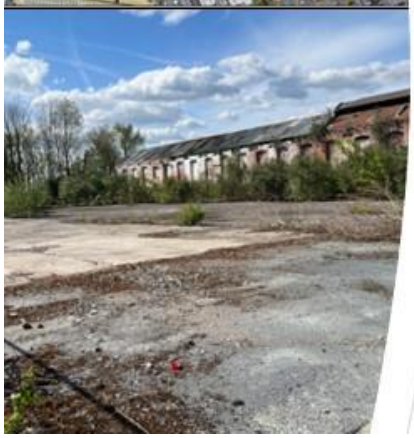

EARTH ENVIRONMENTAL & GEOTECHNICAL

Remediation Report

Louisa Street

Openshaw

October 2023

On behalf of

Westchurch Homes

Earth Environmental & Geotechnical Ltd
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LOUISA STREET

OPENSHAW

REMEDIATION REPORT

FOR

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Report A4755/23/RMS/V2 **October 2023**

Report Title:	**Louisa Street, Openshaw Remediation Report**	
Report Reference:	**A4755/23/RMS/V2**	
Client:	**Westchurch Homes**	
Issue Date:	**22nd October 2023**	
Drafted By:	**L Glover**	
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1.0 INTRODUCTION

Appointment

Earth Environmental & Geotechnical Ltd (EEG) has been commissioned by Westchurch Homes (the Client), to produce a Remediation Strategy for a proposed residential development off Louisa Street in Openshaw, Manchester.

Proposed Development

It is understood that the client intends to construct two three-storey apartment blocks and twenty-nine dwellinghouses.

Vehicular access will be from Louisa Street to the east of the site.

Figure 1 below shows the proposed development layout plan.

Figure 1: Proposed Development Layout Plan

Historical Information

Historically the site was vacant land until it was occupied by an Iron Foundry from the early 1900's. The area was dominated by heavy industry including, iron and steel works, mills, stream hammer works, electric motor works and railway sheds and sidings. The majority of the buildings on site were demolished in 2017/2018.

Objective

The Remediation Strategy is intended to build on the site characterisation information and provide details on the remediation objectives necessary to protect potential receptors and render the site suitable for the proposed development.

In summary this document presents the technical detail behind the proposed remedial activities at the site and includes:

- Clean Cover System in areas of soft landscaping.

This report has been prepared for the purpose of satisfying the requirements of the Local Planning Authority. Earth Environmental & Geotechnical Ltd reserves the right to amend this Remediation Strategy in the light of further information which may become available or future changes in contaminated land guidance, prior to site activities.

Sources of Information

The following reports have previously been prepared for the site by Earth Environmental & Geotechnical Ltd and should be read in conjunction with this Remediation Strategy:

- Earth Environmental & Geotechnical Ltd, Phase I GeoEnvironmental Desk Study, reference: A4755/22/FDS, dated June 2022.

- Earth Environmental & Geotechnical Ltd, GeoEnvironmental Site Investigation Report (reference A4755/22/SI, June 2022).

- Earth Environmental & Geotechnical Ltd, Chemical Testing Letter Report, (reference A4755/23 October 2023).

2.0 SITE LOCATION AND DESCRIPTION

The site is located in Openshaw, Manchester, approximately 5km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SJ 88592 97635 (X:388592, Y: 397635), with the closest postcode being M11 1AD.

The site is a near rectangular shaped parcel of land with current access via two gates off Louisa Street to the east of the site. The maximum dimensions of the proposed site are 82m north to south and 120m east to west. The site occupies an area of approximately 0.93 hectares.

The surrounding area comprises predominantly of residential properties. Industrial land uses are located immediately north of the site and to the south and southeast of the site. An open green space is located immediately south of the site along the boundary.

A location plan is shown below as Figure 2.

Figure 2: Site Location Plan

3.0 PREVIOUS SITE INVESTIGATIONS

As mentioned in Section 1, a Phase I Desk Study and a GeoEnvironmental Site Investigation report have been prepared for the site by Earth Environmental & Geotechnical Ltd. The recommendations in this Remediation Strategy are based primarily on the findings of the Site Investigation report, which are summarised below.

