embankment Starter Layer	6A, 6B, 6C
Capping	6F1, 6F2, 6F3
Fill to reinforced earthworks	6I/J
Backfill to structures	6N, 6P [6NI, 6PI]

Any embankments and site slopes should be constructed utilizing Class 1A, 1B, 1C granular fill as specified within (Series 600 SHW). The starter layer for embankment construction should comprise Class 6A, 6B, 6C granular fill. Unacceptable material, Class U2 shall be as defined in Clause 601.3 Series 600 SHW.

Dry density/moisture content tests were carried out on 3 samples of Made Ground and natural strata materials. Maximum dry densities and optimum moisture contents ranged from 1.79 Mg/m³ to 1.98 Mg/m³ and 10% to 16% respectively.

The results indicate that the materials to be variable, noted to be 'wet' and 'dry' of its optimum moisture content and a degree of site treatment may be required to achieve acceptable compaction criteria. The Made Ground are unlikely to be suitable as a structural fill for foundations and pavements in its current state and treatment (sorting, segregation, screening and replacement) would be required to enable some of the materials to be re-used on parts of the site as structural fill for pavements and floorslabs.

The Made Ground is likely to be suitable as 'bulk' fill following a degree of treatment.

The option for classifying soil/fill should be selected and should maximize the potential to win suitable fill from the site. Unsuitable materials will require treatment (screening/crushing/segregation and reused (where appropriate) on site as part of the site

preparation and upfill. Unsuitable materials will require removal from site to suitably licensed waste management facility.

During site upfilling, consideration should be given for pre-earthworks drainage that allows for temporary fill surfaces to be sealed and shaped to shed water and operational restrictions during periods of rainfall.

The requirements for geotextiles to be used to separate earthworks materials should be assessed by a suitably qualified specialist contractor/manufacturer. The required design life should be no less than 120 years.

Details of laying and lapping shall be in accordance with the specialist contractors recommendations.

Excavations into the Made Ground and Glacial Till should be viable using conventional hydraulic excavating plant. Where relict concrete, cobbles and boulders are present within the upper 3.00m+ (potentially 4.90m+), breaking equipment may be needed to achieve the design depth required.

The stability of foundation excavations are likely to be variable and collapse and spalling of the granular strata (particularly where groundwater is present) and Made Ground materials should be anticipated. All excavations should be conducted in line with CIRIA Report 97 – Trenching Practice and BRE 440 Foundations, Basements and External Works 2002.

Trenchboxes or similar may be required to support drainage and deep foundation excavations locally. Where trenchfill foundations are to be used, support and dewatering would be required in any case to maintain the necessary integrity of the concrete.

Any replaced 'site won' or imported materials will again need to be compacted in a controlled manner in line with the Department of Transport, Specification for Highway Works Specification 600 & 800 series, subject to additional confirmatory earthworks testing.

Where possible all soils should be retained on site to reduce disposal costs.

Pavement Construction

If the CBR is less than 2.5%, foundation improvement work shall be undertaken in accordance with IAN 73/06. An initial design CBR value of 2% is recommended for the granular Made Ground deposits. Should the proposed formation be formed off the recorded compacted gravel at depths ranging from 0.20m bgl to 0.65m bgl a CBR value of 15% may be achievable.

Once the cut and fill volume has been carried out, and where access roads are to be adopted, design CBR values should be confirmed by carrying out in-situ plate load tests. It may be prudent to excavate areas of soft strata, if encountered, and replaced with suitably compacted gravel due to the risk of deformation and short to long term settlements.

If the works are carried out during periods of inclement wet weather, very soft ground should be anticipated and imported stone or ground improvement may be required for temporary enabling works.

Groundwater, excavations & Surface Water Management

A localised perched shallow groundwater regime is present within shallow drift deposits. Ground water shall be control in accordance with CIRIA report 113 "Control of Ground Water to Temporary Works.

It should be noted that water added to aid rotary drilling, within deeper granular strata (between 5.0m and 22.00m depth) may have masked the presence of groundwater within these deposits.

It is likely that seepages of groundwater would be encountered within the Made Ground and in excavations. Specialist dewatering measures are unlikely to be required for shallow excavations, (typically <1m bgl) and sump pumps should be adequate. Excavations below 3.00m bgl to 5.00m bgl may require specialist dewatering measures (such as well point systems) and temporary support from groundwater recorded within the Glacial Sand deposits. Collapse and spalling and running sand deposits should be anticipated within this strata where groundwater is present. A specialist hydrogeologist should be appointed to provide advice in this regard.

If groundwater or surface water flows into foundation excavations, 'blinding' concrete should be used at the base of the foundation and excavations. Foundation concrete should be poured as soon as possible afterwards.

Arrangements should be made to prevent ponding and water softening in any excavation and within formation level soils. The Contractor should ensure that ground levels are of sufficient gradient to enable the collection of surface water run-off in sumps or grips.

Any potentially contaminated water shall not be allowed to migrate into other areas until the results of the analysis are available and, if required, a suitable means of water treatment has been agreed.

Pumping from over excavated sumps may be required to maintain satisfactory working conditions.

Groundwater should be monitored prior to and throughout the construction period to establish and groundwater changes and associated impact on construction and design.

Concrete Classification

The results from the chemical laboratory sulphate and pH analysis for the site indicate that a worst-case Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC-1.

7.5 Soakaway Drainage

Soakaway testing was undertaken within 2 locations broadly in accordance with BRE Digest No 365, to confirm the suitability of the Made Ground, Glacial Sand and Gravel, and Glacial Till. Results were consistent within both TP02 & TP05 as both soakaways succeeded to soakaway 50% of the effective storage volume. Within the granular Made Ground deposits, a preliminary infiltration rate in the region of 3.58E-05m/sec and 8.03E-05m/sec were recorded within TP02 & TP05, respectively.

The depth of drainage and the proposed invert level and volume of the surface water ingress, will be critical; due to clayey nature of the Made Ground and interbedded and cohesive nature of the Glacial Sand and Gravel deposits and underlying Glacial Clay at depths circa 3.00m to 4.00m. Further soakaway tests are required at planned locations if they are to be considered further.

7.6 Shallow Mineworkings

Based on the published geology and Coal Authority Mining Report, the risk to the proposed development from shallow coal mineworkings is considered to be very low.

8.0 GEOCHEMICAL GROUND AND GROUNDWATER ASSESSMENT

8.1 Introduction & Sampling Strategy

The preliminary conceptual site model identified that, the potential for the existence of contamination beneath the site was moderate. A review of the Phase 1 Desk Study Report revealed a number of potential contamination sources, located across the site and beyond associated with historical industrial activities. Therefore, sampling and exploratory holes were targeted for a general screening of site wide soils on a 20m to 25m grid basis and also targeting the areas of former significant developments, identified in historical mapping.

NX Preliminary Works

- RBH01, RBH02, TP02, TP03, TP04, TP05, WS06, WS07, WS09, WS10, WS11 were targeted at buildings relating to former Saw Mill developments and buildings associated to former incinerators/chimneys and existing electricity substation within the western, central and eastern areas of the site.
- RBH01 & RBH02 were targeted any contaminant plume migration, within the sandstone bedrock, relating to former adjacent Gaythorne gas works developments and buildings to the east of site.
- WS15, WS15a, WS16 were targeted at buildings relating to former Timber Yard developments, within the south of the site.

NX Supplementary Works - August 2023

A second phase of supplementary site work was carried out on 25th & 27th July 2023 and the 3rd & 4th August 2023. The first phase of supplementary intrusive works was undertaken to investigate drift deposits encountered prior to bedrock involving the drilling of CP boreholes. The second phase of supplementary intrusive works and laboratory analysis was carried out within internal areas where access was limited during the preliminary phase. These internal positions were positioned to investigate ground conditions and also targeting the areas of former developments, identified in historical mapping.

- WS13, WS14, WS14a were targeted at buildings relating to former Saw Mill developments and buildings associated to former incinerators/chimneys, within the eastern areas of the site.
- WS15, WS15a, WS16 were targeted at buildings relating to former Timber Yard developments, within the south of the site.

Chemical Analytical Strategy

During the preliminary works, 37no. samples of Made Ground soils, and superficial strata were tested for a number of general screening tests including pH and metals, cyanide, phenols, sulphide, sulphur, asbestos, speciated PAH and TPH and BTEX to confirm the site's anticipated risk status to human health receptors from soil contamination as determined within the NX Consulting Desk Study for the site. Where deemed necessary, VOCs, SVOCs, was also undertaken.

Asbestos was recorded in 1no. samples of Made Ground and further quantification was carried out where asbestos was recorded.

25no samples were analysed for petroleum hydrocarbons Criteria Working Group (TPHCWG) for both aliphatic and aromatic compounds and 3 samples of were tested for a suite of volatile and semi-volatile organic compounds; where deemed necessary.

7 samples of Made Ground and natural deposits were sampled for Waste Assessment Classification (WAC).

A waste classification report has been completed to classify the soils based on their chemical composition. All results returned show the samples are non-hazardous waste, besides WS13 @ 1.30m bgl which is recorded as hazardous waste due to elevated Zinc, TPH & PAH concentrations.

5no water samples were analysed where groundwater was present (3no within exploratory holes and 2no within the River Medlock), selected boreholes were purged and analysed for a suite of compounds listed above.

During the preliminary works, all arisings from the Ground Investigation were screened on-site for the presence of volatile organic compounds (VOC) using a MiniRae Photoionisation Detector (PID). No elevated concentrations (above 0.1ppm) were recorded.

The following contamination assessment sub-sections will discuss the identified risks associated with individual contaminant groups based on contamination testing results, undertaken on samples from the intrusive investigation.

8.2 Rationale

In May of 2008, Contaminated Land: Application in Real Environments (CLAIRE) in conjunction with the Chartered Institute of Environmental Health (CIEH), with support from the Soil and Groundwater Technology Association (SAGTA), released a document entitled 'Guidance on Comparing Soil Contamination Data with a Critical Concentration' ⁷.

