

Remediation Strategy for East Lancashire Paper Mill Island Site, Rectory Lane, Radcliffe, M26 2QU

Project No: NX418/R1



Client



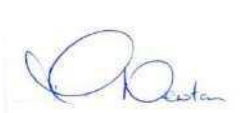
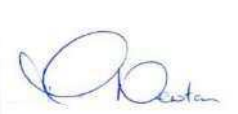
DOCUMENT VERIFICATION**Report Reference:** NX418**Issue:** Rev 1**Date:**13th April 2022**Reviewed by:** Matthew Tomkinson
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Revision History

Revision	Date	Description	Reviewed by	Approved by
Issue	March 2022	Final		
Rev 1	April 2022	Client Amendments		

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EXECUTIVE SUMMARY

NX Consulting Limited have been commissioned by Great Places Housing Association (The Client) to conduct a remediation strategy on land at Rectory Lane, Radcliffe, M26 2QU.

It is understood the site is to be developed for residential purposes with associated gardens, landscaping areas and access roads.

Site investigation works undertaken by NX consulting have identified lead arsenic & PAH contamination in a number of shallow soil samples. As such, it is recommended that these soils not be utilised within shallow soils in garden or landscaped areas as part of the redevelopment.

A Landscape Proposal and Planting Plan and Proposed Levels & External Works drawings provided within Appendix A should be used to establish where 'clean cover systems' should be adopted. Within areas of private domestic gardens (including superficial hardstanding paved areas), a minimum 600mm of clean cover / removal & replacement of made ground is required.

Within areas of soft landscaping a minimum 600mm of clean cover / removal & replacement of made ground is required.

Best practice states that the 'clean cover system' layer should comprise a capillary break layer/hard to dig layer comprising 100mm of compacted stone or geotextile membrane beneath the 450mm of clean imported subsoil and 150mm of topsoil. We recommend that the hard to dig layers or geotextile membrane are placed in gardens of proposed plots 1 to 6 (or where any other gardens are planned). Given the nature of recorded contamination, we consider that hard to dig layers are not required in landscaped areas. However, future contractors should be notified to ensure that appropriate PPE is adopted when future excavation works are carried out within proposed landscaped areas.

Whilst Asbestos Containing Material (ACM) was not found during soil sampling of made ground, given the age and nature of demolition arisings, its presence cannot be discounted. As a contingency measure and to protect construction workers and adjacent receptors from any unidentified asbestos contamination, we recommend that any identified ACM, found during the site enabling works should be dealt with in strict accordance with the Control of Asbestos Regulations (CAR) 2012, UK Waste Management Legislation and the Environmental Protection Act 1994. The following protective measures should be adopted during the proposed ground preparatory works:

- All site personnel should be provided with PPE.
- A water bowser or other dust suppression equipment should be provided in order to dampen exposed surfaces; during the movement of plant and removal of arisings.

The risks to controlled water receptors are deemed to be low post construction.

Certification of ground gas measures are classified as Situation 2 (Amber 1) conditions and Low-level ground gas protection measures are required; comprising the following:

1. Low Permeability membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings.
2. Independent verification of protection measures are required to satisfy planning conditions relating to ground gas risk.
3. 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.

The risks presented to controlled water receptors are deemed to be low given the low sensitivity of the underlying aquifer and low source generating potential of the site.

Any imported subsoil/topsoil materials will require chemical validation to demonstrate that they are suitable for a residential 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.

Materials surplus to requirement or that are unsuitable for re-use on site will require removal to a suitably licensed waste management facility. Waste Acceptance Criteria (WAC) testing will be required prior to the disposal of site soils, if exported to landfill.

Soil operations may 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. If so, 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.

The results indicate that specialist protection measures are not required in relation to the water supply pipework. A UKWIR risk assessment is recommended to be completed at the depth of the proposed water supply pipework. It is recommended that statutory services are consulted at an early stage, with respect to the ground conditions. Additional testing may be required along lines of proposed pipework.

The design team and Client should familiarise themselves with the presence of utility services on the site.

Once the whole site has been remediated; validation and approval from the Local Planning Authority will be required via a validation report encompassing all the findings of the remediation works on this site.

EXECUTIVE SUMMARY	2
1.0 INTRODUCTION	3
1.1 Instruction	3
1.2 Previous Surveys.....	3
1.3 Objectives	3
1.4 Report Layout	4
1.5 Limitations	4
2.0 BACKGROUND	6
2.1 Site Location & Setting	6
2.2 The Proposed Development.....	6
2.3 Environmental Setting	6
3.0 GROUND INVESTIGATION.....	8
3.1 Fieldworks.....	8
3.2 Ground Conditions	8
3.3 Groundwater.....	9
3.4 Underground Service Plans.....	9
3.5 Below ground obstructions	9
3.6 Contaminant observations	9
4.0 CONTAMINATION ANALYSIS AND ASSESSMENT	10
4.1 Rationale.....	10
4.2 Soil Guideline Values.....	11
4.3 LQM/CIEH Suitable 4 Use Levels (S4UL)	11
4.4 Site Soils	12
4.4.1 <i>NX Consulting Investigation</i>	12
5.0 GROUND GAS RISK ASSESSMENT	14
6.0 REMEDIATION STRATEGY	16
6.1 Aims.....	16
6.2 Recorded Contamination	16
6.3 Proposed Remedial Measures & Material Management Plan Requirement	16
6.5 Control of Water	19
6.6 Exported to Landfill.....	19
6.7 Dust Control.....	20
6.8 Previously Unidentified Contamination	20
6.9 Controlled Waters	20
6.10 Potential below Ground Obstructions	21
6.11 Site Setup, Organisation and Safety.....	21
6.12 Contractor's Responsibilities	22
6.13 Engineering Supervision	22
6.14 Health and Safety during Remediation of Unidentified Contamination	23
6.15 Gas Protection Measures	23
6.16 Drainage and Services Installations.....	24
7.0 VERIFICATION	25
APPENDICES.....	27
Appendix A – Drawings	28
Appendix B – NX Phase 1 & Phase 2 Report.....	29

Appendix C – NX Consulting Protocol for Validation of Soil Cover Systems.....	30
Appendix D – Summary of Guidance Relating to Ground Gas	31

1.0 INTRODUCTION

1.1 Instruction

NX Consulting Limited have been commissioned by Great Places Housing Association (The Client) to conduct a remediation strategy on land at Rectory Lane, Radcliffe, M26 2QU.

It is understood the site is to be developed for residential purposes with associated gardens, landscaping areas and access roads.

The remediation strategy is required in conjunction with the following Planning Application and Bury Council's outline planning conditions:

- Application No 67965 (East Lancs Paper site, land between Cockclod Street/Cunliffe Street/Howard Street/Pollitt Street, Radcliffe Manchester, M26 9PG.

1.2 Previous Surveys

NX Consulting have carried out previous surveys at the site.

- NX418 Revision 2 - Rectory Lane, Radcliffe Phase 1 & Phase 2 Geoenvironmental Report; dated 30.07.2021.

White Young Green (WYG) carried out a Phase 1 desk Study of the larger East Lancashire Paper mill site to the south west. The report included a review of a number of reports, made available by the Homes and Communities Agency (HCA), these include;

- Remedial Strategy for land at East Lancashire Paper Mill, Radcliffe. Prepared by Encia Consulting Limited for P&F Properties Limited. (Report ref: 5996/3/Rev-A, July 2005);
- East Lancashire Paper Mill, Radcliffe. Report on Supplementary Groundwater/ Ground Gas Monitoring. Prepared by Encia Consulting Limited for P&F Properties Limited. (Report ref: 5996/BRB, November 2005); and,
- Summary Status Report for The East Lancashire Paper Mill Site. Prepared by ADM Regeneration Limited for P&F Properties Limited. (Report ref: 10109_SSR_01, August 2013).

This Remediation Strategy Report should be read in conjunction with the reports listed above.

1.3 Objectives

The aims of the Site Investigation and Remediation Strategy are as follows:

- To investigate the contaminant status of the shallow soils beneath the site.
- To investigate the ground gas regime beneath the site.

- To comply with the requirements of the Local Planning Authority () and their Environmental Health Department/Pollution Control Unit to ensure that future end users of the site are not put at risk from any chemical contamination arising from its former uses.
- To ensure that construction workers are not put at an unacceptable short-term risk in reclaiming/remediating and redeveloping the site.
- To satisfy the requirements of Bury Council in ensuring that the proposed construction works provide a degree of protection necessary to controlled waters.

1.4 Report Layout

Section 2 of this report provides background information with respect of the site such as site setting and description.

Section 3 details the intrusive investigations carried out to date with a summary of the environmental setting, ground conditions and chemical analyses.

Section 4 details the ground gas risk assessment and target concentrations at the site.

Section 5 details the geochemical risk assessment and target concentrations at the site.

Section 6 presents the remedial strategy for the site and section 7 discusses the requirements for subsequent development at the site.

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 given in this report and the opinions expressed assume that the ground conditions (geology, hydrogeology, contamination) do not vary beyond the range revealed by this assessment. There may be, however, conditions within the site, which have not been identified from the information reviewed and consequently have not been considered in this report: confirmation of such uncertainties should be the focus of any future intrusive investigations.

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.

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2.0 BACKGROUND

2.1 Site Location & Setting

The property is approximately 0.57 hectares in size and located at the former East Lancashire Paper Mill Island, Rectory Lane, Radcliffe, M26 2QU. National grid reference (NGR: E379021, N407407.). A site location plan is presented in Appendix A.

The site is irregular in shape, generally level and comprises a combination of car parks and open landscaped areas.

The south of the site comprises hardstanding carpark within a disused public house and associated garden beyond. Two unnamed containers are present within the car park area.

The centre of the site comprises open land laid to grass with occasional mature and semi-mature trees, benches, bushes and a concrete path running east-west through. The southern boundary of this central area is marked by a row of trees and bushes separating the hardstanding car park to the south.

The north of the site is demarked by an area of paving hardstand with concrete bollards on the northern and southern boundary with Howard Street and Cunliffe Street respectively. The north-eastern corner of the site comprises a small area of scrub and semi-mature trees. An electrical substation contained within a brick housing and concrete slab base is located within the north-eastern corner of the site. A 2m high metal high palisade fence formed the boundaries within this area

A culverted brook runs through the central landscaped (park) area trending north to south.

2.2 The Proposed Development

It is understood that proposals include the residential development of 27 no. houses and apartments with car parking, gardens and landscaped areas.

A site layout is presented on drawings in Appendix A.

2.3 Environmental Setting

A summary of the environmental setting of the site pertinent to this report has been summarised below.

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Drift Geology	On site: Glaciofluvial sheet deposits, Devensian – Sand and Gravel
	Surrounding area: Glaciofluvial sheet deposits, Devensian – Sand and Gravel

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Solid Geology	On Site: Pennine Middle Coal Measures Formation – Mudstone, Siltstone and Sandstone
	Immediate surrounding area: Pennine Middle Coal Measures Formation – Mudstone, Siltstone and Sandstone
Hydrology	Narrow culverted watercourse passes under the site running north to south. Inland river not influenced by tidal action flows underground on site but flows at surface level 16m NW. Outfalls to River Irwell 110m to south. River Irwell – 107m SE
Hydrogeology	Superficial deposits – Secondary A Bedrock deposits – Secondary A
Water Abstractions	No groundwater abstractions lie within 500m of the site. Historical surface water abstraction lies 399m north west of the site.
Source Protection Zone	The site does not lie within a source protection zone.

The site has formerly been in use as a Brewery in the northeast of the site and terraced housing in the south. A surface watercourse ran through the western area of the site which was culverted by 1930 when the area was in use as allotment gardens. Surrounding historical uses have included East Lancashire Paper Mill and reservoirs, a cotton mill, infilled ground and residential properties. The site is currently in use as car parks, landscaped areas with a disused public house in the south and an electricity sub-station in the northeast.

The site is situated above the Middle Coal Measures Secondary Aquifer which is overlain by River Terrace Deposits of Sand and Gravel. There are no registered landfill sites within 250m of the site. A watercourse is culverted below the site. The site is within an area of previous coal mining activity

A refined risk model was developed for the site by NX Consulting. The conceptual model identified a number of potential environmental risks that could arise as a result of the past use of the site. The refined model identified a number of potentially significant pollutant linkages that may affect the potential for redevelopment. These were:

- The presence of isolated elevated benzo(a)pyrene concentrations in the soil
- The presence of elevated arsenic and lead concentrations in the made ground;

As such, it is recommended that these soils not be utilised within shallow soils in garden or landscaped areas as part of the redevelopment.