3.1 Earth Environmental & Geotechnical Ltd, GeoEnvironmental Site Investigation Report, A4755/22/SI, June 2022

Scope of Works

The site investigation was conducted on the 25th of April 2022 and comprised:

- Five window sample boreholes (WS1 - WS5) to a maximum depth of 5.00m bgl.
- 50mm diameter standpipes were installed in all the window sample boreholes to a maximum depth of 5.00m below ground level. EEG carried out groundwater/ground gas monitoring in standpipes after the fieldwork period.
- One cable percussive borehole (CP1) was sunk to a depth of 15.00m bgl.
- Six trial pits (TP1 - TP6) were excavated to maximum depth of 3.50m bgl. The excavations were backfilled immediately on completion of sampling and testing.

Standard Penetration Tests (SPTs) were conducted within the boreholes, and soil samples were retrieved from the exploratory holes at regular intervals for geotechnical and chemical analysis. Soils were logged by an on-site engineer.

An exploratory hole location plan is presented as Figure 3, overleaf.

Ground Conditions

The recorded ground conditions are summarised as follows:

- **Made Ground –**

  Variable Made Ground was encountered in all of the exploratory holes to a maximum depth of 2.90m bgl, comprising:
  - Asphalt Hardstanding.
  - Concrete (with rebar in TP6 only).
  - Sandy GRAVEL containing gravel of sandstone, ash, clinker, slag, metal and redbrick with cobbles of red brick, metal, and timber (CP1 and WS1).
  - Gravelly SAND containing gravel of sandstone, plastic, concrete, and red brick with cobbles of redbrick.
  - Gravelly CLAY containing gravel of ash and clinker.
  - Sandy gravelly CLAY containing gravel of red brick and sandstone.
  - SAND.
  - Clayey sandy GRAVEL containing gravel of sandstone and red brick with cobbles of red brick and timber.
  - Sandy CLAY.
  - Sandy gravelly COBBLES containing gravel of red brick and yellow brick with cobbles of red brick and yellow brick.

- **Superficial Deposits** –

  Sand was encountered in exploratory holes CP1, WS3, WS4, WS5, TP1 and TP2 to a maximum depth of 11.50m bgl, comprising:
  - Gravelly SAND containing gravel of sandstone.
  - Silty gravelly SAND containing gravel of sandstone and carbonaceous fragments.
  - Clayey gravelly SAND containing gravel of sandstone with cobbles of sandstone.

  Clay was encountered in exploratory holes CP1, WS1, WS5, TP3, TP4 and TP5 to a maximum depth of 15.00m bgl, comprising:
  - Sandy CLAY.
  - CLAY.

Soil Contamination Assessment

Ten soil samples were retrieved from the boreholes for chemical analysis.

Samples were analysed for the following suite of contaminants: Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO_4), Sulphide, pH, Soil Organic Matter, Extractable Petroleum Hydrocarbons (EPH), Speciated Total Petroleum Hydrocarbon (TPH) and Speciated Polyaromatic Hydrocarbons (PAH).