The document provides advice on the use of statistical techniques in the assessment of soil contamination data. It forms part of a package of improved UK guidance highlighted in the Defra discussion paper 'Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward (CLAN 06/2006). The overall aim is to increase understanding of the role statistics can play in quantifying the uncertainty attached to estimates of the mean concentration of contaminants thereby creating a more informed basis for regulatory decision-making.

The guidance presents a structured approach that can be followed when employing statistical techniques for data assessment.

In April 2012 revised Statutory Guidance stated that:

"New technical tools and advice may be developed and used to help regulators and others conform to this Guidance."

"Tools might be developed to help assessors apply the Category 1-4 Screening Levels (C4SLs) approach in relation to specific substances or situations. For example, this might include the development of generic screening levels to help assessors decide when land might be assumed to be in Category 4."

C4SLs are intended as generic screening values to help show when land is within Category 4. They describe a level of risk that whilst above 'minimal' is still 'low', providing a 'higher simple test' for deciding that land is suitable for use and definitely not contaminated.

Current Soil Guideline Values / Generic Assessment Criteria can now be replaced with more pragmatic (but still strongly precautionary) Category 4 Screening Levels and provide a higher simpler test for deciding that land is suitable for use and definitely not contaminated

C4SL's retained and used the CLEA framework, modified according to considerations of the underlying assumptions and science, within the context of Defra's policy background.

8.3 Soil Guideline Values

The Environment Agency's position on CLEA guidance is as follows:

"The CLEA guidance is non-statutory. It does not purport to interpret the policies or procedures of the Environment Agency and shall not operate as a statutory license, waiver, consent or approval from the Environment Agency"⁹.

"The CLEA guidance describes the soil concentrations above which, in the opinion of the Environment Agency, there may be concern that warrants further investigation and risk evaluation for both threshold and non-threshold substances. These levels are a guide to help assessors estimate risk. It does not provide a definitive test for telling when risks are significant"⁹.

The soil guideline value (SGV) is derived by estimating the concentration of a substance in soil, which will result in an amount of the contaminant entering the human body that is equal to the relevant Health Criteria Value(s). Revised guidance and software has been published for calculation of generic assessment criteria, which will lead to the publication of SGVs based on the new approach. New TOX and SGV reports for priority substances are due to be published after March 2009. The 'old' ten SGV reports will be replaced.

The Environment Agency and DEFRA have produced two new reports - "Human health toxicological assessment of contaminants in soil" and "Updated technical background to the CLEA model". This has led to the withdrawal of CLR7-10, which no longer reflects the current approach and formed the basis of the existing SGVs, as a result all the existing SGV reports have been withdrawn.

The publication of new substance specific TOX reports will lead to the withdrawal of the existing reports. Practitioners are expected to produce their own generic assessment criteria using the CLEA software and handbook.

8.4 LQM/CIEH Suitable 4 Use Levels (S4UL)

The LQM/CIEH S4ULs are intended for use in assessing the potential risks posed to human health by contaminants in soil and has transparently-derived and cautious 'trigger' values above which further assessment of the risks or remedial action may be needed. They replace the second edition of the LQM/CIEH General Assessment Criteria (GAC) published in 2009.

In this instance initial potential risk to human health will be determined by comparison of appropriate chemical analysis to the values specified in the current LQM/CIEH Suitable 4 Use Levels'. With respect to lead the current Category 4 Screening Level will be used.

8.5 Site Soils

8.5.1 NX Consulting Investigation

The chemistry analysis results, presented in Appendix D, have been compared against the Tier 1 criteria for a *commercial industrial with limited managed landscaping* end use to reflect the development proposals. Exposure pathways are restricted to the following from deep and shallow site soils:

- Ingestion of soil,
- Ingestion of site derived household dust,
- Dermal contact with soil,
- Dermal contact with site derived household dust,
- Inhalation of fugitive soil dust,
- Inhalation of fugitive site derived household dust,
- Inhalation of vapours outside
- Inhalation of vapours inside

For risk assessment purposes a soil organic matter value of 1.0% has been used.

Made Ground & Natural Soils

Table 8.5.1 displays the contaminant results details and any Tier 1 thresholds exceedances:

Table 8.5.1 – Summary of Tier 1 Exceedances

Summary of Tier 1 Exceedances Commercial End Use with limited managed landscaping					
Solid Contamination Results					
DETERMINAND	No. of Samples	Range	Average	GAC	No of Exceedences
Inorganics, Carbon and Asbestos					
Asbestos Quantification (%)	25	Chrysotile / Amosite – Free Fibres		-	1 – HP02 (0.40m)
pH	37	7 – 10.6	8.29	-	-
Total Sulphate	27	100 - 2920	785.75	-	-
Total Cyanide	27	<0.1 – 0.7	0.23	1400	0
Sulphide	27	<10 – 100	26.14	-	-
Total Organic Carbon (%)	25	<0.5 – 9.2	2.52	-	-
Metals and Semi-Metals					

Arsenic	28	0.2 - 25	9.28	640	0
Cadmium	28	<0.1 - 11	0.59	190	0
Chromium III	28	0.81 - 33	12.92	8600	0
Copper	28	0.6 - 180	48.9	68,000	0
Lead	28	0.6 - 1100	131.19	750	1 – WS06 (1.50m)
Mercury (Inorganic)	28	<0.05 - 1.40	0.31	1,100	0
Nickel	28	<1 – 30	15.51	980	0
Selenium	28	<0.5 – 0.7	0.51	1,200	0
Zinc	28	<1 – 820	107.57	730,000	0
Boron	28	<0.2 – 1.6	0.69	240,000	0
Speciated Petroleum Hydrocarbons (TPH-CWG)					
TPH-CWG - Aliphatic >EC5 - EC6	25	<0.01	<0.01	3,200	0
TPH-CWG - Aliphatic >EC6 - EC8	25	<0.01	<0.01	7,800	0
TPH-CWG - Aliphatic >EC8 - EC10	25	<0.01	<0.01	2,000	0
TPH-CWG - Aliphatic >EC10 - EC12	25	<1.50 – 4.2	1.61	9,700	0
TPH-CWG - Aliphatic >EC12 - EC16	25	<1.20 – 13	1.73	59,000	0
TPH-CWG - Aliphatic >EC16 - EC21	25	<1.50 – 17	2.28	1,600,000	0
TPH-CWG - Aliphatic >EC21 - EC35	25	<3.40 – 55	6.45	1,600,000	0
TPH-CWG - Aliphatic (EC5 - EC35)	25	<10.0 – 63	14.24	-	-
TPH-CWG - Aromatic >EC5 - EC7	25	<0.01	<0.01	26,000	0
TPH-CWG - Aromatic >EC7 - EC8	25	<0.01	<0.01	56,000	0
TPH-CWG - Aromatic >EC8 - EC10	25	<0.01	<0.01	3,500	0
TPH-CWG - Aromatic >EC10 - EC12	25	<0.9 – 18	1.66	16,000	0
TPH-CWG - Aromatic >EC12 - EC16	25	<0.5 – 230	10.21	36,000	0
TPH-CWG - Aromatic >EC16 - EC21	25	<0.6 – 870	23.42	28,000	0

TPH-CWG - Aromatic >EC21 - EC35	25	<1.4 – 950	50.78	28,000	0
TPH-CWG - Aromatic (EC5 - EC35)	25	<10.0 – 2100	108.72	-	-
Polynuclear Aromatic Hydrocarbons (PAHs)					
Naphthalene	28	<0.03 – 330	11.95	190	1 – WS13 (@1.40m)
Acenaphthylene	28	<0.03 – 8.3	0.35	83,000	0
Acenaphthene	28	<0.03 – 730	26.45	84,000	0
Fluorene	28	<0.03 – 530	19.26	63,000	0
Phenanthrene	28	<0.03 – 1700	61.68	22,000	0
Anthracene	28	<0.03 – 680	24.83	520,000	0
Fluoranthene	28	<0.03 – 1500	54.5	23,000	0
Pyrene	28	<0.03 – 1400	50.84	54,000	0
Benzo(a)anthracene	28	<0.03 – 980	35.34	170	1 – WS13 (@1.40m)
Chrysene	28	<0.03 – 940	33.92	350	1 – WS13 (@1.40m)
Benzo(b)fluoranthene	28	<0.03 – 1000	36.02	44	1 – WS13 (@1.40m)
Benzo(k)fluoranthene	28	<0.03 – 410	14.98	1,200	0
Benzo(a)pyrene	28	<0.03 – 750	27.43	35	1 – WS13 (@1.40m)
Indeno(1,2,3-cd)pyrene	28	<0.03 – 350	12.76	500	0
Dibenz(a,h)anthracene	28	<0.03 – 40	1.53	3.5	1 – WS13 (@1.40m)
Benzo(ghi)perylene	28	<0.03 – 390	14.23	3,900	0
Total PAH (Sum of USEPA 16)	28	<0.1 – 12000	435.1	-	0
BTEX and MTBE (µg/kg)					
Benzene	25	<0.01	<0.01	27	0
Toluene	25	<0.01	<0.01	55,600	0
Ethylbenzene	25	<0.01	<0.01	5,700	0
p&m-xylene	25	<0.01	<0.01	5,900	0
o-xylene	25	<0.01	<0.01	5,900	0
MTBE (Methyl Tertiary Butyl Ether)	25	<0.01	<0.01	-	0

Table 8.5.2 displays the contaminants for which Tier 1 thresholds have been exceeded and the recorded concentrations:

- Lead
- Asbestos
- Naphthalene
- Benzo(a)anthracene
- Chrysene
- Benzo(b)fluoranthene
- Indeno(1,2,3-cd)pyrene
- Dibenzo(a,h)anthracene

Table 8.5.2 – Summary of Tier 1 Exceedances

Parameter Group	Screening value (mg/kg)	Maximum Concentration of Exceedances (mg/kg)	Locations
Lead	1100	1600	WS06 @ 1.50m
Asbestos	NFD	<0.001%	HP02 @ 0.40m
Naphthalene	0.03	330	WS13 @ 1.40m
Benzo(a)anthracene	0.03	980	WS13 @ 1.40m
Chrysene	0.03	940	WS13 @ 1.40m
Benzo(b)fluoranthene	0.03	1000	WS13 @ 1.40m
Indeno(1,2,3-cd)pyrene	0.03	750	WS13 @ 1.40m
Dibenzo(a,h)anthracene	0.03	40	WS13 @ 1.40m

Asbestos has been detected in 1no. samples; Chrysotile and Amosite have been identified as free fibres within the Made Ground deposits. Quantification of the sample indicates asbestos to be present at a total mass % of <0.006. HP02 at 0.40m bgl recorded Chrysotile with a total mass % of 0.002.