Within areas of private domestic gardens (including superficial hardstanding paved areas), a minimum 600mm of clean cover / removal & replacement of made grounds was recommended.

Within areas of soft landscaping a minimum 600mm of clean cover / removal & replacement of made grounds was recommended.

3.0 GROUND INVESTIGATION

3.1 Fieldworks

An intrusive investigation was carried by Taylor Drilling and monitored by an engineer from NX Consulting between the 26th April 2021 and 28th April 2021.

All locations were checked for services against available service plans and scanned with a cable avoidance tool (CAT) prior to the intrusive investigation; in line with NX Consulting health and safety methodology.

7no. windowless sample boreholes (WS1 through to WS7) were formed to a maximum depth of 5.0mbgl. Hand pits to 1.2mbgl were formed in all boreholes prior to drilling.

Groundwater monitoring wells were installed in WS1, WS3, WS4 and WS7 to circa 2.50mbgl on completion. These comprised an upper 0.50m of plain pipe connected to a length of slotted pipe with a pea gravel surround.

2no. open hole rotary boreholes water flush (RBH1 & RBH2) were formed to a maximum depth of 40.00mbgl under Coal Authority permit No: 21958.

4no. machine excavated trial pits (TP1 through to TP4) were formed to a maximum depth of 2.0mbgl.

Surface soils samples were tested for a number of general screening tests including pH and metals, cyanide, phenols, sulphide, sulphur and speciated PAH, speciated TPH, BTEX and asbestos screening to confirm, or otherwise, the site's anticipated risk status.

3.2 Ground Conditions

Ground conditions identified from 7no. windowless sample boreholes and 4no trial pits have identified Made Ground, to a maximum depth of 2.40 metres below ground level (mbgl) (WS7).

Infilled demolition arisings were recorded within the area of WS1/TP01 which will require pre-treatment (excavation/screening/crushing and replacement) prior to formation of the adopted foundation solution.

Mudstone bedrock was 'tentatively' but not definitively proven in window sampler boreholes WS6 & WS7 between at depths of 3.50m & 5.00 mbgl. RBH01 & RBH02 recorded interbedded siltstone, mudstone and sandstone bedrock at depths ranging from 8.70m bgl (RBH01) & 5.80m bgl (RBH02).

The Made Ground is underlain by generally interbedded firm to stiff or stiffer Glacial Clay and sand/sand and gravel between 0.50m bgl to 2.40m and 3.50m bgl to 5.00m bgl.

SPT N values within the clay deposits were in the range 8-43 indicting firm to stiff to very stiff conditions.

SPT N values within the granular deposits were in the range 6-19 indicating loose to medium dense.

3.3 Groundwater

Groundwater was recorded in WS4, WS5, WS6 & WS7 between 1.94mbgl (WS5) and 3.97mbgl (WS4). Groundwater was found to be absent in WS1, WS2, WS3, TP1, TP2, TP3, & TP4.

3.4 Underground Service Plans

Underground services, BT Lines, gas mains, combined and foul sewers, CCTV and possible fibre optic cables may all impact the site and the design team and Client should familiarise themselves with their presence. A culverted watercourse is also located in the centre of the site, flowing north to south.

3.5 Below ground obstructions

No below ground obstructions were encountered.

3.6 Contaminant observations

No obvious visual or olfactory evidence of significant contamination were observed during the site works.

4.0 CONTAMINATION ANALYSIS AND ASSESSMENT

No visual or olfactory evidence of hydrocarbon/solvent contamination was recorded during the drilling for placement of the gas monitoring boreholes or within shallow surface sampling.

Selected samples of made ground were tested for a number of general screening tests including pH and metals, cyanide, phenols, asbestos, sulphide, sulphur, TPHWCG and speciated PAH were undertaken during the intrusive investigation to confirm, or otherwise, the site's anticipated risk status.

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.

4.1 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 more simple 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.

4.2 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.

4.3 LQM/CIEH Sutable 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 Sutable 4 Use Levels'. With respect to lead the current Category 4 Screening Level will be used. LQM /CIEH S4ULs Copyright Land Quality Management Limited. Reproduced with permission Publication No. S4UL3671. All right reserved.

4.4 Site Soils

4.4.1 NX Consulting Investigation

The chemistry analysis results, presented in Appendix C, have been compared against the Tier 1 criteria for a *residential* end use with plant uptake to reflect the development proposals.

For risk assessment purposes a soil organic matter value of 6.0% has been assumed for both the Made Ground and natural strata. The pH of the soils is generally very slightly acidic (mean value of 8.00).

Made Ground & Natural Soils

The chemistry analysis results, presented in Appendix F, have been compared against the Tier 1 criteria for a *residential end* use (conservative due to the sensitivity of site receptors) to reflect the development proposals.

For risk assessment purposes a soil organic matter value of 1.0% has been assumed for both the Made Ground and natural strata. The pH of the soils is generally very slightly alkaline (mean value of 7.58).

Tier 1 thresholds have been exceeded in the following:

Parameter Group	Screening value (mg/kg)	Maximum Concentration of Exceedances (mg/kg)	Locations
Lead	450	2500 580 560 6000	WS4 @ 1.0mbgl WS5 @ 0.05mbgl WS6 @ 0.4mbgl TP1 @ 0.5mbgl
Arsenic	37	58 74 710 61 190	WS4 @ 0.05mbgl WS4 @ 1.0mbgl WS5 @ 0.05mbgl WS5 @ 1.1mbgl WS6 @ 0.4mbgl
Naphthalene	2.3	4.6	WS6 @ 0.4mbgl
Benzo (a) anthracene	7.2	8 14 25	WS4 @ 0.05mbgl WS5 @ 0.05mbgl WS6 @ 0.4mbgl
Chrysene	15	22	WS6 @ 0.4mbgl
Benzo (a) pyrene	2.2	6.7 6.8 13 23	WS1 @ 0.5mbgl WS4 @ 0.05mbgl WS5 @ 0.05mbgl WS6 @ 0.4mbgl
Benzo (b) fluoranthene	2.6	8.9 7.4 14 2.7 23	WS1 @ 0.5mbgl WS4 @ 0.05mbgl WS5 @ 0.05mbgl WS5 @ 1.1mbgl WS6 @ 0.4mbgl
Dibenzo(ah)anthracene	0.24	1.1 0.27 2.1 0.32 3.8	WS1 @ 0.5mbgl. WS4 @ 0.05mbgl WS4 @ 1.0mbgl WS5 @ 0.05mbgl WS5 @ 1.1mbgl WS6 @ 0.4mbgl

No asbestos was recorded during soil screening, although given the nature of previous development on the site, it cannot be discounted at this stage.

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	Not identified in conceptual model
BTEX, MTBE	0.1	0.03	<1.00
SVOC Suite	2	1.4	Not identified in conceptual model
Phenols	2	0.4	<1.00
Mineral Oils C11-C20	10	N/A	<1.00
Mineral Oils C21-C40	500	N/A	<1.00

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 all samples analysed within the made-ground or natural soils with respect to the end use of the site.

On the basis of the above laboratory analysis shallow soils at the site may pose a potentially unacceptable risk to end users of the site via ingestion, inhalation or dermal contact with shallow soils.

Potential exposure is considered to potentially occur within garden and landscaped areas where site derived soils would be present at the surface.

Therefore, some remedial measures are recommended to remove site derived soils from the near surface, thereby breaking any potential pollutant linkage.

5.0 GROUND GAS RISK ASSESSMENT

Source generation potential on site

Given the low amounts of organic matter identified by the ground investigation data and relatively shallow depths of made ground, the gas generation potential of soils recorded on the site is considered to be low to moderate. The site is underlain by Coal Working and no recorded mineshafts are known to be present upon the site.

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 site through the shallow made ground deposits.

Vertical migration could occur from former coal workings recorded beneath the site.

Receptors

The receptors considered in this assessment are the end users of the buildings.

5.1 Quantitative Assessment

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 and coal workings either on site or on the immediate vicinity.

A number of infilled features have also been recorded within 250m of the site. In addition to this, limited thicknesses of made ground have been encountered and where present, material does not contain significant deleterious items/organic matter.

Gas monitoring has been undertaken to confirm this low to moderate risk.

To date 9 No. rounds of ground gas monitoring have been undertaken in line with CIRIA 665. Atmospheric pressure ranged from 993 to 1019 with 2 No. visits carried out a falling atmospheric pressure.

A summary of the soil gas monitoring results is presented in Table 5.1.1 below and copies of the log sheets presented in Appendix G.

Table 5.1.1 – Summary of Gas Monitoring Results

Borehole Reference	CO ₂ Range (%v/v)	Flow (l/hr)	Max GSV (l/hr)	CH ₄ Range (%v/v)	Max GSV (l/hr)
WS1	0.6 – 2.5	0.10	<0.05	0.0-0.0	<0.05

WS3	0.1 – 4.1	0.10	<0.05	0.0-0.1	<0.05
WS4	0.1-2.7	<0.10	<0.05	0.0-0.0	<0.05
WS7	2.9-9.0	0.20	<0.05	0.0-0.1	<0.05

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 9.0% with a maximum flow recorded of 0.2l/hr. The maximum-recorded concentration for methane was 0.0%. In addition, hydrogen sulphide concentrations of 0.0 ppm were recorded.

On the basis of these results, certification of ground gas measures are classified as Situation 2 (Amber 1) conditions and Low-level ground gas protection measures should be adopted, utilising Low Permeability membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Service entries should be sealed with appropriate Visqueen or similar specialist proprietary equipment. A copy of the anticipated product and design is provided within Appendix A of this document.

Table 5.1.1 Gas Protection

Building Type	Floor Slab Type	Ventilation	Membrane	Required Points Score	Points Achieved
Conventional residential house (Building Type A)	Block and beam suspended floor (0 Points)	Suspended beam and block flooring with suspended ventilated void (2.5 points)	Full gas membrane installed to S8485:2015 and validated to CIRIA 735 (2 points)	3.5	4.5 points

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

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.

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

Soil testing to date indicates that there is a low risk of vapour generation and migration into the proposed buildings. No specific protection measures are envisaged in relation to hydrocarbon contamination.

6.0 REMEDIATION STRATEGY

6.1 Aims

The aims of this remediation strategy are the following:

- Resolve any potential and identified contamination issues in order to protect environmental receptors, and render the site suitable for the proposed development.
- Satisfy the Environmental Agency and the Local Planning Authority with regards to any unidentified soil and groundwater contamination.
- Provide a stable development platform (to agreed levels and gradients) for subsequent construction of the proposed development and associated infrastructure.

6.2 Recorded Contamination

Chemical sampling of site soils, to date, indicate that the site soils are potentially unsuitable for use within private gardens and landscaping due to potentially unacceptable levels of arsenic, lead, PAH. and possible asbestos fibres.

As such remedial measures are recommended with respect to private residential gardens, communal gardens and landscaped areas.

Whilst Asbestos Containing Material (ACM) was not found during soil sampling of made ground, given the age and nature of demolition arisings, its presence cannot be discounted. As a contingency measure and to protect construction workers and adjacent receptors from any unidentified asbestos contamination, we recommend that any identified ACM, found during the site enabling works should be dealt with in strict accordance with the Control of Asbestos Regulations (CAR) 2012, UK Waste Management Legislation and the Environmental Protection Act 1994. The following protective measures should be adopted (Site Wide) during the proposed ground preparatory works:

- All site personnel should be provided with PPE.
- A water bowser or other dust suppression equipment should be provided in order to dampen exposed surfaces; during the movement of plant and removal of arisings.

6.3 Proposed Remedial Measures & Material Management Plan Requirement

Given the nature of the contamination the most cost effective remedial solution is likely to comprise a simple capping layer.

Within areas of proposed private or communal gardens 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.

Where site levels allow, it may be possible to retain the made ground on site and provide the 600mm capping layer above.

Where the made ground materials are less than 600mm thick, only the made ground materials will require removal.

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.