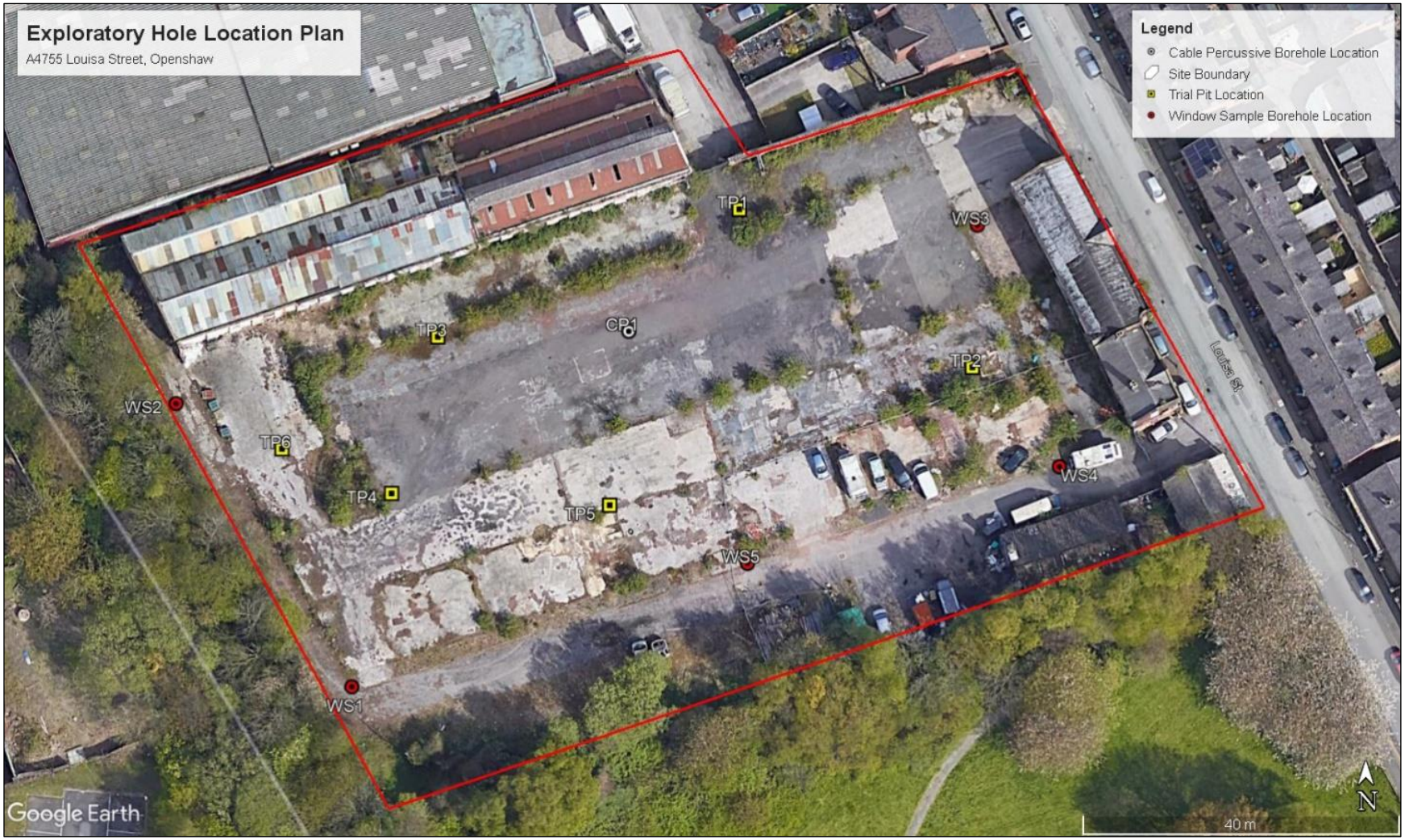
Three soil samples collected from the boreholes were found to contain concentrations of contaminants in exceedance of assessment criteria values relevant to a residential end use with plant uptake.

A summary of the soil contamination encountered is shown in Table 1, below.

Table 1: Summary of EEG Soil Contamination

Location	Contaminants
WS1 (0.30m)	Naphthalene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene
WS5 (0.65m)	Benzo(b)fluoranthene, Dibenz(a,h)anthracene
TP1 (0.40m)	Petroleum Hydrocarbon (Aromatic EC >16-21), Benzo(a)anthracene, Chrysene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene

Figure 3: Exploratory Hole Location Plan (A4755/22/SI)



Asbestos was encountered in two of the samples tested. The details of which are summarised in Table 2, below.

Table 2: Summary of Asbestos Encountered

Location	Depth (m)	Sample Matrix	Asbestos Type	Asbestos Quantification
WS1	0.30	Loose Fibres	Chrysotile	<0.001%
WS2	0.50	Loose Fibres	Chrysotile	0.001%

All but one of the soil samples were classified as Non-Hazardous in accordance with WM3.1. The Hazardous sample was TP1 at 0.40m due to the presence of elevated TPH.

Groundwater Contamination Assessment

Two perched groundwater samples were retrieved from the boreholes for chemical analysis.