Natural soils tested recorded Tier 1 exceedances within WS06, WS13 and HP02. The relevant depths and concentrations recorded are present within Table 8.5.2 above.

8.5.2 Water Supply

Approval should be obtained from the relevant water supply company before supply pipes are installed in order to confirm pipe selection. Pipe selection is currently made based on the UK Water Industry Research Ltd [UKWIR] report entitled "Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites".

Parameter Group	PE Threshold Concentration (mg/kg)	PVC Threshold Concentration (mg/kg)	Maximum Concentration (mg/kg)
VOC Suite	0.5	0.125	-
BTEX, MTBE	0.1	0.03	<0.01
SVOC Suite	2	1.4	0.7
Phenols	2	0.4	2.7
Mineral Oils C11-C20	10	N/A	98
Mineral Oils C21-C40	500	N/A	315

The results indicate that specialist protection measures are required in relation to the water supply pipework. A UKWIR risk assessment is recommended to be completed at the depth of the proposed pipes are likely to be required. It is anticipated that specialist water supply pipework will be required for all new buildings.

8.5.3 Phytotoxicity

Phytotoxicity Guidance on the effects of metal contamination on plant growth is provided within the Ministry of Agriculture, Fisheries and Food (MAFF) Code of Good Agricultural Practice for the Protection of Soil. Thresholds have not been exceeded within the majority of samples analysed within the made-ground or natural soils with respect to the end use of the site.

8.5.4 Controlled Waters

A low to moderate risk to Controlled Waters receptors was identified at the site within the previous NX Consulting Desk Study report requiring a site investigation with groundwater sampling to determine the presence of otherwise of source-receptor pathways.

Groundwater Analysis

NX carried out a number of groundwater samples for analysis from within 3no. of the installed onsite environmental monitoring well. The findings are summarised in Table 8.5.2.

Table 8.5.2 – Groundwater Analysis Summary

DETERMINAND	UNITS	EQS	DWS	No	Max C	No of Exceedences	LOC. OF EX.
INORGANICS							
Arsenic	µg/l	50	10	5	3.1	0	
Cadmium	µg/l	5	5	5	0.09	0	
Chromium	µg/l	2	50	5	0.64	0	
Copper	µg/l	5	2000	5	5.5	2 (5.5 & 5.4)	River Medlock S1 & S2
Lead	µg/l	4	10	5	0.48	0	
Mercury	µg/l	1	1	5	<0.01	0	
Nickel	µg/l	8	20	5	3.2	0	
Selenium	µg/l	-	10	5	5.7	0	
Zinc	µg/l	30	5000	5	11	0	
pH	-	6-9	-	5	10.6	4	WS11 – 1.60m bgl WS06 – 1.50m bgl RBH01 – 0.60m bgl WS15 – 0.50m bgl
ORGANICS							
Naphthalene	µg/l	10	-	5	<0.05	0	

Benzo(a)pyrene	µg/l	0.05	0.01	5	0.05	3	WS05 – 3.30m bgl WS08 – 2.70m bgl RBH01 – 4.20m bgl
benzo[b/k]fluoranthene	µg/l	0.03	-	5	0.06	1	WS08 – 2.70m bgl (benzo[b]fluoranthene)
benzo[g,h,i]perylene & indeno(1,2,3-cd)pyrene	µg/l	0.02	-	5	0.05	2	WS08 – 2.70m bgl RBH01 – 4.20m bgl
Total Petroleum Hydrocarbons	µg/l	-	10	5	1200	1	RBH01 – 4.20m bgl
TPH Aliphatic C5-C6	µg/l	-	10	5	<0.1	0	
TPH Aliphatic C6-C8	µg/l	-	10	5	<0.1	0	
TPH Aliphatic C8-C10	µg/l	-	10	5	<0.1	0	
TPH Aliphatic C10-C12	µg/l	-	10	5	<1.0	0	
TPH Aliphatic C12-C16	µg/l	-	10	5	1.5	0	
TPH Aliphatic C16-C35	µg/l	-	10	5	590	1	RBH01 – 4.20m bgl

*Notes: The WHO Guideline Values for petroleum products in drinking water have been applied in the absence of a current UK specific TPH water quality standard. However, for the aromatic TPH bandings of C6-C7, C7-C8 and C8-C10 the more conservative UK specific EQS for benzene, toluene and ethylbenzene have been selected as the Tier 1 screening criteria.

8.5.5 Discussion and Recommendations

Soils

The environmental chemistry results together with the findings of the intrusive investigation are consistent with the site's historical uses.

Localised elevated concentrations of Lead (WS06) have been recorded in excess of tier 1 screening values in the soils within the western sector of the site. In addition, 1 sample (HP02) of Made Ground have recorded asbestos, with preliminary quantification determining concentrations of <0.006% to 0.002% total mass.

Localised elevated concentrations of Naphthalene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, have all been recorded in excess of tier 1 screening values in the soils within the eastern sector of the site. The elevated concentrations of Polynuclear Aromatic Hydrocarbons (PAHs) were present within the Made Ground of WS13 at 1.40m bgl. Made Ground present at this depth comprised uncompact brown/black/dark grey fine to coarse ashy gravelly sand. Gravel within the Made Ground of brick, limestone, ash, concrete, clinker and other mixed lithology. It is likely the recorded elevated PAH concentrations are related to the presence of ash and clinker within the Made Ground which may be present due to former industrial processes upon the site (incineration, coal or biomass burning, industrial activities and other combustion processes).

Although unlikely, it should be noted that there may of course be areas of undetected contamination between our sampling points.

Given the recorded exceedances a potentially unacceptable risk may be posed to future end users of the site from shallow soils present within areas of P.O.S and landscaped areas.

All Asbestos Containing Material (ACM) identified during the site enabling works must be dealt with in strict accordance with the Control of Asbestos Regulations (CAR) 2012, UK Waste Management Legislation and the Environmental Protection Act 1994.

As a contingency measure and to protect construction workers and future end users from any asbestos contamination, we recommend that the following protective measures are adopted during the proposed ground preparatory works:

- All site personnel should be provided with PPE when excavations and demolition works are taking place.
- A water bowser or other dust suppression equipment shall be provided in order to dampen exposed surfaces; during the movement of plant and removal of arisings.
- Provision of personal monitors for site staff to measure individual exposure to asbestos fibres.

Should off-site disposal be required, then additional asbestos quantification and waste classification testing should be undertaken to ensure that it is classified correctly and disposed at a suitably licenced facility.

All ACM impacted soils must be managed so as to ensure no airborne fibre release during construction or placement of impacted material in such a manner to ensure no future exposure risk.

Site soils will need to be placed below a suitable clean cover layer to ensure they pose no unacceptable risk to the future site users. Given the nature of the contamination the most cost effective remedial solution is likely to comprise a simple capping layer.

Within areas of proposed landscaping it is recommended that a minimum of 600mm of Made Ground (below proposed formation level), should be removed from site and replaced with clean inert materials to form a capping layer over any potential contamination.

In areas of the site where buildings and hardstanding are proposed the made ground can be left in-situ as the buildings and hardstanding areas will break the 'pollutant linkage' and remove the pathway for contamination and come in to contact with the end users.

Materials imported to site are required to be suitable for the intended commercial end use.

All operations will be subject to regulation using a 'Materials Management Plan' (MMP) to be created in accordance with Version 2 of the CL:AIRE Definition of Waste – Industry Code of Practice. The MMP should be created with due consideration to all proposed remediation and enabling works operations prescribed within this document and should be undertaken by a Qualified Person and a signed declaration submitted to the EA prior to re-use of materials on the site.

Topsoil should be in line with BS 3882: 2015 'Specification for topsoil' within the clean cover system.

Risks to Controlled Water Receptors

The NX site investigation works has encountered ground conditions comprising Made Ground over alluvium, Glacial Sand & Gravel/Sand and Glacial Clay. These drift deposits are classified as a Secondary A with the underlying sandstone is recorded to be a Principal aquifer.

The Groundsure report indicates that nearest surface water features is the River Medlock situated 12m north of the site. Both site and regional groundwater flow is anticipated to be to the north and northwest towards the River Medlock.

The drift deposits have been recorded to depths ranging from 0.25m bgl to 7.50m over the Principal Aquifer. Glacial Till deposits are expected to provide infiltrations rates in the order of 10E-09m/sec.

The proposed development is to comprise complete building cover and concrete hardstanding cover with concrete based areas of limited landscaping strips and tree planters.

During the NX site investigation, no visual or olfactory evidence of hydrocarbon contamination was noted. Groundwater testing highlighted above has recorded a number of organic contaminants within the groundwater in both Made Ground and drift deposits; at concentrations exceeding the respective EQS and UKDWS screening values.

Groundwater testing also highlighted TPH concentrations of 20µg/l for Aliphatic C16-C21 and 590µg/l for Aliphatic C21-C35 within RBH01 at a depth of 4.20m bgl. These exceedances are considered typical of a Brownfield development and unlikely to pose a significant risk to identified controlled water receptors given the localised and discontinuous nature of site groundwater. Given the low mobility of these contaminants, the potential for the contaminants to represent suspended solids and development proposals comprising predominantly hardstanding impermeable surfaces reducing infiltration the risks to controlled water receptors post construction is deemed to be low.

No elevated concentrations of TPH was recorded from river samples obtained up and downstream from the River Medlock, possibly indicating that site groundwater has/is not influenced/influencing the water quality of the River Medlock (12m to the north).

It is considered that risks to controlled waters will be low, from potentially unrecorded hydrocarbon contamination, upon completion of the development works. However, to confirm the above and to ensure that migration pathways to the underlying sandstone, are not generated during piling, we recommend that supplementary boreholes and installations are formed around RBH01; to establish the extent of TPH contaminated soil and groundwater and discount any associated risk to the underlying Principal Aquifer and River Medlock. If contamination is found during additional sampling, the associated risks should be reassessed in line with the Environment Agency's Hydrogeological Risk Assessment Methodology.