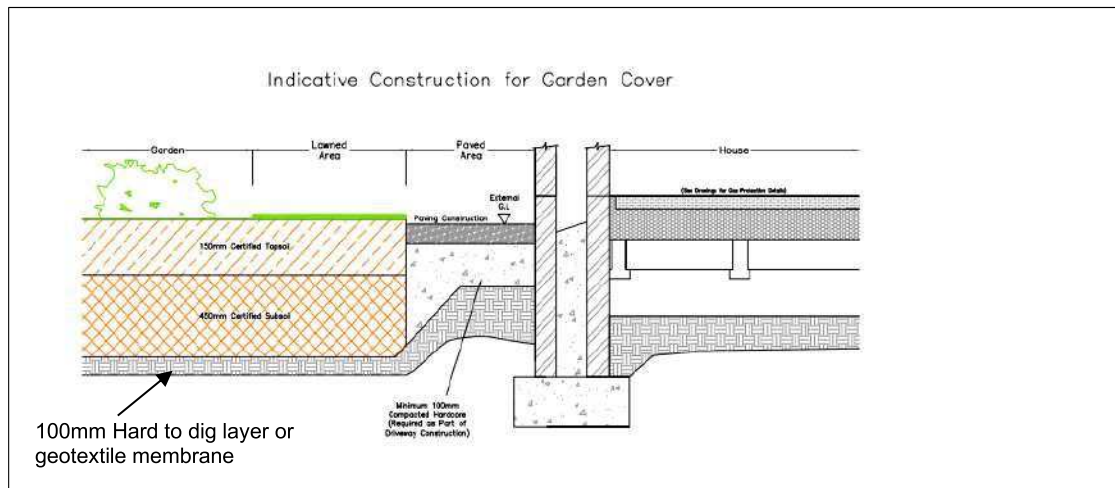


Figure 6.3.1 – Clean Cover System Example within Plots 1 to 6 Garden areas.

Although not shown above, best practice states that the 'clean cover system' layer should comprise a capillary break layer/hard to dig layer comprising 100mm of compacted stone or geotextile membrane beneath the 450mm of clean imported subsoil and 150mm of topsoil to form the 600mm the cover system thickness. We recommend that hard to dig layers or geotextile membrane are placed in gardens of proposed plots 1 to 6. Given the nature of recorded contamination, we consider that hard to dig layers are not required in landscaped areas. However, future contractors should be notified to ensure that appropriate PPE is adopted when future excavation works are carried out within proposed landscaped areas.

Materials imported to site are required to be suitable for the intended residential purpose.

Construction operations may 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. If so, 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.

Table 6.1 presented below, provides values for suitable soils dependent upon the intended use.

Topsoil should be in line with BS 3882: 2015 'Specification for topsoil' above the break subsoils and/or breaker layer.

At the site boundaries care should be taken not to undermine any existing structures or infrastructure. Where, such a risk may be present, it is recommended that any remedial excavations are battered back at a suitable angle (1:1). Given the relatively low levels of contaminants recorded and the very limited areas this is likely to entail any potential residual risk is likely to be very low.

	Residential 0mm Cover		Residential 600mm Cover		Residential Apartments with Landscaping	
Units	mg/kg	source	mg/kg	source	mg/kg	source
Arsenic	37	C4SL			37	C4SL
Cadmium	26	C4SL			26	C4SL
Mercury (inorganic)	170	CLEA 2009			170	CLEA 2009
Nickel	130	CLEA 2009			130	CLEA 2009
Selenium	350	CLEA 2009	No Pathway		350	CLEA 2009
Chromium III	3000	LQM/CIEH			3000	LQM/CIEH
Chromium VI	21	C4SL			21	C4SL
Lead	86-210	C4SL			86-210	C4SL
Copper	2,330	LQM/CIEH	No Pathway		2,330	LQM/CIEH
Zinc	3,750	LQM/CIEH			3,750	LQM/CIEH
Boron	291	LQM/CIEH			291	LQM/CIEH
Benzo(a)Pyrene	5	C4SL	No Pathway		5	C4SL
Naphthalene	4	CLEA 2009	4	CLEA 2009	4	CLEA 2009
Benzene	0.87	C4SL	0.87	C4SL	0.5	C4SL
Toluene	497	CLEA 2009	1440	CLEA 2009	1340	CLEA 2009
Ethylbenzene	240		416		398	
Xylenes	127		146		145	
Aliphatic C5-C6	41		41		41	
Aliphatic C6-C8	123		123		123	
Aliphatic C8-C10	31		31		31	
Aliphatic C10-C12	151		151		151	
Aliphatic C12-C16	500		685		500	
Aliphatic C16-C21	1000		5000		1000	
Aliphatic C21-C35	1000		5000		1000	
Aromatic C5-C7	52		56		56	
Aromatic C7-C8	15		16		16	
Aromatic C8-C10	47		50		50	
Aromatic C10-C12	212		261		261	
Aromatic C12-C16	683		1000		1000	
Aromatic C16-C21	1000#		5000		1000	

Aromatic C21-C35	1000#		5000		1000	
PCB	1.7	CLEA 2009	1.8	CLEA 2009	1.8	CLEA 2009
Phenol	412	CLEA 2009	2,360	CLEA 2009	514	CLEA 2009
Cyanide	527	CLEA 2009	527	CLEA 2009	531	CLEA 2009

Table 6.1 Specification for imported soils.

6.4 Construction Workers & Asbestos Control Measures

As a contingency measure and to protect construction workers and adjacent receptors from any unidentified 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 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.

6.5 Control of Water

During the removal of below ground obstructions and the excavation through of the made ground, perched water may be encountered.

Groundwater shall be control in accordance with CIRIA report 113 "Control of Ground Water to Temporary Works".

Arrangements should be made to prevent ponding in any excavation, the Contractor shall 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.

6.6 Exported to Landfill

Any soils to be exported from site should be allocated an appropriate waste code, following the steps within Technical Guidance WM3: Waste Classification - Guidance on the classification and assessment of waste 2015.

The results appended to this document indicate that the samples tested are likely to be classified as NON-HAZARDOUS and HAZARDOUS WASTE. This should be confirmed by the appointed waste management contractor following submission of all available test results carried out at the site to date.

Any material exported from the site to landfill should be hauled by a registered waste carrier in accordance with the requirements of the Duty of Care Regulations, 1991 and the Landfill (England and Wales) Regulations 2005.

A transfer note should then be completed, signed and retained by the parties involved. The transfer note should include the volume of waste, the nature of the material and a statement of its chemical composition, details of the source and destination sites, and details of the haulier.

In order to protect the general public from dust and vapour emissions, wagons that are used for the haulage of the contaminated material from the site must be sheeted. In addition, the Contractor must ensure that no fluids seep from the wagons.

All hazardous waste going for disposal at landfills must be classified according to the new European Waste Catalogue (EWC).

Contaminated soils are minor entries in the EWC. Waste contaminated soils may be classified as either hazardous or non-hazardous depending on the concentrations of "dangerous substance" in the waste soil. An assessment of the composition of the waste soil will therefore be undertaken to determine if it is hazardous waste.

The WAC set threshold concentrations for leachable components of the waste stream and landfill operators will have waste acceptance procedures in place to ensure that only compliant waste is landfilled. Most waste will need to be treated before it can be landfilled to reduce its quality and the hazard it presents. Leaching compliance testing will be required in accordance with BS EN 14899:2005.

6.7 Dust Control

The excavation of fill should not present a significant problem with regard to emission of dust during the excavations and transport. However, at all times during the excavation works, Best Practicable Means shall be employed to minimise dust and odour generation and their emission off site.

6.8 Previously Unidentified Contamination

Should any suspected contaminated materials other than those detailed in this and previous reports be encountered during the re-development, then it should be excavated and stockpiled on an impermeable material and sampled and tested for an appropriate range of determinants.

Once the laboratory analysis of the material is available an assessment should be undertaken to determine whether it can be retained on-site or whether it should be disposed off-site.

Depending on the nature of any such impact it may be necessary to undertake validation testing of the excavation in order to demonstrate that no such materials are left in-situ.

6.9 Controlled Waters

No pathways should be created which results in impact to the underlying aquifer or surface water features.

The risk to Controlled Water receptors from leaching and groundwater migration is deemed to be low.

6.10 Potential below Ground Obstructions

Obstructions in the form of relic foundations and infrastructure may be found on site during groundworks.

It is recommended that these materials be 'grubbing out' and treatment (screening/crushing/segregation and reused (where appropriate) on site as part of the site preparation. Materials unsuitable for reuse on site will require removal from site to suitably licensed waste management facility.

Deep excavations for the removal of structures will be unstable in the short term and side support may be necessary.

6.11 Site Setup, Organisation and Safety

It is recommended that site works should be supervised (when only deemed suitable by the contractor), by a suitably qualified Engineer, who will report to a Project Manager. Supervision may be part time for certain activities but must be full time if (in the unlikely event) any grossly contaminated soil/fill is identified during construction works.

Site cabins and welfare provisions should to be provided in accordance with the HSE Guidelines by the appointed contractor.

It is recommended that all personnel should undergo a site specific health and safety induction prior to commencement of work on site.

Works will be carried out with the proper regard to the following standards:

- Health and safety at work act 1974
- Management of Health and safety at work Regulations 1999
- Construction (Health, Safety and Welfare) Regulations 1994
- Construction (Head Protection) Regulations 1998
- Provision and Use of Work equipment Regulation 1998
- Lifting Operations and Lifting Equipment Regulations 1994
- Construction (design and management) Regulations 1994
- Health and Safety Executive "Protection of Workers and the general public during the redevelopment of Contaminated Land", HS(G)66, HMSO 1991
- The Control of Substances Hazardous to Health Regulations 1994
- Any successive legislation to the above

It is recommended that during the construction works, all personnel on site should comply with guidance provided in the Health and Safety Executive (HSE) document "Protection of Workers and the general public during the redevelopment of potentially Contaminated Land". In summary, the following should be provided by the appointed contractor:

- Protective clothing, footwear, glasses and gloves. (Personnel should be instructed in why and how they are to be used).

- Disposable coveralls should be provided where appropriate.
- Hand-washing, eye-washing and boot-washing facilities.
- Smoking shall be limited to designated areas.

6.12 Contractor's Responsibilities

Prior to the commencement of any works the Contractor, in agreement with the Engineer, should:

- Satisfy requirements of the Client's contract documentation.
- Establish the boundaries of the site and the working areas
- Liaise with Local Authority regarding working hours, noise/dust/odour control, and protected trees.
- Liaise with the Local Water Company prior to any proposed discharge to local sewers.
- Provide and erect secure Herras-type fence to protect site and any remedial activities and discourage entrance by the general public.
- Provide the engineer with consignment notes and Waste management tip tickets and records

It is recommended that the Contractor satisfy the HSE with regards to all matters concerning health, safety and the welfare of personnel on site.

It is recommended that the contractor ensures that:

- Personnel, plant, materials and other equipment related to the contract are confined within the boundaries of the site.
- Good practise relating to personal hygiene are adopted.
- Suitable precautions are taken to prevent the spread of soil and debris onto public roads.
- Suitable precautions are implemented to prevent offsite migration of any found pollutants via airborne dust and vapours.
- Refuelling of mobile plant is undertaken in a designated area. Above ground fuel storage tanks shall comply with the requirements of the Pollution Prevention Guideline PPG2. A spill kit shall be kept adjacent to any fuel storage area.

6.13 Engineering Supervision

It is recommended that the engineer ensures that the requirements of the Remediation Strategy are complied with in a safe and orderly manner.

The responsibilities of the Engineer shall include but are not limited to the following:

- Advice on the correct handling of unidentified soils/groundwater and conditions encountered.
- Retrieval of soil and water samples from within any unidentified areas of contamination and the subsequent scheduling of appropriate laboratory analysis to enable validation of various aspects of the works, and to advise the project manager of progress and unforeseen occurrences.
- Liaise with statutory authorities as required.

- Liaise with Client as required.

When onsite, the engineer will maintain a record of the works to include the following:

- Daily record sheets and summary of the day's activities.
- Date and weather conditions
- Test results

6.14 Health and Safety during Remediation of Unidentified Contamination

During construction works, it is recommended that the workforce adopts full HSE measures to ensure that the elevated concentrations of contaminants, established during construction works, requiring cover, treatment and/or removal are dealt with according to current guidelines and codes of practice. Suitably experienced and competent staff should be employed to carry out the on-site remediation.

It is recommended that site personnel are not permitted to enter unstable excavations, nor excavations in which contamination is present, nor unsupported excavations deeper than 1.2m, in accordance with standard HSE protocols. Standard air sampling and monitoring equipment should be used which emits an audible warning of the presence of any volatile gases and/or low oxygen atmospheres.

NX Consulting are not the Planning Supervisor for this scheme and therefore, a site pre-tender health and safety plan has yet to be made available and will not form part of this scope of works.

6.15 Gas Protection Measures

Gas protection measures should be installed in accordance with BS8485: 2015.