Samples were analysed for the following suite of contaminants: Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO_4), Sulphide, pH, Soil Organic Matter, Extractable Petroleum Hydrocarbons (EPH), Speciated Petroleum Hydrocarbon and Speciated Polyaromatic Hydrocarbons (PAH).

Neither sample contained levels of contamination in exceedance of Environmental Quality Standards (EQS) or UK Drinking Water Standards(2000).

Ground Gas Assessment

Ground gas monitoring has been carried out on the site and identified the absence of elevated gas levels on site.

The Carbon Dioxide GSV was calculated to be 0.0066 litres/hour, with an absence of methane detected. These results suggested that the site can be given a Characteristic Situation 1, very low risk.

Remedial Recommendations

Soil Contamination

Based on the results of the chemical testing, there was deemed to be a moderate potential risk to residential end users.

A follow-up investigation was recommended to delineate the contamination present.

The development of a Remediation Strategy was also recommended, detailing the remedial measures to be implemented to mitigate the risk and any following validation work.

Groundwater Contamination

Chemical testing was carried out on two groundwater samples and no exceedances in contaminants were observed.

The risk to controlled waters from contamination was therefore considered to be low**.**

Ground Gas

The report concluded that the monitoring dataset indicated the site would fall in Characteristic Situation 1 (CS1) ('very low' gas risk). Therefore, ground gas protection measures were not considered necessary for the proposed development.

3.2 Earth Environmental & Geotechnical Ltd, Chemical Testing Letter Report, A4755/23, October 2023

A delineation exercise was commissioned to undertake soil sampling around areas of previously detected soil contamination.

At the time of the investigation, the area surrounding WS1 and WS5 had already been excavated as part of a large archaeological investigation with the excavated material stockpiled adjacent to the excavation.

Scope of Works

The site investigation was conducted on the 8th of September 2023 and comprised sampling in eleven locations (HP1 to HP11) around the existing locations where contamination was identified. An additional four samples were recovered from stockpiled material removed from the contaminated locations during the archaeological investigation.

Soils were logged by an on-site engineer.

A delineation soil sampling location plan is presented as Figure 4, overleaf.

Ground Conditions

HP1-HP5 encountered Made Ground comprising black sandy GRAVEL comprising redbrick, sandstone and ash beneath a layer of asphalt.

HP6-HP11 encountered Made Ground comprising black gravelly SAND comprising redbrick and ash. These hand pits were sampled between 1.00m and 1.55m below ground level due to an archaeological excavation on the targeted hotspot area.

Material sampled from the stockpiles generally encountered Made Ground comprising black sandy GRAVEL comprising redbrick, ash and concrete fragments.

Figure 4: Delineation Sampling Location Plan (A4755/23)

Soil Contamination Assessment

Fifteen soil samples were retrieved from the site and analysed for *Arsenic, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO_4), Sulphide, pH, Sulphur, Soil Organic Matter, Speciated Polyaromatic Hydrocarbons (PAH) and Speciated Petroleum Hydrocarbons (TPH).*

The full chemical results are included in Appendix 2.

One of the soil samples tested was found to contain a concentration of inorganic arsenic marginally in exceedance of the assessment criteria value relevant to a residential end use with plant uptake.

All soil samples collected were classified as Non-Hazardous for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

Remedial Recommendations

Soil Contamination

It was recommended that the hotspot at WS1 be excavated due to the presence of volatile naphthalene. ***However, this location has already been excavated during the archaeological investigation and the material is no longer present.***

The hotspots at WS5 and TP1 were deemed to be not significant as the previously identified material will be removed to construct the plots and there will be no plausible pollutant linkage.

It was stated that all landscaped areas should be covered by imported topsoil.

The stockpiled material is suitable to be used on site, if required, or removed offsite to a non-hazardous waste facility.

4.0 LICENCES & APPROVALS

Various licences, permits and approvals are required at various stages before certain works can commence. Some activities can start before all such approvals are in place.

(i) Approval of this Remediation Method Statement.

(ii) All documentation in accordance with the CDM 2015 Regulations.