During demolition and enabling works, any recorded free phase hydrocarbon contamination in soils and groundwater should be removed during a process of remediation. The above verification works should form part of a remediation strategy agreed with Manchester City Council and Environment Agency.

8.5.6 Waste Classification

Soil samples have been characterised against hazardous waste criteria using HazWaste Online. Any soils to be exported from site should be allocated an appropriate waste code, following the steps within WM3.

The results appended to this document indicate that the samples tested are likely to predominantly be classified as NON-HAZARDOUS WASTE. However, localised shallow Made Ground deposits were determined to be classified as HAZARDOUS WASTE. Furthermore, samples of Made Ground have recorded asbestos, which could result in soils being classified as Hazardous. This should be confirmed by the appointed waste management contractor following submission of all available test results carried out at the site to date. The waste classification assessment only applies to those soils that have been tested. If other soils are to be disposed of off-site then further analysis may be required.

It is the responsibility of those generating the waste (i.e. the site), to ensure that the waste is handled and disposed of appropriately. Waste carriers transporting, and sites accepting, this material should have a corresponding code within their permits.

Waste acceptance criteria (WAC) testing results indicate that the majority of sampled Made Ground soils will be suitable for a non-hazardous and inert non-hazardous landfills.

A waste classification report has been completed to classify the soils based on their chemical composition. All results returned show the samples are non-hazardous waste, besides WS13 @ 1.30m bgl which is recorded as hazardous waste due to elevated Zinc, TPH & PAH concentrations.

In order to prevent excessive costs and reduce the environmental impact of the development it is recommended that removal of wastes from the site, including waste soils, is kept to a minimum. It is however, envisaged that arisings will be created during the works; in particular within service excavations and site reprofiling.

To evaluate the various on-site soils for potential offsite disposal, soils are classified in accordance with the Hazardous Waste Directive (HWD) that enables the provision of a European Waste Catalogue (EWC) Code for use during offsite disposal and a Hazardous or Non-Hazardous Classification. Non-Hazardous material is suitable for disposal in a Non-Hazardous landfill; however, disposal to an Inert Landfill requires further Waste Acceptance Criteria (WAC) testing in accordance with BS EN 12457-3. Material classed as Hazardous also requires WAC testing to assign a suitable hazardous classification.

The Landfill Regulations require that all Hazardous and Non-Hazardous solid waste must be treated prior to offsite disposal to landfill. You can define 'treatment' by using the following 'three-point test'. All three criteria must be satisfied for all of the waste to qualify as being treated:

1. It must be a physical, thermal, chemical or biological process including sorting.
2. It must change the characteristics of the waste.
3. It must do so in order to:
 - a. Reduce its volume; or
 - b. Reduce its hazardous nature; or
 - c. Facilitate its handling; or
 - d. Enhance recovery.

It should be noted that a site investigation is unable to identify all below ground conditions at a site and therefore, it should be noted that if during construction works soils that require offsite disposal are identified as being different to what has been preliminarily tested in this report, additional testing will be required prior to disposal or recovery at a licensed offsite facility.

It is also recommended that prior to offsite disposal or recovery of any waste soils; the receiving landfill facility should be sent copies of all relevant chemical analysis and written confirmation of acceptance of soils provided.

All producers of waste have a duty of care to ensure that any waste they produce is handled safely and within the law. They must check that anyone they pass waste on to is authorised to take it. This includes the authorised site earmarked to handle the waste and any haulier (licensed waste carrier) used to transport the waste between the sites.

All waste holders must act to keep waste safe against:

1. Corrosion or wear of waste containers;
2. Accidental spilling or leaking or inadvertent leaching from waste unprotected from rainfall;
3. Accident or weather breaking open contained waste and allowing it to escape;
4. Waste blowing away or falling while stored or transported;
5. Scavenging of waste by vandals, thieves, children, trespassers or animals.

Holders should protect waste against the above risks while it is in their possession and they should also protect it for its future handling requirements. Waste should reach not only its next holder but a licensed facility or other appropriate destination without escape. It is recommended that the container used to transport the waste is suitable not only to prevent solid and liquid residues escaping, but also any potentially dangerous vapours or odours associated with the waste.

Segregation of different categories of waste where they are produced may be necessary to prevent the mixing of incompatible wastes. Segregation may assist the disposal of waste to specialist outlets. Where segregation is practiced on sites, the waste holder should ensure that his employees and anyone else handling waste there are aware of the locations and uses of each segregated waste container.

Waste handed over to another person should be in some sort of container, which might include a skip. The only reasonable exception would be loose material loaded into a vehicle and then covered sufficiently to prevent escape before being moved. Waste containers should suit the material put in them.

A waste transfer note (WTN) is a document which must accompany any transfer of waste between different holders. The purpose of a WTN is to allow other people who handle your waste to know what they are dealing with so that they can manage it safely and properly.

A WTN must be created for each load of waste that leaves the site.

The WTN must contain enough information about the waste to enable anyone coming into contact with it to handle it safely, and either dispose of it or allow it to be recovered within the law. If insufficient information is given on the WTN the responsible party may liable to be prosecuted.

Records of all waste transferred or received must keep for at least two years.

8.6 Ground Gases

8.6.1 Asphyxiant, Noxious or Explosive Gases

Risk Assessment & Methodology

CIRIA Report 665 "Assessing Risks Posed by Hazardous Ground Gases to Buildings" presents current best practice on the assessment of ground gases for commercial and residential buildings (with the exception of low rise traditional housing). The report presents a risk based approach based on gas screening levels which depend on both the concentration and emission rate of gas from the ground. Gas screening levels are calculated as follows:

$$\text{Gas screening value (l/hr)} = \text{gas concentration (\%)} \times \text{measured borehole flow rate (lh)} / 100$$

Gas screening values should be calculated on a borehole basis in the first instance. Consideration of worst case i.e. highest flow and highest concentrations should only be considered if the CSM warrants it.

The monitoring boreholes were installed with ground gas monitoring wells, with response zones set within the made ground and drift deposits. Exploratory hole records showing monitoring well constructions and locations of monitoring wells are presented in Appendix C.

The assessment of potential ground gas generation is based on the observations of trends and patterns of change in ground gas concentration, by the direct measurement of ground gas from the monitoring wells. During each visit the measurement of methane, carbon dioxide, oxygen, hydrogen sulphide, carbon monoxide, gas flow, groundwater level and barometric pressure were recorded.

Potential Sources

The preliminary risk assessment identified the risk from hazardous ground gas as moderate risk and low to moderate source generating potential in line with CIRIA 665, due to the potential for Made Ground situated across the site. The Made Ground and drift deposits were recorded to maximum depths of 4.90m+ and where present, material does not contain significant deleterious items/organic matter.

Potential pathways

The potential pathways into the building are:

1. Horizontal and vertical migration through the ground into the building via cracks in the floor slab or around services.

Lateral migration could occur from the adjacent infilled sites through the shallow made ground deposits and drainage annulus within service trenches.

Receptors

The receptors considered in this assessment are the users of the building and the building. The buildings will comprise 2no. blocks of 11-14 storey commercial office buildings, with some open ventilated spaces and will have smaller workspaces (storerooms/toilets, offices etc) within it. The buildings are a low to moderate sensitivity receptor due to its anticipated infrequent occupancy and potential for well-ventilated areas within office spaces.

Ground Gas Monitoring

Suitability of Data

During the monitoring visits, the response zones in none of the boreholes have been flooded since installation. Groundwater was largely absent but was present within certain boreholes.

Results

To date, 6No.rounds of monitoring have been undertaken with a barometric pressure of between 999-1016mb.

A summary of the soil gas monitoring results is presented in Table 8.6.1 below and copies of the log sheets presented in Appendix G.

Table 8.6.1 – Summary of Gas Monitoring Results (NXC)					
NX Consulting Borehole Reference	Max CO2 (%v/v)	Max Flow (l/hr)	Max GSV (l/hr)	Max CH4 (%v/v)	Max GSV (l/hr)
RBH01	1.6	0.0	<0.01	0.2	<0.01
RBH02	4.8	0.1	<0.01	8.0	<0.01
WS01	1.3	0.0	<0.01	0.2	<0.01
WS05	0.2	0.0	<0.01	0.2	<0.01
WS06	3.3	0.1	<0.01	0.2	<0.01
WS07	1.1	0.1	<0.01	0.2	<0.01
WS08	3.2	0.0	<0.01	0.2	<0.01
WS10	2.7	0.1	<0.01	0.2	<0.01
WS12	4.1	0.0	<0.01	0.3	<0.01
WS14a	1.0	0.0	<0.01	0.3	<0.01
WS15a	5.7	0.0	<0.01	12.6	<0.01

Recommendations & Gas Protection Design

In line with CIRIA 665 Guidance on methane and carbon dioxide, the site is to be developed for commercial end use and the ground gas investigation has identified a maximum carbon dioxide concentration of 5.7% with a maximum flow recorded of 0.1l/hr. The maximum-recorded concentration for methane was 12.6%. In addition, hydrogen sulfide concentrations of 5.0 ppm were recorded.

Elevated GSV values, Carbon Dioxide concentrations within greater than 5.0% resulting in the determination of Characteristic Situation 2 classification were noted in WS15a. Methane concentrations greater than 10% were also noted within WS15a.

Therefore, in line with CIRIA 665 risk assessment methodology, it is recommended that gas protection measures should be installed beneath all buildings in accordance with BS8485: 2015. Based on a Type C development and CS2 classification and a ground gas protection score of 2.5 to would need to be achieved as highlighted within Table 8.6.2 below.

Table 8.6.2 Gas Protection – No.1 City Road East, Manchester

Building Type	Floor Slab Type	Ventilation	Available Points Score
C	Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended.	Full reinforced gas proof membrane installed to BS8485:2015 and validated to CIRIA 735, and passively vented underfloor sub-space.	3.5 to 6

Gas protection measures should be installed as prescribed in BRE 414 with the ventilation of the sub-floor void designed to provide a minimum of one complete volume change per 24 hours.