Table 6.15.1 Gas Protection

Building Type	Floor Slab Type	Ventilation	Membrane	Required Points Score	Points Achieved
Conventional residential house (Building Type A)	Block and beam suspended floor (0 Points)	Suspended beam and block flooring with suspended ventilated void (2.5 points)	Full gas membrane installed to S8485:2015 and validated to CIRIA 735 (2 points)	3.5	4.5 points

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

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.

No radon protective measures are required.

6.16 Drainage and Services Installations

It is recommended that statutory services are consulted at an early stage, with respect to the ground conditions within which they will lay services, in order to enable them to assess at an early state any protection measures required. This includes submission of a potable water risk assessment.

Once approved, the nature of water supply pipework should be submitted to Bury Council's Council Director of Planning prior to construction being commenced.

Underground services, comprising BT Lines, gas mains, culverted watercourse, combined and foul sewers, CCTV and possible fibre optic cables may all impact the site and the design team and Client should familiarise themselves with their presence.

All drainage installation will encounter Made Ground. Any suitable Made Ground arisings from drainage trenches etc, if not returned to the original excavation must be placed beneath proposed hard end-use areas of the site, placed beneath a cover of suitable thickness in landscaped areas, or disposed off-site adhering to the guidelines outlined above.

7.0 VERIFICATION

Validation samples will need to be collected from all materials to be imported onto site to facilitate the proposed residential development.

Soil samples destined for chemical analysis to be collected in appropriate sampling containers. All samples will subsequently be stored in cool boxes prior to submission to a suitably accredited laboratory for analysis.

Where materials are found to contain concentrations of potential contaminants at levels in excess of the site specific screening criteria (as detailed within Table 6.1), undertake further assessment and recommendations on the appropriate use for the material in question.

For any imported materials required to complete the cover soils, the frequency of testing to be undertaken shall be as given in the Yorkshire & Lincolnshire Pollution Advisory Group (YALPAG) document Verification Requirements for Cover Systems, Version 3.4 dated November 2017. The sampling frequency for materials to be managed under the Remediation Strategy is presented within Table 7.0 below. Where less than the stated volumes are utilised a minimum of three samples will be taken from each material/soil source.

Table 0 Proposed Testing frequency and analysis.

Soil Source	Testing frequency	Analysis suite
Imported soils brownfield source	1 sample per 50m ³	CLEA metals/metalloids, cyanide, Speciated PAH, Banded TPH, asbestos screen.
Imported Soils Greenfield Source	1 sample per 250m ³	CLEA metals/metalloids, cyanide, Speciated PAH.

Analysis suite subject to review of specific soil source.

Any site-won materials deemed textually suitable for re-use as a growing / planting media within gardens / soft landscaping areas shall be tested at a frequency of a minimum three samples or 1 sample per 150m³ (whichever is greater) to confirm its chemical suitability. All testing shall be carried out at a UKAS and MCERTS accredited laboratory.

Should any analyte exceed the concentrations shown, then the soil should be considered unsuitable for use within the capping system. The re-use of site won natural soils within the clean growing medium will require careful control of excavation arisings and soil management during the development. Clean soils won on site, or imported, that are not immediately placed, should be stored in stockpiles at agreed locations and sealed, by 'blading', to reduce water ingress and softening.

Depth validation of the capping system will be required. The validation will comprise a hand dug pits, with photographic record and hand pit logs.

The Validation Report will include the following:

- A summary of the preparatory works undertaken and remediation strategy.
- Details of who carried out the respective remedial works.

- Details and justification of any changes from the original remediation strategy, including unforeseen ground conditions.
- Copies of any correspondence with Regulators relating to specific aspects of remedial works.
- Substantiating validation data included as follows:
 - Laboratory and in-situ test results.
 - Chemical test results
 - Representative plans depicting treated areas and any amendments to strategy as a result of finding further contamination (if necessary).
 - Photographic records
 - Waste management tip tickets and records

The final Validation Report will need to be submitted to the Local Authority for agreement.

APPENDICES

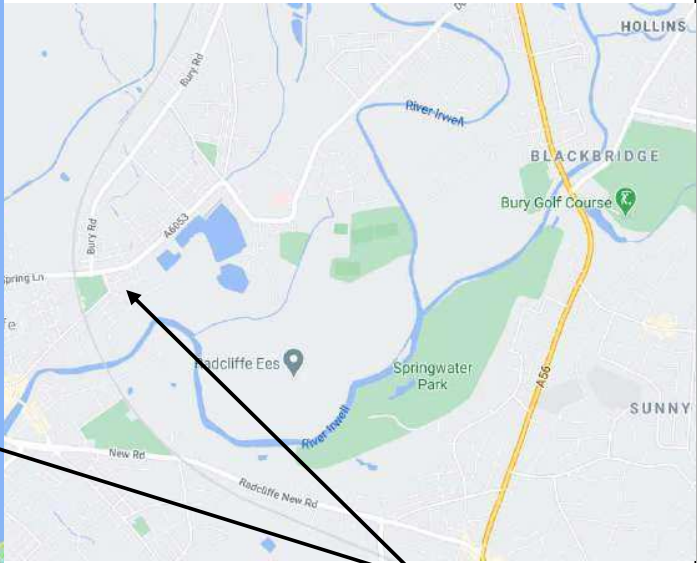
Appendix A – Drawings

Appendix B – NX Phase 1 & Phase 2 Report

Appendix C – NX Consulting Protocol for Validation of Soil Cover Systems

Appendix D – Summary of Guidance Relating to Ground Gas

Appendix A – Drawings



**SITE
LOCATION**



Site Centre:
OS X (Eastings) 379021
OS Y (Northings) 407407



Next Generation Engineering Consultancy Services

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

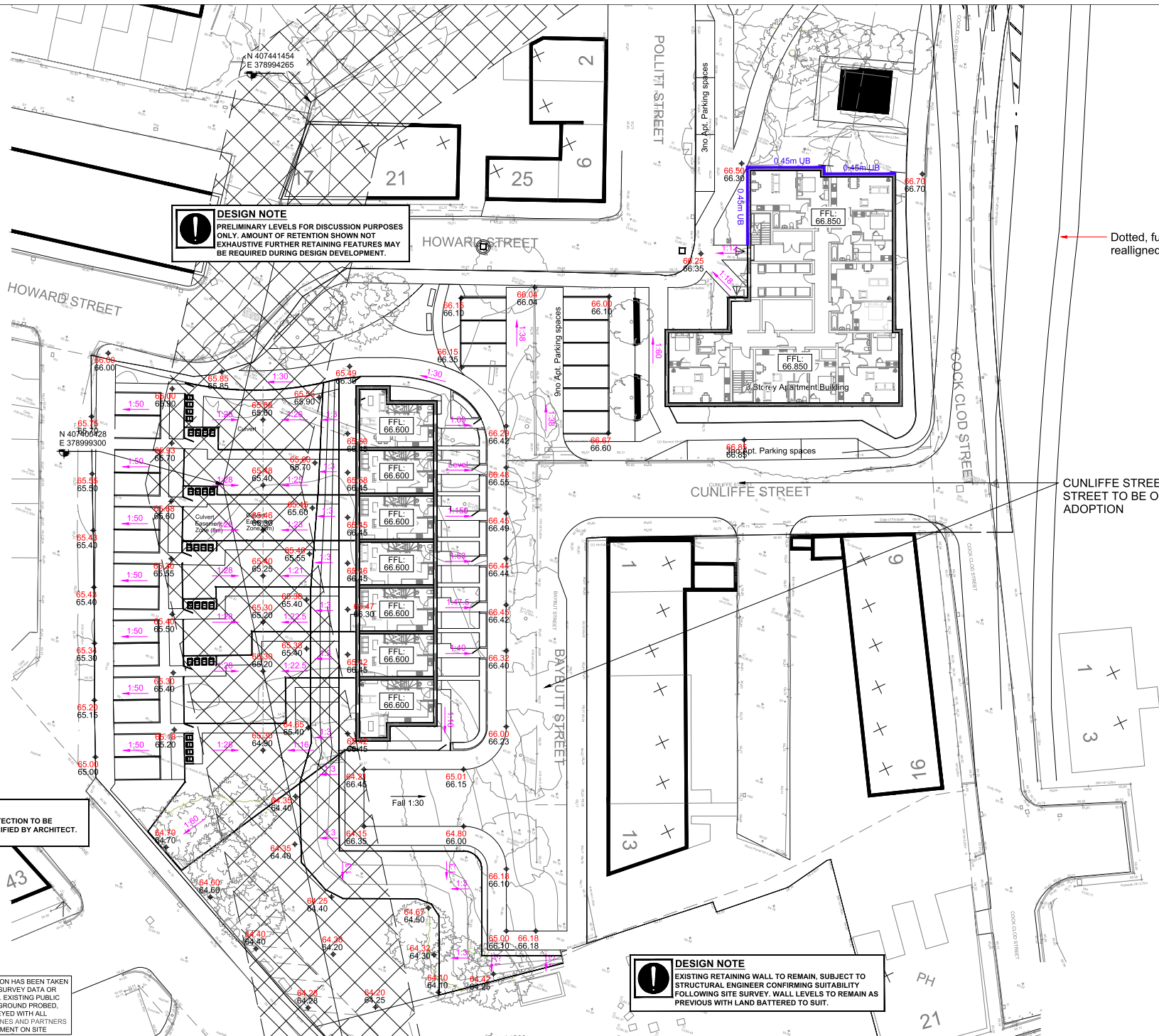
Ref: NX418 Figure 1

Project:

East Lancs Paper Mill

Title:

Site Location Plan

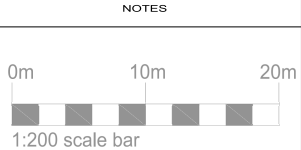


DESIGN NOTE
PRELIMINARY LEVELS FOR DISCUSSION PURPOSES
ONLY. AMOUNT OF RETENTION SHOWN NOT
EXHAUSTIVE FURTHER RETAINING FEATURES MAY
BE REQUIRED DURING DESIGN DEVELOPMENT.

DESIGN NOTE
POTENTIAL FALL PROTECTION TO BE
CONFIRMED AND SPECIFIED BY ARCHITECT.

ALL COVER & INVERT LEVEL INFORMATION HAS BEEN TAKEN
FROM AVAILABLE TOPOGRAPHICAL SURVEY DATA OR
UNITED UTILITIES AND CCTV REPORT. EXISTING PUBLIC
WATER SEWERS ARE TO BE ABOVE GROUND PROBED,
ROUTED AND INTERNALLY SURVEYED WITH ALL
INFORMATION PASSED TO CARLEY DAINES AND PARTNERS
FOR REVIEW PRIOR TO COMMENCEMENT ON SITE

DESIGN NOTE
EXISTING RETAINING WALL TO REMAIN, SUBJECT TO
STRUCTURAL ENGINEER CONFIRMING SUITABILITY
FOLLOWING SITE SURVEY. WALL LEVELS TO REMAIN AS
PREVIOUS WITH LAND BATTERED TO SUIT.



SITE LOCATION
FORMER EAST LANCS PAPER
MILL, RADCLIFFE, BURY,
GREATER MANCHESTER.
M26 2GU.
EASTINGS: 379000;
NORTHINGS: 407400.