(iii) A signed declaration by qualified person of the Material Management Plan (MMP) in accordance with CL: AIRE Waste Code of Practice, Version 2, March 2011. This would allow for reuse of excavated soils after demonstration of suitability for use. MMP will be created with due consideration to all proposed remediation and enabling works operations prescribed within this document and will be undertaken by a Qualified Person and a signed declaration submitted to the EA prior to re-use of materials on the site. The importation of material for use within the proposed construction of a development platform will be subject to the compliance with the EEG Protocol for the importation of materials as set out within the specification for material import included within the Appendix of this report.

(iv) Site Waste Management Plan.

(v) General condition survey of boundary features.

5.0 PROPOSED WORKS

Aims

The remediation aims are to resolve contamination issues to protect human and environmental receptors and render the site suitable for the proposed end use and satisfy the requirements of the Local Planning Authority and Insurance bodies (Premier Guarantee, NHBC).

The remediation strategy for the site has been developed following review and assessment of the site investigation reports previously prepared for the site.

Topsoil in Gardens

Due to the absence of significantly elevated concentrations found during the additional sampling work carried out by EEG, a capping system is no longer deemed necessary for this site.

The previously identified material around WS1 and WS5 has already been excavated from the area during the archaeological investigation and the material at TP1 will be removed during the construction of the plots.

It should be noted that a covering of topsoil no less than 150mm should be present in all areas of soft landscaping to facilitate plant growth. The material should ideally meet the requirement of BS3882:2015 specification for topsoil.

The thickness of topsoil could be increased to 300mm if shrubs are to be planted.

6.0 SITE WORKS

Outlined below are some of the main task and activities associated with the remediation works.

Site Organisation

Site works will be supervised throughout by a suitably qualified Engineer, who will report to a Project Manager. Supervision may be part-time for certain activities but will be full-time during the removal of any contaminated soil/fill and any placement of fill to an engineering specification.

Welfare Facilities/Security

Initial mobilisation works will include the establishment of appropriate office and welfare facilities. Such facilities may include but are not restricted to; office accommodation, canteen facilities, washroom/drying room, toilets, wheel wash, car parking, stores, and security unit.

The site should be secured by fencing to prevent unauthorised access onto the site during the enabling works.

Health & Safety

All site personnel will undergo a site-specific health and safety induction prior to commencement of work on site.

The Engineer will be informed prior to any proposed entry of a confined space or deep excavation. Entry will be restricted to suitably qualified and equipped personnel.

Works will be carried out about current statutory requirements and guidance by the Health & Safety Executive “Protection of workers and the general public during the redevelopment of contaminated land”. Protective clothing, footwear and gloves will be required with hand washing and boot-washing facilities made available. Smoking will be limited to designated areas.

Site Clearance

Any trees currently under a preservation order should be identified and agreed with relevant authorities prior to the commencement of the works. All trees subject to a Tree Preservation Order should be clearly identified and protected by chestnut paling with fluorescent tape.

The site should then be cleared of all residual debris, fly tipped materials, any vegetation, shrubs, bushes, and unprotected trees as instructed by the client.

Placement of New Fill Materials

It is understood that the soils on site will be undergoing vibro-compaction. Therefore, any placement of new fill materials will need to be conducted to the following specification.

Granular

For any areas requiring Ground Treatment, upfill shall be essentially granular and free draining with an upper size limit of 100mm and less than 10% passing the 75-micron sieve test. In addition, there shall be less than 20% material finer than 2mm. Particles shall be stable and

have a Los Angeles Coefficient (LA Value) not exceeding 30%. The materials should be loosely end tipped and levelled without being specifically compacted.

Cohesive

Any cohesive fill placed must be suitably engineered in place, with moisture contents controlled, according to an appropriate specification (e.g., Department of Transport Specification for Earthworks Series 600 Method 2). This is in order to eradicate any self-weight issues with this newly placed fill. In order to ensure that the newly placed ground is readily penetrable by normal equipment, without the need to pre-bore, a minimum dry density of 95% compaction should be used with a CBR of 5% (not exceeding a CBR of 8%).

Excavation of Subsurface Obstructions/Voids

A basement was encountered in the west of the site. This will need to be remediated and infilled with suitable material. The fill material should be placed in line with the 'Placement of New Fill Material' section above.