Independent validation of gas protection measures is needed to achieve the required points score.

Prior to the adoption of any gas protection measures, agreement should be sought from the local authority environmental health department and building control.

Construction Personnel

Methane concentrations in excess of the lower explosive limit have been recorded to date along with carbon dioxide concentrations above which respiratory distress and unconsciousness can occur (10% in air). As such, unprotected construction workers within excavations and any confined spaces may be at significant risk. Mitigation measures should therefore, be adopted in this regard.

8.5.2 Radon & Hydrocarbons

The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level. Therefore, no radon protective measures are necessary.

No visual or olfactory evidence of hydrocarbon or solvent contamination were observed during the intrusive works. Volatile analysis shows the samples do not contain significant concentrations of volatile materials. Despite this, supplementary works around RBH01 and/or a human health risk assessment is recommended to establish vapour risks to indoor air from potential TPH contaminated groundwater. Alternatively consideration could be to adopt a low vapour membrane should programme not permit the above works.

9.0 PRE-REMEDIATION CONSTRAINTS AND OUTLINE REMEDIATION STRATEGY

9.1 Invasive Plants

The presence of Japanese Knotweed and/or other invasive plants was not apparent during the fieldwork, however, advice should be sought from a suitably qualified ecologist should any suspicious plant growth be encountered.

9.2 Services

The following utilities are present across the site:

- Electricity cables routed through the site.
- Electricity Substation on the western boundary.
- Drainage systems are recorded across the site.
- Fibre Optics
- Gas mains

9.3 Hardstanding & Surface Cover

The external portion of the sites surface cover comprises areas of tarmacadam hardstanding within car parking areas and pavement surrounding the building. Internal areas comprise areas of concrete floor slab & screed.

Photographs presented in Appendix A of shows the nature of surface cover.

9.4 Land Condition and Outline Remediation

9.4.1 Foundations and Ground Stability

Ground conditions encountered across the site (during the NX investigation) comprise Made Ground to possible maximum depths in excess of 4.90mbgl, with occasional below ground obstructions drift deposits and sandstone bedrock present depths between 6.00-22.5mbgl+.

Numerous obstructions have been recorded within the formed exploratory holes associated with previous site infrastructure.

Groundwater was recorded at depths of 3.00mbgl & 3.50mbgl, within WS16 & WS05, respectively. Groundwater level monitoring has recorded groundwater levels in the range 2.73m and 5.34m bgl. The site and regional groundwater is likely to flow to the north/northwest, towards the River Medlock.

Foundations

The Made Ground deposits are considered unsuitable as an adequate founding stratum due to the proposed loads and the possible risks of unacceptable total and differential settlements occurring.

It is considered that the use of vibro replacement stone columns are suitable for lightly loaded foundations and floor slab. For the main building Contiguous Flight Augur or a bored piled foundations are the most suitable solution for both foundation to reduce the risk of excessive total and differential settlement associated with Made Ground and drift deposits.

A piling mat will be required in line with BRE470 Working Platforms for Tracked plant. This should be able to be developed from 'site won' crush which is likely to be a significant amount following site preparation and treatment.

Existing piles and possibly oversize foundation bases are likely to be present upon site and during site preparation will need to be recorded /surveyed to enable foundations and infrastructure to the new development to be designed.

A piling risk assessment will be required to establish the most suitable pile type and mitigate the risk of contamination to impact the underlying secondary A and Principal Aquifers.

A number of trees are present which are within possible influencing distance of the site. Foundations and drainage should be designed in line with NHBC Standards guidance document Chapter 4.2 Building Near Trees.

Site Won Soils

The Made Ground is unlikely to be suitable as a structural fill for foundations and pavements in its current state and treatment (sorting, segregation, screening) would be required to enable some of the materials to be re-used on parts of the site as structural fill for pavements and floorslabs. Granular soils would need to consider inclement weather as the soils would turn very soft during heavy rainfall if left exposed.

Excavation and Groundwater Measures

Excavations into the Made Ground and Glacial Till should be viable using conventional hydraulic excavating plant. Where relict concrete, insitu brick footings, hard to dig gravel, cobbles and boulders are present within the upper 4m, breaking equipment may be needed to achieve the design depth required.

The stability of foundation excavations are likely to be variable and collapse and spalling of the granular strata (particularly where groundwater is present) and Made Ground materials should be anticipated.

Where possible all soils should be retained on site to reduce disposal costs.

During periods of inclement weather, surface water management controls will be required.

Access Road and Hardstanding

A CBR value of 2% should be used for pavement construction within the Made Ground deposits. Where pavements intercept existing car parking sub base a CBR value of 5 to 15% may be achievable. CBR testing should be carried out to inform design.

Where pavements intercept existing car parking sub base a CBR value of 5 to 15% may be achievable. CBR testing should be carried out to inform design. Prior to the construction, it is recommended in-situ CBR tests using a bearing plate to be carried out at the formation once the formation elevation is determined.

Soakaways

Soakaway testing was undertaken within 2 locations broadly in accordance with BRE Digest No 365, to confirm the suitability of the Made Ground, Glacial Sand and Gravel, and Glacial Till. Results were consistent within both TP02 & TP05 as both soakaways succeeded to soakaway 50% of the effective storage volume. Within the granular Made Ground deposits,

a preliminary infiltration rate in the region of $3.58\text{E-}05\text{m/sec}$ and $8.03\text{E-}05\text{m/sec}$ were recorded within TP02 & TP05, respectively.

The depth of drainage and the proposed invert level and volume of the surface water ingress, will be critical; due to clayey nature of the Made Ground and interbedded and cohesive nature of the Glacial Sand and Gravel deposits. Further soakaway tests are required at planned locations if they are to be considered further.

Concrete Design

Concrete should be of minimum Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC-1s.

9.4.2 Contamination

A preliminary and refined risk assessment, based upon the findings of the intrusive investigation, is presented in Appendix F the general findings of which are discussed below.

Heavy metals, PAH's and ACM have been recorded in excess of tier 1 screening values in the soils beneath the site when compared to commercial end use values within proposed landscaping areas. A site strip of the upper vegetation and topsoil should be anticipated. These soils are unlikely to be suitable upon site for re-use and will need to be disposed to a suitably licensed waste management facility.

Within landscaping areas and P.O.S. a minimum requirement of 600mm of clean cover (150mm topsoil) / removal & replacement of made grounds should be assumed at this stage. A hard to dig layer or geotextile (designed to reduce infiltration) will be required within the cover system platform. If a geotextile is adopted then drainage should be introduced within the cover system layer to prevent waterlogged conditions within landscaped and P.O.S areas.

Specialist potable water pipework will be required. This will need to be confirmed following completion of a UKWIR assessment with the Regulators. Additional testing is required once the line of any new pipework is established to confirm whether specialist measures are required.

Site workers involved in excavations for foundations, roads, sewers etc during the construction works may come into direct contact with the soils containing elevated concentrations of heavy metals and asbestos. We would therefore recommend that simple precautionary measures be adopted during the construction phase i.e. good personal hygiene, provision of suitable welfare facilities and basic personnel protective equipment.

Any areas of proposed landscaping and public open space will require imported subsoil/topsoil materials which will require chemical validation to demonstrate that they are suitable for a commercial end use and taken to depths sufficient to provide a sufficient cover system for all proposed materials used which are capable to support root growth.

Risk to Controlled water are considered to be low upon completion of the developments. Although notwithstanding the above, to ensure a low risk to controlled waters it is recommended that additional boreholes and installations are carried out around RBH01 where TPH contaminated groundwater was recorded.

Soil samples have been characterised against hazardous waste criteria using HazWaste Online. Any soils to be exported from site should be allocated an appropriate waste code, following the steps within WM3.

The results appended to this document indicate that the samples tested are likely to predominantly be classified as NON-HAZARDOUS WASTE. However, localised shallow Made Ground deposits were determined to be classified as HAZARDOUS WASTE.

It is the responsibility of those generating the waste (i.e. the site), to ensure that the waste is handled and disposed of appropriately. Waste carriers transporting, and sites accepting, this material should have a corresponding code within their permits.

Gas protection measures should be installed in accordance with BS8485: 2015. Based on a Type C development and CS2 classification a gas protection score of 2.5 to will need to be achieved.

An appropriate gas protective membrane should be adopted with adequately vented sub-floor to mitigate potential risks.

Prior to the adoption of any gas protection measures, agreement should be sought from the local authority environmental health department and building control.

A CL:AIRE COP Materials Management Plan (MMP), remediation strategy and final validation reports are recommended and will be required prior to discharge of any outlying planning conditions.