- LEGEND**
- FFL: 96.650 PROPOSED FFL
 - 97.570 EXISTING LEVEL vs
 - 98.140 PROPOSED LEVEL
 - Fall 1:25 PROPOSED ROAD FALL
 - 1:25 PROPOSED GARDEN FALL
 - 150mm UB PROPOSED UNDER-BUILD

C	21/12/21	DESIGN CONFIRMED. ISSUED FOR PLANNING.
B	14/12/21	RETAINING WALL IN REAR GARDENS OMITTED IN LIEU OF 1:3 BATTER.
A	23/11/21	EXTENTS OF RETAINING WALL IN EASEMENT REDUCED.
-	15/11/21	INITIAL ISSUE FOR COMMENT AND DISCUSSION PURPOSES.
REV.	DATE	DESCRIPTION

CLIENT
GREAT PLACES HOUSING GROUP
AEW ARCHITECTS

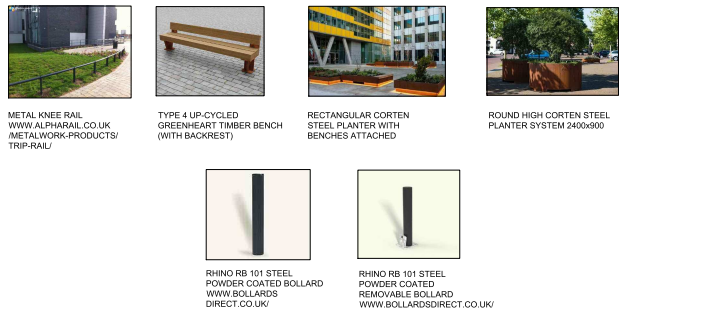
**Carley
Daines and
Partners Limited**
Consulting Civil and Structural Engineers

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TITLE
EAST LANCS PAPER MILL
RADCLIFFE, MANCHESTER

PROPOSED LEVELS AND
EXTERNAL WORKS DRAWING

Drawn	AM	Checked	DM
Date	11/11/2021	Date	11/11/2021
Scale	1:200 @ A1		
Drawing No.	21-B-12866-101		C

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Appendix B – NX Phase 1 & Phase 2 Report

Phase 1 & Phase 2 Geoenvironmental Desk Study & Ground Stability Risk Assessment for East Lancashire Paper Mill Island Site, Rectory Lane, Radcliffe, M26 2QU

Project No: NX418



Client



DOCUMENT VERIFICATION

Report Reference: NX418

Issue: Rev 2

Date: 16th June 2021

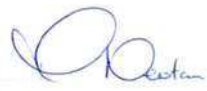
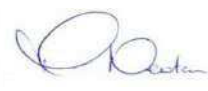
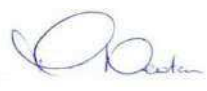
Written by:

Robbie Lee
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	25 th May 2021	Final		
Rev 1	June 16 th 2021	Final		
Rev 2	July 30 th 2021	Final Gas monitoring results		

Issued By:
NX Consulting Limited
Thorpe House,
11 Thorpe Close
Altrincham
WA15 7WZ

Contact: Mark Newton
Email: marknewton@nxconsulting.org.uk
Telephone: 0161 9040187

EXECUTIVE SUMMARY

Site Location & Access	East Lancashire Paper Mill Island, Rectory Lane, Radcliffe, M26 2QU Access is gained from Rectory Lane via Spring lane.
Grid Reference	E379021, N407407.
Site Area	Approximately 0.57 hectares.
Site description & Proposed Development	The site is irregular in shape, generally level and comprises a combination of car parks and open landscaped areas. The south of the site comprises hardstanding carpark within a disused public house and associated garden beyond. Two unnamed containers are present within the car park area. The centre of the site comprises open land laid to grass with occasional mature and semi-mature trees, benches, bushes and a concrete path running east-west through. The southern boundary of this central area is marked by a row of trees and bushes separating the hardstanding car park to the south. The north of the site is demarked by an area of paving hardstand with concrete bollards on the northern and southern boundary with Howard street and Cunliffe street respectively. The north-eastern corner of the site comprises a small area of scrub and semi-mature trees. An electrical substation contained within a brick housing and concrete slab base is located within the north-eastern corner of the site. A 2m high metal high palisade fence formed the boundaries within this area. The site is located approximately 200m east of Radcliffe Metrolink station along Spring lane. It is understood the site is to be developed for a residential end-use with associated gardens and landscaped areas.
Geological Mapping	Glaciofluvial sheet deposits, Devensian – Sand and Gravel. The Pennine Middle Coal Measures Formation underlies the site and comprise a mixture of mudstone, siltstone and sandstone. Several coal seams lie within this formation. Although unlikely, based on previous ground investigations works undertaken on the adjacent East Lancashire Paper Mill site, there is evidence that previously worked shallow coal seams may be present beneath the site.
Coal Mining & Ground Stability Risk	The site is within a Coal Authority High Risk area with coal workings at depth beneath the site. The Ashclough coal seam is the nearest sub-cropping seam to the site (approx. 405m Northwest). The rock dip is likely to be around 9-10° down to the southeast. NX anticipate that this coal seam would be present approximately 70m below the rock head surface. Rotary drilling recorded very shaley coal in RH02 between 5.80-6.70m bgl. Given that the seam is unrecorded, very shaley implies that it is unlikely that it's been worked and probably carbonaceous mudstone with some thin coal partings present. The BGS and Coal

	Authority have no record of it which suggests that the coal will be very thin/discontinuous/of very poor quality. Based upon information provided to date, we consider that there is a low risk of coal mining related ground instability upon the site.
Flood Risk	The site located in an EA defined Zone 2 and Zone 3 flood risk area (from fluvial/tidal models) and high risk from rivers and sea. There have been 3 recent flood events within 200m: 80m SW, January 2008, River Irwell unknown cause 122m SE, December 2015, River Irwell channel capacity exceeded 165m SE, October 1998, River Irwell obstruction/blockage of channel The site is stated to be at risk from surface water flooding. The risk of surface flooding is deemed to be 1 in 30 year event (0.3 – 1.0 m). The Groundsure data indicates that the Environment Agency has classified a moderate risk of groundwater flooding on the site. The appointed engineer should establish if a quantitative flood risk assessment is required.
Site History	On-Site Historical mapping shows the site to have comprised a brewery and works in the north east of the site and open fields, allotments and residential housing in the centre and south of the site. A chimney is present in the north of the site associated with the brewery. The north of the site is cleared circa by 2003 and an electricity substation is present. Offsite The site has historically been located within a coal mining area which was active throughout the 1900's, with various past coal wharfs and collieries located within 500m of the site. There are also railways, cotton mills, infilled reservoirs, engineering works, dye works, sand pits, chemical works, paper mills and factories within 500m of the site with potential for contamination.
Utility Locations	Underground services impact the site and the design team should familiarize themselves with their presence and implications on the development. An electricity substation is also located in the north eastern corner.
Landfill Sites & Ground Gases	Made ground is present upon site with demolished properties and the former allotment. Several waste disposal sites were recorded within 500m of the site including: - Gravel pits 39m East (E) - Reservoirs 60m East - Historical refuse tip 399m Southeast (SE)

- Historical landfill 254m SE – Paper mill & infilled reservoirs
- Historical landfill 318m E – Boiler house
- Scrap Yard 204m SW

Further information can be found on the attached Groundsure report.

Given the developmental history of the site and surrounding area, the risk from hazardous ground gas is considered to be low to moderate generation potential and a moderate risk to existing properties and site users.

The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

Geotechnical Assessment

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 recommended suspended floor slab to be adopted.

Preliminary foundation assessment indicates that for Made Ground less than 1.5m thick, the conventional strip footings. For the Made Ground between 1.5m and 3.0m thick, deep trench fill can be considered but may not be a cost-effective solution and ground improvement using vibro stone columns and/or driven piles will be able to provide adequate capacity. A degree of ground treatment will be required where former buildings have occupied the site. It is recommended RC foundations to be designed to prevent differential settlement.

There are several buried services including a culverted watercourse underneath the site, the foundation solution should allow for protection measures and ensure no damage to these services.

NHBC guidance in relation to trees should be followed, due to the presence of glacial clay. Heave protection measures should be used for foundations and drainage where trees are present within influencing distance.

Pavement Construction

An initial design CBR value of 2% is recommended for the Made Ground and clay deposits.

Where access roads are to be adopted, design CBR values should be confirmed by carrying out in-situ plate load tests.

Soakaways

Given the low permeability of the underlying clays we consider that soakaway are unlikely to be suitable at the site. If soakaways are to be considered then soakaways should be carried out in line with BRE 365 Soakaway Design.

Groundwater and Excavations

Any excavations extending below the water table would need to be dewatered in advance of the main excavation works. Sump pumps or possibly well points may be required for this. It is recommended that groundwater levels are monitored during the construction work to enable any dewatering requirements to be identified in advance.

Excavation stability is likely to be moderate to good in the upper 1.00m of strata but poor below this depth in the underlying granular materials. Excavations would need to be battered back to a suitable angle of repose or fully supported during construction. Below 1.80m bgl running sand conditions should be anticipated. However, infilled demolition arisings were recorded within the area of WS1/TP01 (former brewery and chimney) which will require pre-treatment (excavation/screening/crushing and replacement) prior to formation of the adopted foundation solution.

Excavations should be feasible with conventional plant.

The presence of other relic below ground structures should be anticipated associated infrastructure having previously occupied the site. Deepening of foundations should be anticipated within these areas. The locations of which are shown on historical mapping within Appendix C.

Conceptual Model

Chemical analysis carried out across the site recorded concentrations generally below Tier 1 guidelines for a residential end use. However, in areas where made ground have been recorded (particularly beneath former building areas and hardstand), direct contact with asbestos fibres and lead contamination may remain a potentially viable pathway in garden and construction scenario.

For preliminary assessments remediation or mitigation can be expected to comprise the following:

- Excavation & removal from site of granular made grounds, or cohesive made ground with asbestos fibres from areas where future site levels are to be reduced.
- Placement of clean cover soil system within of soft landscaping, public open spaces or domestic gardens; where site levels are to be raised.
- Removal and replacement with clean cover systems within soft landscaping, public open spaces or domestic gardens where site levels are to be more or less unchanged.

The depths of material to be removed or the thickness of a soil barrier shall need to be determined once the final site development proposals are known.

Within areas of private domestic gardens (including superficial hardstanding paved areas), a minimum 600mm of clean cover / removal & replacement of made grounds should be assumed at this stage.

Within areas of soft landscaping a minimum 600mm of clean cover / removal & replacement of made grounds should be assumed.

Within areas of areas of public open space to be grassed; a minimum 600mm of clean cover / removal & replacement of made ground should be assumed.

Certification of ground gas measures are classified as Situation 2 (Amber 1) conditions and Low-level ground gas protection measures should be adopted, utilising Low Permeability membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Independent verification of protection measures are required to satisfy planning conditions relating to ground gas risk.

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.

The risks presented to controlled water receptors are deemed to be low given the low sensitivity of the underlying aquifer and low source generating potential of the site.

Any imported subsoil/topsoil materials will require chemical validation to demonstrate that they are suitable for a residential 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.

A potable water supply risk assessment is required to establish the nature of water supply pipework for the proposed development.

No radon protection measures are necessary in the construction of new dwellings on the site.

EXECUTIVE SUMMARY	2
1.0 INTRODUCTION	9
1.1 Instruction	9
1.2 Scope of Work	9
1.3 Report Layout	10
1.4 Limitations	10
2.0 PHASE 1 ASSESSMENT SUMMARY	12
2.1 Site Location & Setting	12
2.2 Geology, Hydrology and Hydrogeology	12
2.3 Mining Extraction and Natural Cavities	14
2.4 Site History	14
2.5 Environmental Information	16
2.6 Coal Mining	16
2.7 WYG Report for East Lancashire Paper Mill Site (ELPM)	18
2.8 Ground Stability Risk Assessment.....	19
3.0 PRELIMINARY CONCEPTUAL MODEL	21
3.1 Risk Assessment	21
4.0 FIELDWORKS.....	27
4.1 General	27
4.2 Windowless Sampler Boreholes	27
4.3 Rotary Boreholes	27
4.4 Trial Pits.....	27
4.5 Sample Collection and Analysis	27
5.0 GROUND CONDITIONS.....	28
5.1 Ground Conditions	28
5.2 Groundwater.....	29
5.3 Underground Service Plans.....	29
5.4 Below ground obstructions	29
5.5 Contamination.....	29
6.0 GEOTECHNICAL TESTING.....	31
6.1 Laboratory Analysis.....	31
7.0 GEOTECHNICAL ASSESSMENT.....	33
7.1 General	33
7.2 Foundations	33
7.3 Earthworks, Excavations and Groundwater	34
7.3 Concrete Classification.....	35
7.4 Soakaway Drainage	36
8.0 GEOCHEMICAL GROUND AND GROUNDWATER ASSESSMENT.....	37
8.1 Introduction	37
8.2 Rationale.....	37
8.3 Soil Guideline Values.....	38
8.4 Site Soils	39
8.4.1 NX Consulting Investigation	39
8.4.2 Water Supply	40

8.4.3	Phytotoxicity	40
8.4.4	Discussion and Recommendations	40
8.4.5	Waste Classification	42
8.5	Ground Gases	44
8.5.1	Asphyxiant, Noxious or Explosive Gases.....	44
8.5.2	Radon & Hydrocarbons.....	45
9.0	PRE-REMEDIATION CONSTRAINTS AND OUTLINE REMEDIATION STRATEGY	46
9.1	Invasive Plants.....	46
9.2	Services.....	46
9.3	Hardstanding & Surface Cover	46
9.4	Land Condition and Outline Remediation	46
9.4.1	Foundations and Ground Stability.....	46
9.4.2	Contamination.....	47
	APPENDICES	50
	Appendix A – Drawings & Site Photographs	51
	Appendix B – GroundSure Information.....	52
	Appendix C – Historical Mapping	53
	Appendix D - Exploratory Hole Logs	54
	Appendix E– Geotechnical Laboratory Test Results.....	55
	Appendix F – Chemical Test Results	56
	Appendix G – Gas monitoring Record Sheet.....	57
	Appendix H – Conceptual Models & Risk Assessments.....	58

1.0 INTRODUCTION

1.1 Instruction

NX Consulting Limited have been commissioned by Great Places Housing Association (The Client) to conduct a pre-acquisition Phase 1 Geoenvironmental Desk Study and ground stability risk assessment and preliminary phase 2 assessment on land at Rectory Lane, Radcliffe, M26 2QU.