A potential obstruction was encountered in WS2 at 2.50m. This may require excavation prior to any foundation/piling works in the vicinity.

Any material identified as potentially contaminated should be stockpiled on a non-permeable membrane, and tested for suitability for either re-use on site, or offsite disposal.

Should the material be removed from site, waste acceptance criteria testing should be undertaken, and the material disposed of in a suitably licensed facility. The development of a Materials Management Plan (MMP) in line with the CL: AIRE Code of Practice may be required to remove or re-use soils.

Unexpected Contamination

If during site clearance works or other excavations, material with visual or olfactory evidence of previously unrecorded contamination is encountered, the principal contractor should contact Earth Environmental & Geotechnical.

These soils should be then sampled, and chemical analysis carried out. The environmental consultant shall decide upon the chemical suitability of the material, to either remain on site or if it is likely to present a risk to receptors.

If the soils present a risk, the materials should be removed from site or remediated as per the specification in Section 5.0.

Any excavated material identified as potentially contaminated should be stockpiled on a non-permeable membrane, and tested for suitability for either re-use on site, or disposed offsite.

If prolonged stockpiling is unavoidable, these soils should be covered with a non-permeable membrane at the end of each working day, to prevent the possibility of leachate migrating from the soils due to infiltration.

Should the material be removed from site, waste acceptance criteria testing should be undertaken, and the material disposed of in a suitably licensed facility. The development of a Materials Management Plan (MMP) in line with the CL:AIRE Code of Practice may be required to remove or re-use soils.

Backfill of Excavations

All excavations shall, prior to backfilling, be surveyed to ascertain their spatial extent and depth. Excavations (to remove relict structures, contamination etc) should be backfilled with suitable materials in line with 'Placement of New Fill Materials' section above.

Control of Perched Groundwater

The regional groundwater table is unlikely to be encountered during remediation earthworks; however, discontinuous perched groundwater may be present within Made Ground. If encountered during the excavation works, this perched water will be recovered by pumping from open excavations. Dependant on volumes recovered, some form of temporary storage may also be required.

Provision should be made for pumping from sumps and appropriate excavation support for all excavations.

7.0 ENVIRONMENTAL MONITORING & CONTROLS

General

All works should be carried out in a manner that minimises impact on the environment and generates adequate and accurate records to demonstrate remediation works have been carried out to the required standard and in accordance with all applicable legislation. All such records should be collated on contract completion (or sooner as required) and included within the contract completion report. Appropriate progress reports should be provided in a format and at a frequency as agreed with the client and project manager including on-going monitoring/validation information.

Comprehensive records should be maintained throughout the project. These should be collated on contract completion into a completion and validation report, which should be submitted to the appropriate regulators for approval. It will be presented in an appropriate manner to allow interested third parties to fully understand the whole remediation process.

The records should include correspondence with the regulators & other third parties, environmental monitoring data, validation testing, comprehensive as-built drawings, photographs, collation of all site investigation reports, operational method statements & risk assessments, construction phase health & safety plan and confirmation of post remediation considerations especially in respect of interaction with initial construction (groundwork's).

Noise Control

Earthworks will only take place during normal working hours 8.00am – 6.00pm Monday to Friday and 8.00am to 13:00pm on Saturdays with no working on Sundays or Bank Holidays. The site manager shall assess noise and its impact upon neighbours through the working day and to ensure the following mitigation measures are being utilised:

All plant and machinery will be fitted with adequate silencers and will not be operated unless in good condition.

Noise levels will be as per normal for a project of this nature. Pneumatic breakers will be used but location and hours of use controlled whenever possible.

Should residents make any complaints regarding noise associated with the works, the site manager shall investigate. Such investigation may include the use of portable monitoring equipment to record noise levels at the location of the complainant. The nature of the complaint and findings of the investigation shall be discussed with the local EHO. If the complaint is upheld appropriate remedial action shall be taken. Such action may include the adjustment of working hours or the alteration of site practices and working methods.

Odour Control

Works may produce odours, but good site practice and associated mitigation measures should ensure fugitive odours are kept to an absolute minimum. Such controls may include:

- Additional covers will be applied to stockpiles if they are contributing to fugitive odours.
- Areas of excavation i.e., area of exposed contaminated soils, will be kept to a minimum and covered/re-instated as soon as is practicably possible.