APPENDICES

Appendix A – Drawings & Site Photographs

Appendix B – Groundsure Report & Historical Mapping

Appendix C – Exploratory Hole Logs

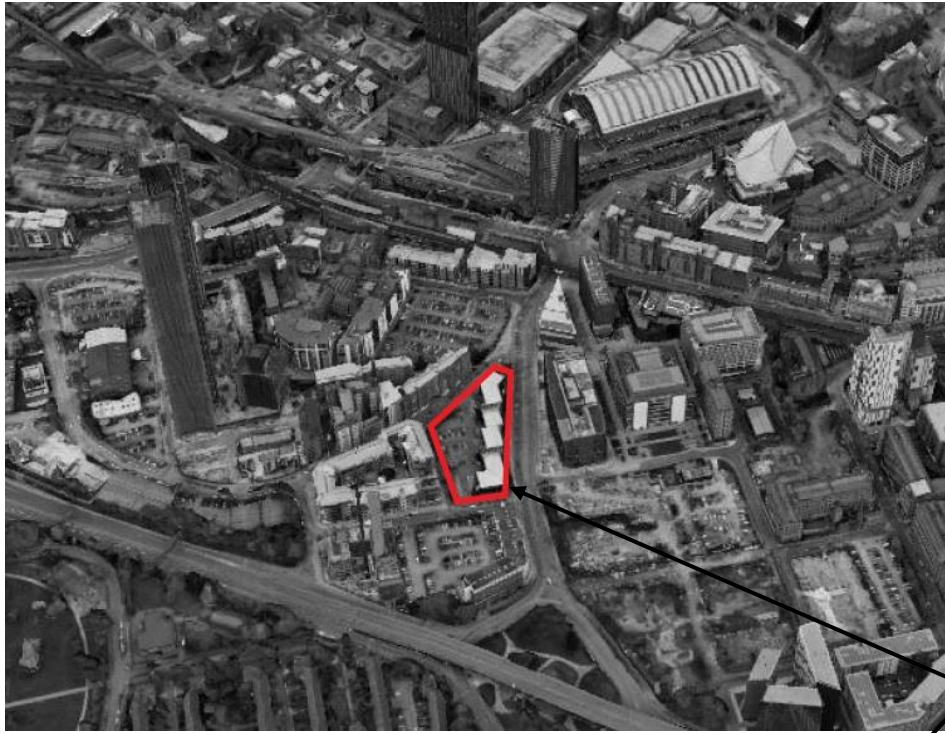
Appendix D - Geotechnical Laboratory Test Results

Appendix E – Chemical Test Results

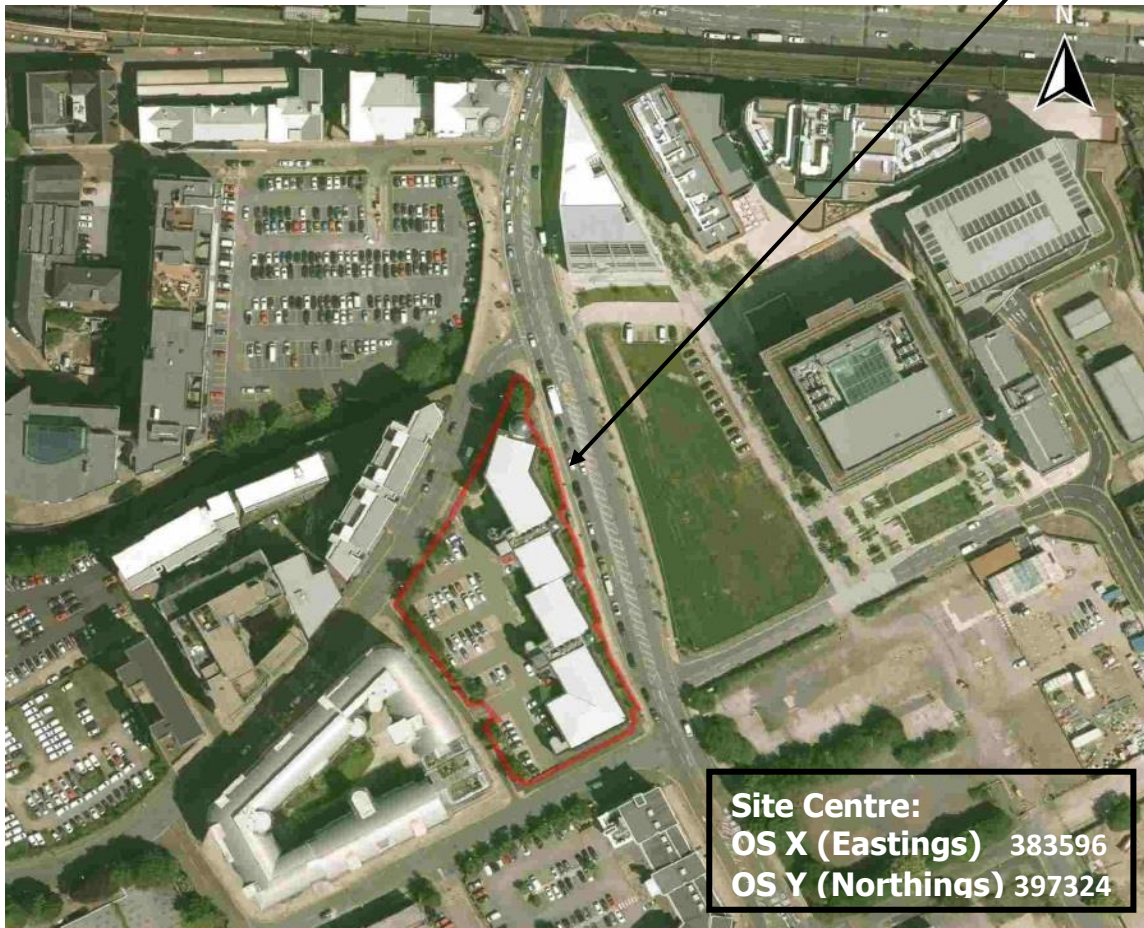
Appendix F – Conceptual Models & Risk Assessments

Appendix G – Preliminary Gas Monitoring Results

Appendix A – Drawings & Site Photographs



**SITE
LOCATION**



Site Centre:
OS X (Eastings) 383596
OS Y (Northings) 397324



Next Generation Engineering Consultancy Services

Tel: 0161 904 0187
 E-mail: admin@nxconsulting.org.uk
 Web: www.nxconsulting.org.uk

Ref: NX406 Figure 1

Project:

One City Road, Manchester

Title:

Site Location Plan



Key	
	Approximate Site Boundary
	Denotes Significant Former Developments
	Denotes Subordinate Former Developments
	Denotes Former Roads
	Former Electricity Station
1	Former Gaythorn Gas Works
2	Former Dunlop Rubber Works
3	Former Engineering Works and Bus Depot
4	Former Works/Warehouse

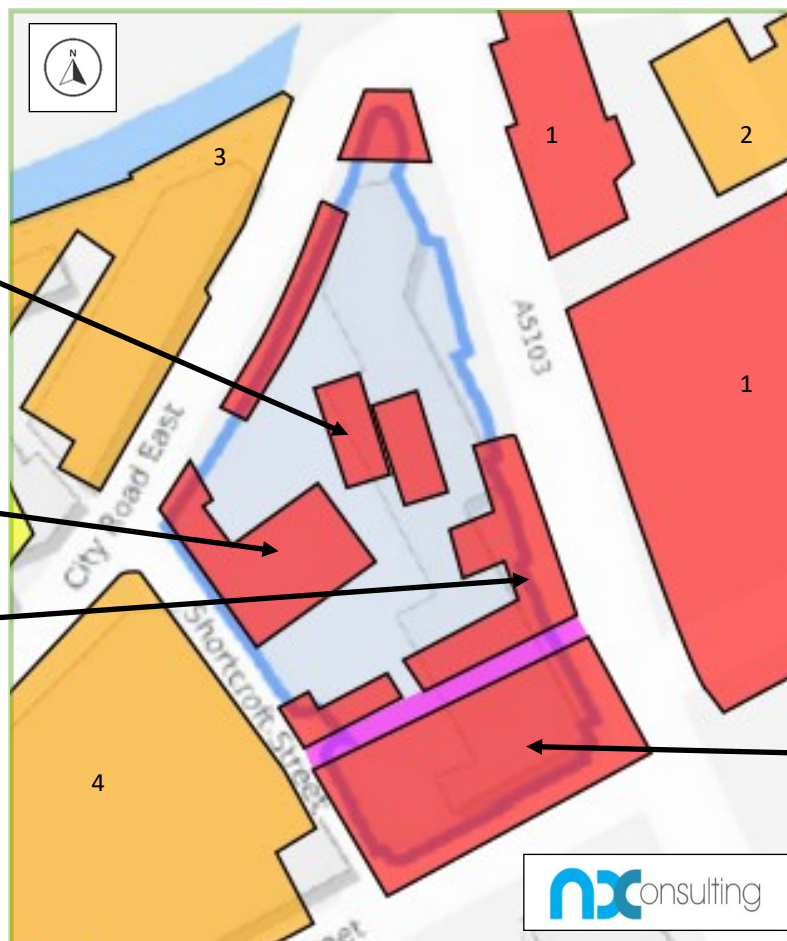
Ref: NX406 Figure 2 - Plate 1

Project:
No. 1 City Road, Manchester, M15 5PN

Title:
Conceptual Site Plan

Buildings associated to former Saw Mill development on site (northwards of former road).

Buildings associated to former Saw Mill hosting former incinerator/ chimney.



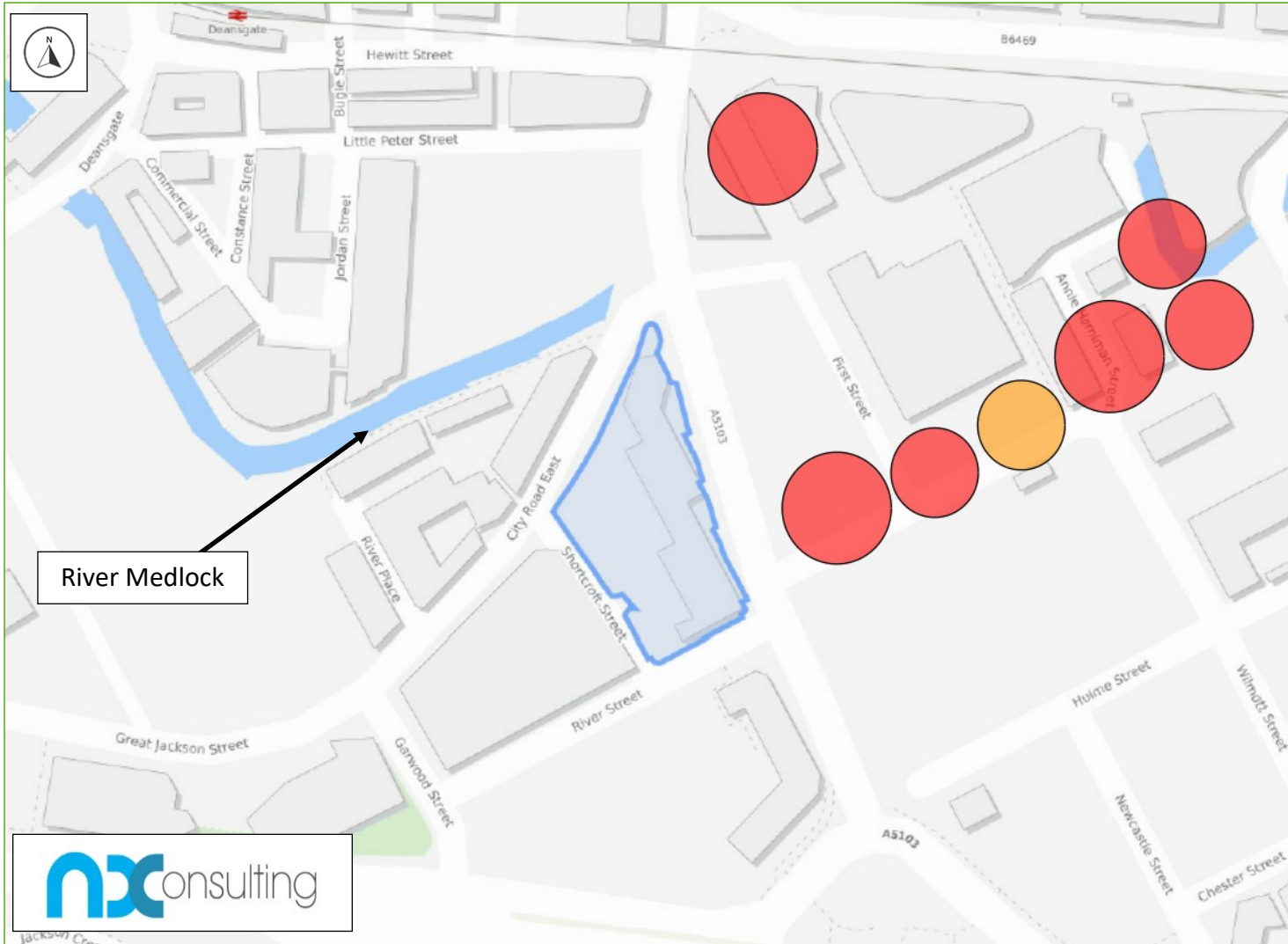
Buildings associated to former Timber Yard development within the southern area of the site.