It is understood the site is to be developed for residential purposes with associated gardens, landscaping areas and access roads.

1.2 Scope of Work

Guidance set out in CLR11¹, 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/preliminary flooding risk and inform part of a pre-acquisition survey .

The aim of any Desk Top Study is to assess the potential ground related risks at the site. In order to achieve the above stated aims and objectives, the following scope of works has been determined:

- Present a discussion of the current site status and key environmental influences around the site.
- Undertake and present a historical site and area review, primarily referring to old Ordnance Survey Maps.
- Undertake preliminary data searches.
- Present a discussion of the ground and groundwater conditions within the topographical and area context.
- Present a preliminary ground contamination assessment discussing the results of the research above, not only concerning potential on-site conditions and contamination but also with an overview of the potential for migration on or off-site with respect to the surrounding neighboring sites.
- The information gathered will be used to identify potential geotechnical constraints associated with the redevelopment of the site.
- Present a preliminary qualitative risk assessment and make recommendations for a characterisation stage of physical investigation and testing, if appropriate.

¹ EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

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 investigation were as follows:

- To provide further information on ground conditions to facilitate design of buildings and infrastructure for the site.
- To conduct limited 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.

- 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 overall scope of the current work comprised 7no. windowless sample boreholes to a maximum depth of 5.0mbgl, 2no. open hole rotary boreholes to a maximum depth of 40.0mbgl and 4no. machine excavated trial pits to a maximum depth of 2.0mbgl.

1.3 Report Layout

- Section 2 of this report provides a summary of the Phase 1 desk study findings; including the site history, as established from available public record information.
- 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.

1.4 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.

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2.0 PHASE 1 ASSESSMENT SUMMARY

This section summarises pertinent information gained from reviewing the Groundsure Geoinsight, Enviroinsight Reports and Historical Mapping. Full copies are presented in Appendix B and C respectively.

2.1 Site Location & Setting

Table 2.1 – Site location and Setting

Site Location	East Lancashire Paper Mill Island, Rectory Lane, Radcliffe, M26 2QU Access is gained from Rectory Lane via Spring lane.	
Site Description	The site is irregular in shape, generally level and comprises a combination of car parks and open landscaped areas. The south of the site comprises hardstanding carpark within a disused public house and associated garden beyond. Two unnamed containers are present within the car park area. The centre of the site comprises open land laid to grass with occasional mature and semi-mature trees, benches, bushes and a concrete path running east-west through. The southern boundary of this central area is marked by a row of trees and bushes separating the hardstanding car park to the south. The north of the site is demarked by an area of paving hardstand with concrete bollards on the northern and southern boundary with Howard street and Cunliffe street respectively. The north-eastern corner of the site comprises a small area of scrub and semi-mature trees. An electrical substation contained within a brick housing and concrete slab base is located within the north-eastern corner of the site. A 2m high metal high palisade fence formed the boundaries within this area. The site is located approximately 200m east of Radcliffe Metrolink station along Spring lane. It is understood the site is to be developed for a residential end-use with associated gardens and landscaped areas.	
Grid Reference	E379021, N407407.	
Site Area	Approximately 0.57 hectares.	
Site Setting	Surrounding area:	North: Residential Properties. East: Residential properties and open field South: Residential properties and open field West: Residential properties

2.2 Geology, Hydrology and Hydrogeology

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Drift Geology	On site: Glaciofluvial sheet deposits, Devensian – Sand and Gravel
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Table 2.2 – Summary of Geology Hydrology and Hydrogeology

	Surrounding area: Glaciofluvial sheet deposits, Devensian – Sand and Gravel
Solid Geology	On Site: Pennine Middle Coal Measures Formation – Mudstone, Siltstone and Sandstone
	Immediate surrounding area: Pennine Middle Coal Measures Formation – Mudstone, Siltstone and Sandstone
Hydrology	Narrow culverted watercourse passes under the site running north to south. Inland river not influenced by tidal action flows underground on site but flows at surface level 16m NW. Outfalls to River Irwell 110m to south.
	River Irwell – 107m SE
Hydrogeology	Superficial deposits – Secondary A Bedrock deposits – Secondary A
Water Abstractions	No groundwater abstractions lie within 500m of the site. Historical surface water abstraction lies 399m north west of the site.
Source Protection Zone	The site does not lie within a source protection zone.
Flood Risk	The site located in an EA defined Zone 2 and Zone 3 flood risk area (from fluvial/tidal models) and high risk from rivers and sea. There have been 3 recent flood events within 200m: • 80m SW, January 2008, River Irwell unknown cause • 122m SE, December 2015, River Irwell channel capacity exceeded • 165m SE, October 1998, River Irwell obstruction/blockage of channel
	The site is stated to be at risk from surface water flooding. The risk of surface flooding is deemed to be 1 in 30 year event (0.3 – 1.0 m). The Groundsure data indicates that the Environment Agency has classified a moderate risk of groundwater flooding on the site.
Shrink Swell Clays	Negligible risk
Landslides	Very low risk
Ground Dissolution of soluble Rocks	Negligible Risk
Compressible deposits	Negligible Risk

Table 2.2 – Summary of Geology Hydrology and Hydrogeology

Collapsible Deposits	Very Low Risk
Running Sands	Very low risk – No identified constraints on land use unless water table rises rapidly.

2.3 Mining Extraction and Natural Cavities

Table 2.3 – Mining and Mineral Extraction

Coal Mining	A historic Colliery lies 285m north west
Johnson Poole and Bloomer	The site is recorded as within a JPB coal mining area
Other mining	- Sand and Gravel britpit 74m west - Sandstone britpit 337m south west - Sand and Gravel surface mineral workings 258m south east
Historic Ground Workings	- Gravel pits 48m west - Reservoirs 39m east - Refuse heap 80m west - Pond 94m east All remaining surface ground workings can be found on the attached Groundsure report.

2.4 Site History

Historical maps of the site area have been obtained from Groundsure. Pertinent information determined from review of these maps is set out in the following table (overleaf); a full copy of the maps is presented in Appendix C.

Table 2.4 – Site History

Map Date	On Site Potentially Contaminative Past Uses	Off Site Potentially Contaminative Past Uses
1848-1850	Site comprises of open fields and a group of buildings in the north east corner named Spring Lane Brewery. A brook/stream is present in the west of the site running north to south towards the River Irwell.	- Several unnamed buildings bound the site to the north. - A well is present to the west. - Bleach works approx. 400m north east. - Print works approx. 400m east - Colliery and cotton mill approx. 750m west. - Several dye works, railway stations, sand pits, bleach works, cotton mills and collieries feature south west of the site between 100m and 1000m.

Table 2.4 – Site History

Map Date	On Site Potentially Contaminative Past Uses	Off Site Potentially Contaminative Past Uses
1890-1893	Further unnamed buildings have been built in the south east corner of the site	- East Lancashire paper mill has been built south east of the site within 100m. - Radcliffe railway station has been built 150m west of the site. - Further development in the surrounding township including a colliery 400m north
1907-1909	Alignment of brook/stream appears to have changed.	- Wilton Cotton Mill 100m south - Pioneer Cotton Mill 200m south east. - Cotton mill 100m north - Iron works and dye works 200m north west. - Tramway runs along northern boundary of site. - Further development of the railways connecting different collieries in the surrounding area – non within 500m.
1927-1932	Brook/Stream culverted beneath the site.	- Engineering works approx. 180m north of site. - Chemical works approx. 300m south west of site. - Iron works approx. 400m west of site. - Sewage works approx. 450m south east of site. - Further development of surrounding township.
1937	No further development on site however the brewery appears to have relocated 150m north west of site	Park Street Cotton mill 100m north of site.
1955-1956	The open space has now been named as allotment gardens.	- Warehouse 50m south west of site. - Engineering works 150m south west of site, adjacent to the preexisting Wilton Cotton Mill.
1965	No further development on site	By this time there are 15 mills/works within 500m of the site, and 22 within 750m of the site.
1987-1992	Brewery now named as works, with an electrical substation. The buildings in the south east corner have been demolished.	Works 50m south west of site.
1992-1995	No further development on site	Largely unchanged.

Table 2.4 – Site History

Map Date	On Site Potentially Contaminative Past Uses	Off Site Potentially Contaminative Past Uses
2001	All buildings on site appear to have been demolished except for the electrical substation	Wilton Mill 100m south west appears to have been demolished.
2010	No further development on site	East Lancashire paper mill appears to have been demolished.
2021	No further development on site	Petrol station 250m west.

2.5 Environmental Information

Table 2.5 – Environmental Information

Landfill Sites and Other Waste Disposal Facilities	- Historical refuse tip 399m SE - Historical landfill 254m SE – Paper mill - Historical landfill 318m E – Boiler house - Scrap Yard 204m SW Other waste sites can be found on the attached Groundsure report
Potentially contaminative land uses	- Electrical substation onsite - Unspecified works 12m W (Site walkover found Knotweed treatment works) - Vehicle repair 42m SW - Tank 105m E - East Lancashire paper mill 126m E - Electricity substation 149m S - Unspecified works 150m SE and SW - Container and storage depot 163m S - Electricity substation 167m NW
Ecological Setting	No SSSI's, Areas of Outstanding Beauty, Special Areas of Conservation are located in the immediate area.
Radon	The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

2.6 Coal Mining

Table 2.7 – Coal Authority Information

Coal Authority Mining Report	The Coal Authority Mining Report (Ref:51002394719001) dated February 2021 has been obtained for the subject site by NX Consulting. A summary of the findings are provided as follows: <i>The property is in a surface area that could be affected by underground mining in 5 seams of coal at 150m to 350m depth, and last worked in 1893. Any movement in the ground due to coal</i>
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	<i>mining activity associated with these workings should have stopped by now.</i> ▪ <i>The site is not within a surface area that could be affected by present underground mining.</i> ▪ <i>There are no recorded coal mine entries known to the Coal Authority within, or within 20 m of the boundary of the property;</i> ▪ <i>The Coal Authority is not aware of any damage due to geological faults or other lines of weakness that have been affected by coal mining.</i> ▪ <i>The property is not within the boundary of an opencast site from which coal has been removed by opencast methods.</i> ▪ <i>The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.</i> ▪ <i>The Coal Authority has no record of a mine gas emission requiring action.</i>
Coal Authority Interactive Map	The Coal Authority Interactive Map indicates that the site not within a defined Coal Authority High Risk Area. No recorded coal seams subcrop beneath the site. The nearest outcropping seam situated approximately 150m to the north west is shown to be present at 61m below ground level. A mine entry is present 150m to the north west. Several further mine entries are recorded approximately 500m north west of the site. A series of coal seams striking northeast - southwest outcrops at the surface approximately 250m north west of site and dips towards the south east towards the site.
British Geological Survey Mapping	BGS Sheet 85 Manchester shows that several coal seams lie beneath the site, however none outcrop at a surface level on site. The local coal seams strike northeast/southwest and dip approximately 15 degrees south east. These coal seams have been displaced by a series of steeply dipping northwest/southeast trending normal faults, therefore varying in dip direction (northeast or southwest). The Bradley Fold fault dips southwest, and positioned approximately 100m north of site. The fault truncates at least 5 coal seams in close proximity to the site including the RAMS (Bottom Furnace) coal. The Ashclough coal seam is the nearest sub-cropping seam to the site (approx. 405m Northwest). The rock dip is likely to be around 9-10o down to the southeast. NX anticipate that this coal seam would be present approximately 70m below the rock head surface. A BGS borehole 133m east of the site records a 0.3m thick coal seam 84.73m deep.

Based upon information provided to date, we consider that there is a low risk of coal mining related ground instability upon the site.