- Odour suppressing equipment shall be utilised at appropriate locations at appropriate times.

If a complaint is made regarding odours from nearby residents, the site manager shall respond by attending the complainant's property to assess the nature and level of odour nuisance including monitoring where appropriate. Appropriate mitigation measures as described herein shall than be enforced including, if necessary, suspension of excavation works until the prevailing weather conditions become more favourable.

Dust Control

Earthworks may produce dust during prolonged periods of dry weather. The site manager shall assess dust and its impact upon neighbours through the working day and ensure the following mitigation measures are being utilised to control dust:

- The use and maintenance of good quality site roads;

- Enforcing speed limits of site plant and;

- Dust suppression via water applied by towed bowser, particularly in the vicinity of locations where trace asbestos fibres have been detected in soils.

APPENDIX 1

EEG GEOENVIRONMENTAL SITE INVESTIGATION REPORT, A4755/22/SI, JUNE 2022

APPENDIX 2

EEG GEOENVIRONMENTAL CHEMICAL TESTING LETTER REPORT, A4755/23 OCTOBER 2022

APPENDIX 3

ASSESSMENT CRITERIA FOR IMPORTED SOILS IN GARDEN AREAS

Assessment Criteria for Imported Soils in Garden Areas

Inorganic Compounds	Assessment Criteria - Residential with Homegrown Produce (mg/kg)		
Arsenic	37		
Cadmium	22		
Chromium (III)	910		
Chromium (VI)	21		
Lead	200		
Inorganic Mercury	40		
Nickel	130		
Selenium	250		
Copper	2400		
Zinc	3700		
Organic Compounds	**1% SOM**	**2.5% SOM**	**6% SOM**
Naphthalene	2.3	5.6	13
Acenaphthene	210	510	1100
Acenaphthylene	170	420	920
Fluorene	170	400	860
Phenanthrene	95	220	440
Anthracene	2400	5400	11000
Fluoranthene	280	560	890
Pyrene	620	1200	2000
Benzo(a)anthracene	7.2	11	13
Chrysene	15	22	27
Benzo(b)fluoranthene	2.6	3.3	3.7
Benzo(k)fluoranthene	77	93	100
Benzo(a)pyrene	5.0		
Dibenz(a,h)anthracene	0.24	0.28	0.3
Indeno(1,2,3-cd)pyrene	27	36	41
Benzo(g,h,i)perylene	320	340	350
Benzene	0.2	0.41	0.87
Toluene	130	290	660
Ethylbenzene	47	110	260
o-Xylene	60	140	330
m-Xylene	59	140	320
p-Xylene	56	130	310
TPH Fractions	**1% SOM**	**2.5% SOM**	**6% SOM**
Aliphatic EC 5-6	42	78	160
Aliphatic EC >6-8	100	230	530
Aliphatic EC >8-10	27	65	150
Aliphatic EC >10-12	130 (48)[vap]	330 (118)[vap]	760 (283)[vap]
Aliphatic EC >12-16	1100 (24)[sol]	2400 (59)[sol]	4,300 (142)[sol]
Aliphatic EC >16-35	65,000 (8.48)[f,sol]	92,000 (21)[f,sol]	110,000[f]
Aliphatic EC >35-44	65,000 (8.48)[f, sol]	92,000 (21)[f,sol]	110,000[f]
Aromatic EC 5-7	70	140	300
Aromatic EC >7-8	130	290	660

	Assessment Criterial - Residential with Homegrown Produce (mg/kg)		
TPH Fractions	**1% SOM**	**2.5% SOM**	**6% SOM**
Aromatic EC>8-10	34	83	190
Aromatic EC >10-12	74	180	380
Aromatic EC >12-16	140	330	660
Aromatic EC >16-21	260[f]	540[f]	930[f]
Aromatic EC >21-35	1,100[f]	1,500[f]	1,700[f]
Aromatic EC >35-44	1,100[f]	1,500[f]	1,700[f]
Asbestos Fibres	< 0.001%		

The site-specific risk-based criteria are based upon DEFRA/EA CLEA 1.07 modelling assuming a sandy loam with 1% Soil Organic Matter and pH of 7.