Key	
	Approximate Site Boundary
	Denotes Significant Former Developments
	Denotes Subordinate Former Developments
	Denotes Former Roads
	Former Electricity Station
1	Former Gaythorn Gas Works
2	Former Dunlop Rubber Works
3	Former Engineering Works and Bus Depot
4	Former Works/ Warehouse

Ref: NX406 Figure 2 - Plate 2

Project:
No. 1 City Road, Manchester, M15 5PN

Title:
Conceptual Site Plan



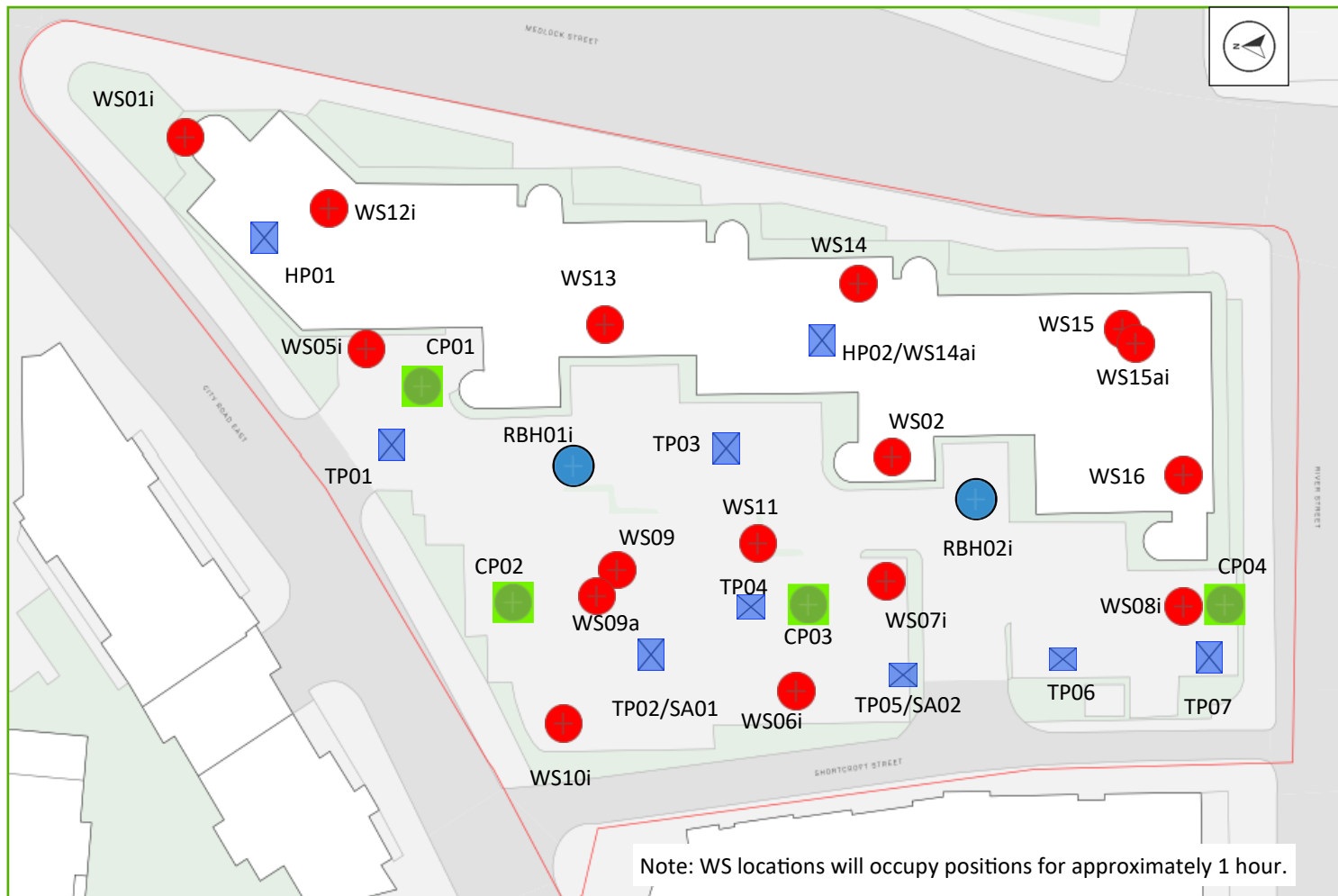
Key	
	Approximate Site Boundary
	Denotes Significant Former Gaythorn Gas Works Gas Cylinders
	Denotes Former Gaythorn Gas Works Tank

Gaythorn Gas Works initially appears on historical mapping in 1891. The five cylinders and the tank appear visible in 1893 mapping, and the large one to the north of site in 1908. Prior to the gas works the land previously accommodated: Finch Street Size Works, Street Dye Works and a Cotton Mill.

Ref: NX406 Figure 2 - Plate 3

Project:
No. 1 City Road, Manchester, M15 5PN

Title:
Conceptual Site Plan

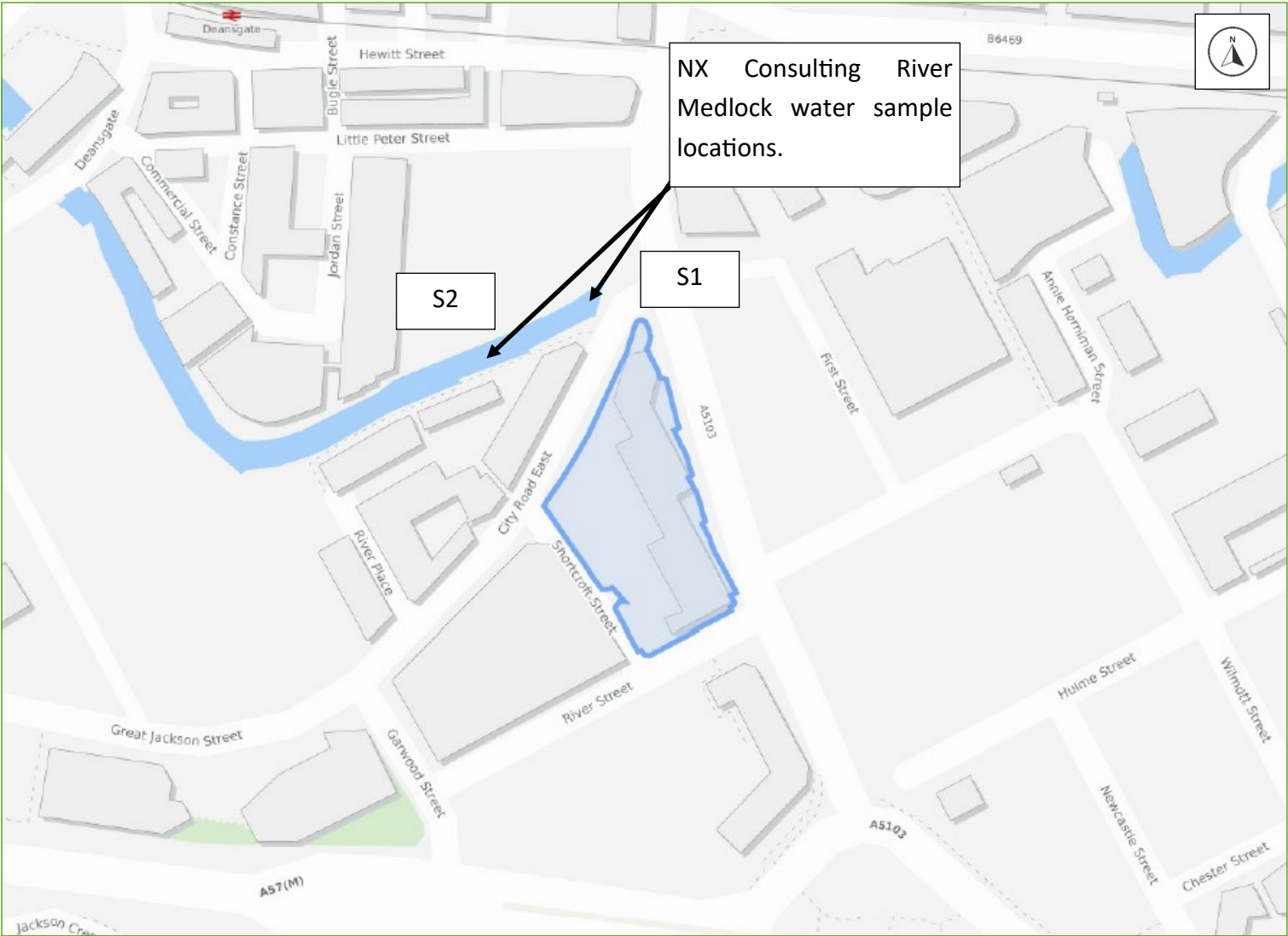


Key	
	Approximate Site Boundary
	NX Consulting Handheld Window Sampler Bore-holes (WS) to maximum depths of 6.45mbgl.
i	Denotes NX groundwa-ter/gas installation
	NX Machine Excavated Trial pit (TP)
	NX Manually Excavated Hand pit (HP)
	NX Consulting Rotary Core Boreholes, to maxi-mum depths 22.00m bgl (RBH)
	NX Consulting Cable Percussive Boreholes, to maximum depths 7.00m bgl (CP)

Due to the development history which has occurred on the site and surrounding area, NX Consulting will obtain upstream and downstream water samples of the River Medlock water at two sample locations.