2.7 WYG Report for East Lancashire Paper Mill Site (ELPM)

White Young Green (WYG) carried out a Phase 1 desk Study of the larger East Lancashire Paper mill site to the south west. The report included a review of a number of reports, made available by the Homes and Communities Agency (HCA), these include;

- Remedial Strategy for land at East Lancashire Paper Mill, Radcliffe. Prepared by Encia Consulting Limited for P&F Properties Limited. (Report ref: 5996/3/Rev-A, July 2005);
- East Lancashire Paper Mill, Radcliffe. Report on Supplementary Groundwater/ Ground Gas Monitoring. Prepared by Encia Consulting Limited for P&F Properties Limited. (Report ref: 5996/BRB, November 2005); and,
- Summary Status Report for The East Lancashire Paper Mill Site. Prepared by ADM Regeneration Limited for P&F Properties Limited. (Report ref: 10109_SSR_01, August 2013).

The WYG report referenced a BGS record of one mine shaft, located approximately 350m northwest of the site at Withins Lane Colliery and two water well boreholes which have been drilled at the site. The Withins Colliery Shaft (BGS Reference: SD70NE25) record shows that the coal seams encountered in the Withins Colliery shaft are not considered a risk to the proposed future site development.

Based on the observations identified on the Encia rotary borehole logs and from a water well borehole (BGS Reference: SD70NE28, bored 1954) (broken ground and loss of drilling flush) was recorded in 3 no seams of coal at approximate depths of 17.00m bgl, 51.00 and 84.00m (Possibly Top Three Yard Mine or Top Yard Mine, RAMS mine and unnamed coal seam respectively) may have been worked beneath the East Lancashire Paper Mill site.

In summary, the report found that the Top Three Yard Mine has been possibly identified beneath the ELPM site sub-cropping at the top of bedrock to 19m below the top of bedrock in the south east corner. The Top Yard Mine may be present on site above the Top Three Yard Mine and if present would be to the south of the identified sub-crop. The Rams Mine is found beneath the Top Three Yard Seam. The fault indicated on the geological map may lie further south based on the geology encountered within the exploratory holes.

If this is the case, then the potential exists for the Top Five Quarters Mine to sub crop beneath the south east corner of the ELPM site and further intrusive works and possible remedial drill and grout works were recommended.

2.8 Ground Stability Risk Assessment

Made ground is anticipated to depths of 3.0 to 4.0m beneath parts of the site over glaciofluvial sand and gravel deposits.

The Pennine Middle Coal Measures Formation underlies the site comprising a mixture of mudstone, siltstone and sandstone and underlying coal seams. BGS mapping indicates that to the south of the fault the solid geology comprises Westphalian Coal Measures. The sequence includes Nob End Rock (sandstone) and Pennine Middle Coal Measures in the east and west respectively.

2no. BGS borehole records are available 133m E and 237m E and noted to consist of loose silty SAND with occasional roots, clay and gravel to 2.8m bgl, overlying compact/dense SAND and GRAVEL to 6.5m bgl, overlying soft to firm silty CLAY to 7.1m bgl, overlying interbedded silty CLAY, and SAND and GRAVEL to 10.9m bgl where it transitions into very soft mudstone. The deeper borehole found interbedded layers of marl, mudstone and shale, with a 0.30m thick coal seam at 84.73m bgl.

The WYG report highlighted that borehole logs recorded probable mineworkings in 3no seams of coal at approximate depths of 17.00m bgl, 51.00 and 84.00m (Possibly Top Three Yard Mine or Top Yard Mine, RAMS mine and unnamed coal seam respectively) may have been worked beneath the East Lancashire Paper Mill site.

Coal Authority & BGS Mapping

The property is in a surface area that could be affected by underground mining in 5 seams of coal at 150m to 350m depth, and last worked in 1893.

BGS mapping indicates that none outcrop at a surface level on site. The nearby coal seams strike northeast/southwest and dip approximately 15 degrees south east. These coal seams have been displaced by a series of steeply dipping northwest/southeast trending faults varying in dip direction (northeast or southwest). The Bradley fold fault dips to the southwest, positioned approximately 100m north of site, and is seen to truncate at least 5 coal seams in close proximity to the site; including the RAMS (Bottom Furnace) coal seam. These coal seams outcrop to the northwest and dip southeast towards the site at anticipated depths of 120m below ground level and deeper.

The Ashclough coal seam is the nearest sub-cropping seam to the site (approx. 405m Northwest). The rock dip is likely to be around 9-10° down to the southeast. NX anticipate that this coal seam would be present approximately 70m below the rock head surface.

Risk Assessment

The property is in a surface area that could be affected by underground mining in 5 seams of coal at 150m to 350m depth, and last worked in 1893.

Rotary drilling recorded very shaley coal in RH02 between 5.80-6.70m bgl. Given that the seam is unrecorded, very shaley implies that it is unlikely that it's been worked and probably carbonaceous mudstone with some thin coal partings present. The BGS and Coal Authority have no record of it which suggests that the coal will be very thin/discontinuous/of very poor quality.

Given the depth of the anticipated seams, proposed low level housing and cover of superficial clay, sand and gravel deposits, we consider that the risks from ground instability associated with former coal workings is deemed to be low.

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 National Planning Policy Framework 2018.

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 6.0. Phase 1 Conceptual Site Model (CSM) and Preliminary Risk Assessment (Proposed Residential 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*
Potential contaminants may be present beneath the site - Ash and clinker - Heavy metals, sulphates and PAHs. - Hydrocarbons - VOC/SVOC/ - Electrical substation in the north east of the site (PCBs).	Possibly within sub surface strata & Groundwater	Ground water (Secondary Superficial Aquifer – Low Risk)	Vertical percolation to groundwater	Groundwater (Medium – pollution of sensitive water resource)	Low Likelihood - Localised leakages and spillages may migrate into sub-surface aquifer resources.	Moderate/Low Site investigation works required.
		Surface Water – on site river, tributary to river Irwell	Lateral percolation & Surface Run-off to surface water	Surface Water (Medium – pollution of sensitive water resource)	Low Likelihood – Given distance to River Irwell	Moderate/Low Site investigation works required.
		End user of site.	Direct contact, Ingestion, Inhalation (Dust and Vapours)	Human Health (Severe).	Low likelihood - Made Ground on site; there is potential for localised asbestos and contaminants to be present within the near sub-surface soils and groundwater.	Moderate/Low Site investigation works required.
		Site Workers, Construction Staff.	Direct contact, Ingestion, Inhalation (Dust and Vapours)	Human Health (Minor – providing suitable PPE equipment is worn)	Low likelihood - Made Ground on site; there is potential for localised asbestos and contaminants to be present within the near sub-surface soils and groundwater.	Very low risk (if PPE equipment worn and potential asbestos suppressed)
		End user of site (Staff and patrons)	Migration through strata and accumulation under buildings of explosive and asphyxiating gases.	Human Health (Severe)	Low Likelihood - The site history recorded numerous former structures, infilled gravel pits/reservoirs on site and surrounding area which may generate low levels of hazardous ground gas.	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

An intrusive investigation was carried by Taylor Drilling and monitored by an engineer from NX Consulting between the 26th April 2021 and 28th April 2021.

A plan showing all the exploratory hole locations is presented in Appendix A. All locations were checked for services against available service plans and scanned with a cable avoidance tool (CAT) prior to the intrusive investigation; in line with NX Consulting health and safety methodology.

4.2 Windowless Sampler Boreholes

7no. windowless sample boreholes (WS1 through to WS7) were formed to a maximum depth of 5.0mbgl. Hand pits to 1.2mbgl were formed in all boreholes prior to drilling.

A groundwater monitoring well was installed in WS1, WS3, WS4 and WS7 to circa 2.50mbgl on completion. These comprised an upper 0.50m of plain pipe connected to a length of slotted pipe with a pea gravel surround.

Detailed Boreholes log sheets are included in Appendix D.

4.3 Rotary Boreholes

2no. open hole rotary boreholes water flush (RBH1 & RBH2) were formed to a maximum depth of 40.00mbgl under Coal Authority permit No: 21958.

Detailed boreholes log sheets are included in Appendix D.

4.4 Trial Pits

4no. machine excavated trial pits (TP1 through to TP4) were formed to a maximum depth of 2.0mbgl.

Detailed trial pit log sheets are included in Appendix D.

4.5 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 Ground Conditions

Made Ground

Ground conditions identified from 7no. windowless sample boreholes and 4no trial pits have identified Made Ground, to a maximum depth of 2.40 metres below ground level (mbgl) (WS7).

The made ground in WS1 and TP1 comprised black/brown slightly organic sand with gravel of clinker, coal and brick (MG1) to 0.1mbgl overlying 0.2m of light brown sand with gravel and cobbles of brick and sandstone (MG2), overlying 1.7m of brown/red sand with gravel of brick, coal, clinker, slate and sandstone, and cobbles of brick (MG3). MG3 was found in WS2 to 0.5mbgl underlying 0.15m of MG1. In WS3, MG3 was found to 0.7mbgl underlying a 0.1m thick concrete slab.

The made ground in the grass (WS4, WS5, WS6, and TP3) comprised 0.1 – 0.3m of brown/black slightly organic sand with a fine gravel of mixed lithology. A layer of black/brown slightly organic sand with gravel of brick, coal, clinker, and mixed lithology (glass and tiles in WS6), and subangular cobbles of brick slate and sandstone was recorded to depths of 0.1mbgl to 1.3mbgl. In WS6 a layer of brown/black slightly organic sand with subangular gravel of mixed lithology and angular limestone cobbles was recorded between 0.1mbgl and 0.4mbgl.

The made ground in the hardstand borehole (WS7) comprised 0.1m of concrete overlying 0.15m of MG2, overlying 0.2m of MG3, overlying 0.1m of concrete. A layer of MG3 was recorded between 0.55mbgl and 0.8mbgl, overlying black sand and gravel of coal, clinker and brick, with angular cobbles of brick and slate recorded to 1.1mbgl. A layer of brown/orange sandy clay with subangular gravel of coal, brick and mixed lithology was recorded between 1.1mbgl and 1.2mbgl. A layer of dark grey/black soft silty clay with angular gravel of coal and clinker and subrounded mudstone cobbles was recorded between 1.2mbgl and 2.4mbgl.

The made ground in TP2 comprised 0.03m of paving slab overlying MOT type 1 limestone gravel to 0.3mbgl. A layer of dark brown/black clayey silty sand with subangular gravel of brick, coal, clinker, slate, bathroom tiles, timber and other mixed lithology including plastic was recorded to 1.0mbgl.

The made ground to TP4 comprised Tarmac to 0.05mbgl, overlying MG2 to 0.3mbgl, overlying MG3 to 0.5mbgl overlying a layer of orange/yellow/brown clayey sand and gravel of mixed lithology with subrounded cobbles of sandstone to 0.75mbgl, overlying MG3 to 1.0mbgl.

Glacial Till

The Made Ground is underlain by firm to stiff or stiffer Glacial Clay with coal, slate, and sandstone secondary constituents. Glacial clay was recorded between 1.3mbgl and 5.0mbgl.

SPT N values within the clay deposits were in the range 8-43 indicating firm to stiff to very stiff conditions.

Shear vane values within the clay deposits were in the range 22 - 60 KPa indicating firm to stiff clays.

Sand and Gravel

In WS5 & WS6, fine to coarse sand with a fine gravel was recorded between 2.1mbgl and 5.0mbgl, interbedded with the glacial clay.

In WS2, WS3, WS5 & WS6, a layer of yellow/brown silty clayey angular sand and gravel of coal, slate and sandstone was recorded at depths between 0.5mbgl and 2.3mbgl, overlying the glacial till.

Bedrock

Bedrock, comprising mudstone, siltstone, sandstone and coal seams was tentatively proven in WS6 and WS7 between depths of 3.5mbgl and 5.0mbgl and at 8.70m bgl and 5.80m bgl to proven depths of 40.00m bgl, in RB01 & RBH02 respectively.

5.2 Groundwater

Groundwater was recorded in WS4, WS5, WS6 & WS7 between 1.94mbgl (WS5) and 3.97mbgl (WS4). Groundwater was found to be absent in WS1, WS2, WS3, TP1, TP2, TP3, & TP4.

5.3 Underground Service Plans

Underground services, BT Lines, gas mains, combined and foul sewers, CCTV, electric cables and possible fibre optic cables may all impact the site and the design team and Client should familiarise themselves with their presence.

5.4 Below ground obstructions

No obstructions were encountered within the made ground and superficial deposits and excavations should be achievable with conventional plant.

The presence of other relic below ground structures should be anticipated beneath the former school and associated infrastructure having previously occupied the site. The location of which are shown on historical mapping within Appendix C.