The samples are to be taken to determine whether any potential contaminant migration from site to the nearby water course.

Proposed sample locations are to be taken from up and downstream for comparison purposes.



Ref: NX406 Figure 3 - Plate 2

Project:
No. 1 City Road, Manchester, M15 4PN

Title:
River Medlock Water Sampling Plan



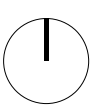
RBH1 & 2 under centre of 2no. proposed building footprints which should highlight any contaminant plume migration from the adjacent gas works

WS and TP exploratory holes within the south of the site. Areas of investigation comprise former road and timber yard.

WS and TP exploratory holes within the centre of the site. Areas of investigation comprise former Saw Mill hosting former incinerator/chimney.



Notes:
 Site Application Boundary



Project Name: One City Road		Title: Existing Site Location Plan		Scale: 1:1250 @ A1	
Drawn:	Checked:	Status:	Project:	Drawing No:	Rev:
FM	MH	Planning	140	_MP_00_1000	C
Details: C 11/09/20		Issued for Planning			

Jon Matthews Architects

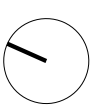
22 City Tower, Piccadilly Plaza, New York St, Manchester, M1 4BT 0161 974 3690

Copyright of this drawing is vested in Jon Matthews Architects and must not be copied or reproduced without written consent. Figures dimensions only are to be taken from this drawing. Don not scale from this drawing. For full company disclosure please visit www.jonmatthewsarchitects.com



Notes:

Site Application Boundary

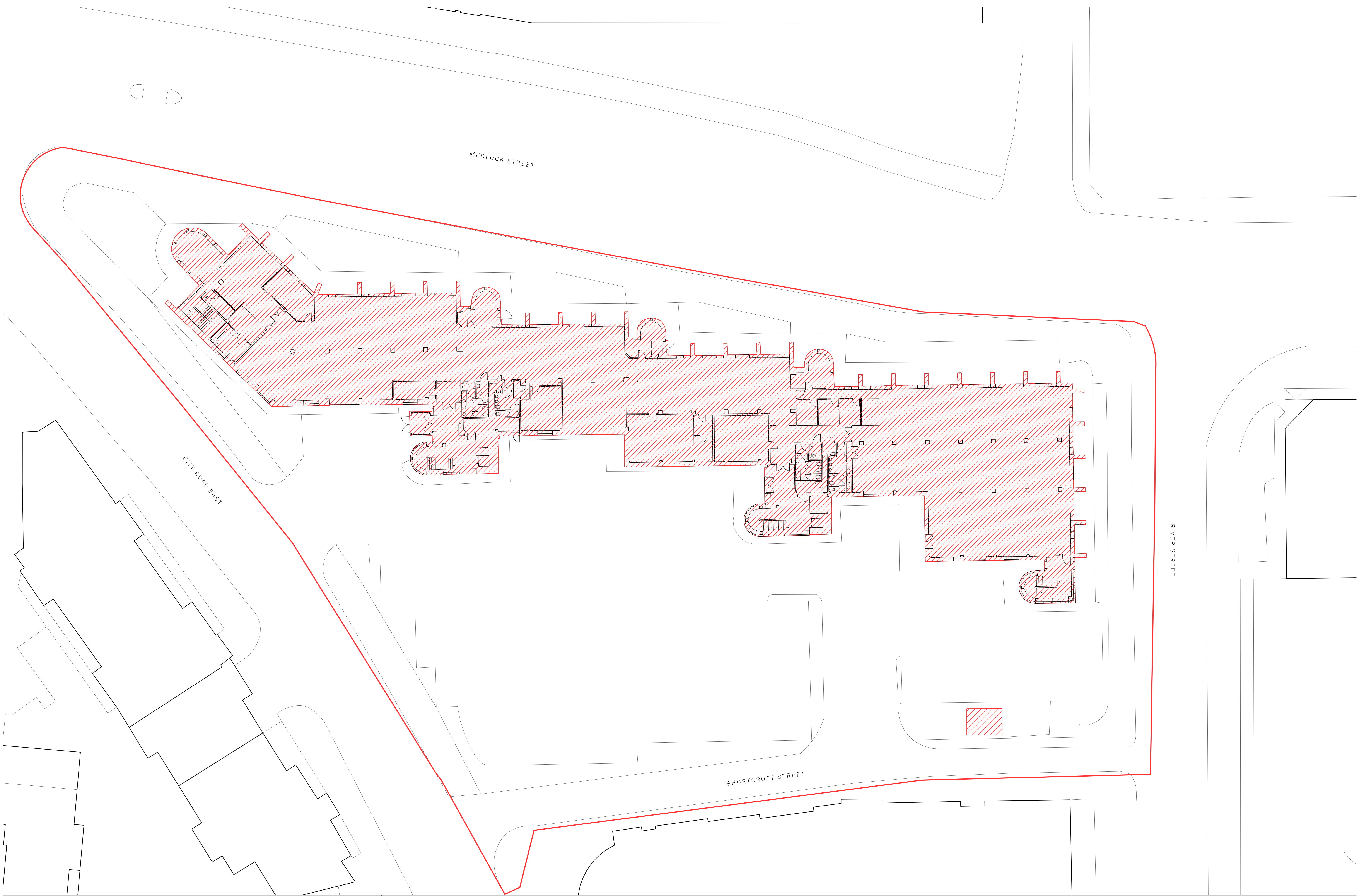


Project Name:		Title:		Scale:	
One City Road		Red Line		1:200 @ A1	
		Boundary Plan			
Drawn:	Checked:	Status:	Project:	Drawing No:	Rev:
POB	MH	Planning	140	_MP_00_1001	-
Details:					
- 11/09/20 Issued for Planning					

Jon Matthews Architects

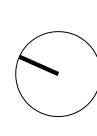
22 City Tower, Picadilly Plaza, New York St, Manchester, M1 4BT 0161 974 3690

Copyright of this drawing is vested in Jon Matthews Architects and must not be copied or reproduced without written consent. Figured dimensions only are to be taken from this drawing. Don not scale from this drawing. For full company disclosure please visit www.jonmatthewsarchitects.com



Notes:

-  Site Application Boundary
-  Area to be Demolished



Project Name: One City Road		Title: Demolition Site Plan		Scale: 1:200 @ A1	
Drawn: FM	Checked: MH	Status: Planning	Project: 140	Drawing No: _MP_00_1100	Rev: -
Details: - 11/09/20 Issued for Planning					

Jon Matthews Architects

22 City Tower, Piccadilly Plaza, New York St, Manchester, M1 4BT 0161 974 3690

Copyright of this drawing is vested in Jon Matthews Architects and must not be copied or reproduced without written consent. Figured dimensions only are to be taken from this drawing. Don not scale from this drawing. For full company disclosure please visit www.jonmatthewsarchitects.com



Notes:

Site Application Boundary

PLAN KEY:

01 Block 01 roof plan	04 Plot 9	07 Car park	10 Offices	13 HOME Manchester	16 Number 1 - retail and offices	19 Vita - student accommodation
02 Block 02 roof plan	05 Medlock Street junction with Mancunian Way	08 Plot 10	11 Sainsburys / Junk Yard Golf Club	14 Number 8 - retail, leisure and office	17 James Grigor Square	20 Plot 11, First Street
03 New landscaping	06 Existing Premier Inn	09 Residential	12 INNSIDE Manchester	15 Tony Wilson Place	18 Q-Park	21 River Street tower

Project Name:		Title:		Scale:	
One City Road		Proposed Site Plan		1:500 @ A1	
Drawn:	Checked:	Status:	Project:	Drawing No:	Rev:
FM	MH	Planning	140	_MP_00_1200	-
Details:					
- 11/09/20		Issued for Planning			

Jon Matthews Architects

22 City Tower, Piccadilly Plaza, New York St, Manchester, M1 4BT 0161 974 3690

Copyright of this drawing is vested in Jon Matthews Architects and must not be copied or reproduced without written consent. Figured dimensions only are to be taken from this drawing. Don not scale from this drawing. For full company disclosure please visit www.jonmatthewsarchitects.com

NORTH

South

 = CDP Parking Spots

 = KOG

+ 32.9m

CITY ROAD EAST

SHORTCRAFT STREET

LOCK

MEDLOCK STREET

DD

Sub to

83 84 85 86 87

79 80 81 82

78 77 76 75 74 73

71 70

69 68 67 66 65 64 63

62 61

48 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31

30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10

9 8 7 6 5 4 3 2 1

24

26

28



Plate 1 – No 1 City Road Office Development in East of Site Looking South



Plate 2 – Site Looking South



Plate 3 – Site Looking Northeast from Western Car park



Plate 4 – Mechanical Plant in East of Site



Plate 5 – First Street Development to East of Site (Former Gaythorne Gas Works)



Plate 6 – No 1 City Road Building in Southeast of Site Looking South



Plate 7 – Electricity Substation in West and Centre of Site



Plate 8 – Eastern Boundary Looking South



Plate 9 – Southern Boundary Looking East



Plate 10 – Western Boundary Looking South