5.5 Contamination

No visual or olfactory evidence of hydrocarbon and/or solvent contamination was identified during drilling works.

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

Moisture Content

5no. samples of clay and 2no. samples of sand were tested for natural moisture content. The results are summarised below:

Property	Range	Mean
Moisture Content	11 -30	15.86

Plasticity Index

5no. samples of clay were analysed for plasticity index and hence shrinkage/swelling potential. The results are summarised below:

Property	Range
Plasticity index	13-23%
*Amended Plasticity index	11.05% –20.7%

The results demonstrate Clay is of low to medium plasticity with a corresponding low to moderate volume change potential based on amended plasticity.

Particle size distribution

6no. 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 (g/l)
Sulphate as SO ₄ (g/l)	0.018 – 0.15
Sulphate as SO ₄ (mg/kg)	260-2000
pH	6.5-9.2

7.0 GEOTECHNICAL ASSESSMENT

7.1 General

It is understood that the site is to be redeveloped with new 2-storey residential housing. No building loads or finished site/building levels have been provided to NX Consulting at the time of drafting this document.

The following assessment should be considered preliminary. The recommendations should be verified and validated once the development details are finalised. At this stage, neither the proposed site level nor the cut and fill plan are available. The proposed ground level is assumed to be similar to the existing site level and without significant changes to be made.

Ground conditions identified from 7no. windowless sample boreholes and 4no trial pits have identified Made Ground, to a maximum depth of 2.40 metres below ground level (mbgl) (WS7).

Infilled demolition arisings were recorded within the area of WS1/TP01 which will require pre-treatment (excavation/screening/crushing and replacement) prior to formation of the adopted foundation solution.

Mudstone bedrock was 'tentatively' but not definitively proven in window sampler boreholes WS6 & WS7 between at depths of 3.50m & 5.00 mbgl. RBH01 & RBH02 recorded interbedded siltstone, mudstone and sandstone bedrock at depths ranging from 8.70m bgl (RBH01) & 5.80m bgl (RBH02).

The Made Ground is underlain by generally interbedded firm to stiff or stiffer Glacial Clay and sand/sand and gravel between 0.50m bgl to 2.40m and 3.50m bgl to 5.00m bgl.

SPT N values within the clay deposits were in the range 8-43 indicting firm to stiff to very stiff conditions.

SPT N values within the granular deposits were in the range 6-19 indicting loose to medium dense.

Groundwater was recorded in WS4, WS5, WS6 & WS7 between 1.94mbgl (WS5) and 3.97mbgl (WS4). Groundwater was found to be absent in WS1, WS2, WS3, TP1, TP2, TP3, & TP4.

7.2 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 recommended suspended floor slab to be adopted.

Preliminary foundation assessment indicates that for Made Ground less than 1.5m thick, the conventional strip footing of indicative 600mm and 750mm wide founded at min. 1.25m on medium strength Glacial Till (min. Cu 40kPa) will be adequate for an applied

line loads of 40kN/m and 70kN/m for 2 to 3 storey residential housing, respectively. The total settlement is anticipated to be within 25mm.

For the Made Ground between 1.5m and 3.0m thick, deep trench fill can be considered but may not be a cost-effective solution. For Made Ground thicker than 1.5m, ground improvement using vibro stone column as well as driven piles will be able to provide adequate capacity.

Alternatively, bored type or CFA piles are considered the most feasible solution and will cause less impact on the assets owned by others. It is recommended RC foundations to be designed to prevent differential settlement.

Foundation design should also take into account the potential impact of trees and soil volume change potential.

There are several buried services including a culverted watercourse underneath the site, the foundation solution should allow for protection measures and ensure no damage to these services.

NHBC guidance in relation to trees should be followed, due to the presence of glacial clay. Heave protection measures should be used for foundations and drainage where trees are present within influencing distance.

7.3 Earthworks, Excavations and Groundwater

Earthworks materials should be classified in accordance with Table 6/1 of Department of Transport Specification for Highways Works.

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 removal from site to suitably licensed waste management facility.

Any excavations extending below the water table would need to be dewatered in advance of the main excavation works to prevent running sand conditions from developing. Sump pumps or possibly well points may be required for this. It is recommended that groundwater levels are monitored during the construction work to enable any dewatering requirements to be identified in advance.

Excavation stability is likely to be moderate to good in the upper 1.00m of strata but poor below this depth in the underlying granular materials. Excavations would need to be battered back to a suitable angle of repose or fully supported during construction. Below 1.80m bgl running sand conditions should be anticipated. However, infilled demolition arisings were recorded within the area of WS1/TP01 (former brewery and chimney) which will require pre-treatment (excavation/screening/crushing and replacement) prior to formation of the adopted foundation solution.

Excavations should be feasible with conventional plant.

The presence of other relic below ground structures should be anticipated beneath the former brewery and areas of residential housing and associated infrastructure having previously occupied the site. Deepening of foundations and breaking out of surface slabs should be anticipated within these areas. The locations of which are shown on historical mapping within Appendix C.

All excavations and basement construction should be conducted in line with CIRIA Report 97 – Trenching Practice and BRE 440 Foundations, Basements and External Works 2002.

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.

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

The made ground is likely to be unsuitable as a structural fill; requiring treatment prior to re-use upon site.

Pavement Construction

An initial design CBR value of 2% is recommended for the granular Made Ground deposits (below topsoil).

Where access roads are to be adopted, design CBR values should be confirmed by carrying out in-situ plate load tests.

Groundwater

Any excavations extending below the water table would need to be dewatered in advance of the main excavation works to prevent running sand conditions from developing. Sump pumps or possibly well points may be required for this. It is recommended that groundwater levels are monitored during the construction work to enable any dewatering requirements to be identified in advance.

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.

A suitably qualified hydrogeologist should be employed to help in design of dewatering measures.

7.3 Concrete Classification

Concrete Design

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[Table C2 given in BRE Special Digest 1:2005, 3rd Edition, 'Concrete in aggressive ground'] is considered to be applicable for the site.

7.4 Soakaway Drainage

Given the low permeability of the underlying glacial clays we consider that soakaway are unlikely to be suitable at the site. If soakaways are to be considered then soakaways should be carried out in line with BRE 365 Soakaway Design.

8.0 GEOCHEMICAL GROUND AND GROUNDWATER ASSESSMENT

8.1 Introduction

The preliminary conceptual site model identified that, the potential for the existence of contamination beneath the site, was low to moderate. No significant risk to controlled water receptors were deemed to be apparent at the site. Total soils, leachate analysis carried out in WAC testing did not establish concentrations which are likely to impact controlled water receptors. As such, leachate and groundwater analysis in this instance is considered to be unnecessary. Though potential risks to human health receptors needed to be quantified.

No visual or olfactory evidence of hydrocarbon/solvent contamination was recorded during the ground investigation.

Selected samples of made ground and natural drift deposits were tested for a number of general screening tests including pH and metals, cyanide, phenols, asbestos, sulphide, sulphur, TPHWCG and speciated PAH were undertaken during the intrusive investigation to confirm, or otherwise, the site's anticipated risk status.

Waste Acceptance Testing was carried out to enable materials to be classified prior to disposal to landfill; if deemed necessary by the appointed contractor.

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 Site Soils

8.4.1 NX Consulting Investigation

The chemistry analysis results, presented in Appendix F, have been compared against the Tier 1 criteria for a *residential end* use (conservative due to the sensitivity of site receptors) to reflect the development proposals.

For risk assessment purposes a soil organic matter value of 1.0% has been assumed for both the Made Ground and natural strata. The pH of the soils is generally very slightly alkaline (mean value of 7.58).

Tier 1 thresholds have been exceeded in the following:

Parameter Group	Screening value (mg/kg)	Maximum Concentration of Exceedances (mg/kg)	Locations
Lead	450	2500 580 560 6000	WS4 @ 1.0mbgl WS5 @ 0.05mbgl WS6 @ 0.4mbgl TP1 @ 0.5mbgl
Arsenic	37	58 74 710 61 190	WS4 @ 0.05mbgl WS4 @ 1.0mbgl WS5 @ 0.05mbgl WS5 @ 1.1mbgl WS6 @ 0.4mbgl
Naphthalene	2.3	4.6	WS6 @ 0.4mbgl
Benzo (a) anthracene	7.2	8 14 25	WS4 @ 0.05mbgl WS5 @ 0.05mbgl WS6 @ 0.4mbgl
Chrysene	15	22	WS6 @ 0.4mbgl
Benzo (a) pyrene	2.2	6.7 6.8 13 23	WS1 @ 0.5mbgl WS4 @ 0.05mbgl WS5 @ 0.05mbgl WS6 @ 0.4mbgl
Benzo (b) fluoranthene	2.6	8.9 7.4 14 2.7 23	WS1 @ 0.5mbgl WS4 @ 0.05mbgl WS5 @ 0.05mbgl WS5 @ 1.1mbgl WS6 @ 0.4mbgl
Dibenzo(ah)anthracene	0.24	1.1 0.27 2.1 0.32 3.8	WS1 @ 0.5mbgl. WS4 @ 0.05mbgl WS4 @ 1.0mbgl WS5 @ 0.05mbgl WS5 @ 1.1mbgl WS6 @ 0.4mbgl

No asbestos was recorded during soil screening, although given the nature of previous development on the site, it cannot be discounted at this stage.

8.4.2 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	Not identified in conceptual model
BTEX, MTBE	0.1	0.03	<1.00
SVOC Suite	2	1.4	Not identified in conceptual model
Phenols	2	0.4	<1.00
Mineral Oils C11-C20	10	N/A	<1.00
Mineral Oils C21-C40	500	N/A	<1.00

The results indicate that specialist protection measures are not required in relation to the water supply pipework. A UKWIR risk assessment is recommended to be completed at the depth of the proposed water supply pipework. It is anticipated that specialist water supply pipework will not be required for the proposed development based upon testing carried out to date.

8.4.3 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 all samples analysed within the made-ground or natural soils with respect to the end use of the site.

8.4.4 Discussion and Recommendations

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

Contaminants were found to be above tier 1 screening values in the soils beneath the site for 6 locations within the upper 1.10m of made ground; where ash clinker, coal gravel were recorded.

No visual or olfactory evidence of hydrocarbon or solvent contamination was encountered during the NX Consulting investigation.

Soils

PAH, arsenic and lead contaminants have been recorded in excess of tier 1 for a residential end use with plant uptake scenario, in the shallow made ground soils beneath the site. PCBs were found to be absent within the samples obtained from area of the existing electricity substation.

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

- Based on the chemical laboratory results no significant risk is likely to be posed to indoor air of any future residential properties.
- Within areas of private domestic gardens, a minimum 600mm of clean cover / removal & replacement of made grounds should be assumed at this stage.
- Within areas of soft landscaping a minimum 600mm of clean cover / removal & replacement of made grounds should be assumed.
- Within areas of areas of public open space to be grassed; a minimum 450mm of clean cover / removal & replacement of made ground should be assumed.

Site workers involved in excavations for foundations, roads, sewers etc during the construction works may come into direct contact with the soils containing slightly elevated concentrations of inorganic and organic contaminants and unrecorded 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 will require imported subsoil/topsoil materials which will require chemical validation to demonstrate that they are suitable for a residential 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.

For any imported materials required to complete the cover soils, the frequency of testing to be undertaken shall be as given in the YALPAG document Verification Requirements for Cover Systems, Version 3.4 dated November 2017.

Groundwater

Based upon the total soils concentrations, lack of groundwater within the interbedded sand and gravel/clay deposits and predominantly low permeability clay and mudstone deposits we consider there to be a negligible risk to controlled water receptors. The nearby unnamed surface water course crossing through the site is culverted and unlikely to be in hydraulic connectivity with groundwater and site soils. As such no further groundwater or leachate testing was undertaken.

The risks presented to controlled water receptors are deemed to be low post construction. This will need to be confirmed with the local authority and Environment Agency.

8.4.5 Waste Classification

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 be classified as NON-HAZARDOUS & HAZARDOUS WASTE as a result of elevated lead compounds. This should be confirmed by the appointed waste management contractor following submission of all available test results carried out at the site to date.

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 Made Ground soils will be suitable for a non-hazardous landfill.

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.

Testing conducted to date would indicate that any site materials to be removed off site to landfill; would be classified as inert or stable non-reactive waste in a non-hazardous landfill.

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.

If site soils are removed from site to landfill WAC testing indicates site soils are unlikely to be classified hazardous waste under current UK Waste Management Regulations.