Purpose	Classification	Testing Frequency	Chemical Analysis
Source Testing & Suitability For Use	Topsoil	1 sample per 100m^3 [Minimum of 3 per source]	➢ Inorganic Compounds; ➢ Speciated Polycyclic Aromatic Hydrocarbons; ➢ Speciated Petroleum hydrocarbons; ➢ Asbestos Identification.
	Sub-Soil	1 sample per 100m^3 [Minimum of 3 per source]	

The sampling frequency for materials intended for landscaping is to be managed under the Remediation Strategy.

APPENDIX 4

REPORT LIMITATIONS

LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd based on a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget, and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd provides no other representation or warranty whether express or implied, is made in relation to the services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of Earth Environmental & Geotechnical Ltd.

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It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important factor in determining the scope and level of the services. Should the purpose for which the report is used, or the proposed use of the site change, this report will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2023 and should be read considering any subsequent changes in legislation, statutory requirements, and industry best practices. Ground conditions can also change over time and further investigations, or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full of those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further Earth Environmental & Geotechnical Ltd was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the services. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.

EARTH ENVIRONMENTAL
& GEOTECHNICAL

Geo-Environmental

Site Investigation

Report

Louisa Street

Openshaw

June 2022

Westchurch Homes

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GEOENVIRONMENTAL SITE INVESTIGATION REPORT

LOUISA STREET

OPENSHAW

Report Ref: A4755/22/SI

JUNE 2022

Prepared on Behalf of:

Westchurch Homes

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GEOENVIRONMENTAL SITE INVESTIGATION REPORT

LOUISA STREET, OPENSHAW

Report Reference: A4755/22/SI

Version B.0

Date: 26th June 2022

Prepared for: Westchurch Homes

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Definition of Version Code:
D. Applied during initial drafting of the report before it has been reviewed.
C. Applied after the report has been reviewed but before it has been approved by the Project Manager.
B. Applied after the Project Manager has approved the report ready for issue to the client.
A. Applied to reports after external/internal review.

The version number starts at "0" and is raised by "1" at each re-type.

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1.0 EXECUTIVE SUMMARY

Appointment	A Site Investigation has been commissioned by Westchurch Homes (the Client), to examine ground conditions for a proposed new residential development at a site off Louisa Street, Openshaw.
The Investigation	The investigation comprised five windowless sample boreholes, one cable percussive borehole and six trial pits with associated sampling and in situ testing, laboratory geotechnical and contamination testing.
The Site	The site is located in Openshaw, Manchester, approximately 4.67km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SJ 88592 97635 (X:388592, Y: 397635) The site is underlain by Devensian Till Deposits and the solid geology beneath the site is the Chester Pebble Beds Formation.
Site History	Historically the site was vacant land until it was occupied by an Iron Foundry from the early 1900's. The area was dominated by heavy industry including, iron and steel works, mills, stream hammer works, electric motor works and railway sheds and sidings. The majority of the buildings on site were demolished in 2017/2018.
Ground Conditions Encountered	The exploratory holes generally encountered Made Ground to a maximum depth of 2.90m. Underlying the Made Ground in all exploratory boreholes were superficial deposits of variable Clay and Sand to a maximum depth of 15.00m bgl. Groundwater was encountered during the fieldwork at depths between 3.50m and 4.00m bgl and encountered during subsequent monitoring visits. A basement was found at TP5 and additional basements may be present.
Geotechnical Assessment	Shallow strip/pad foundation placed in the superficial deposits at a minimum depth of approximately 1.50m bgl are considered appropriate for the houses included in the proposed development. However, other foundation options may need to be considered such as ground improvement or piles for the larger apartment blocks and in areas of deep made ground. Pavement Design – preliminary design value = 1% in Made Ground. Design Sulphate Class = DS-1 ACEC Site Classification = AC-1s
Contamination Assessment	Risk from contamination to groundworkers during development – Moderate to Low Risk from contamination to future site users – Moderate. Asbestos identified in two soil samples. Soil Waste Assessment: One sample classified as Hazardous. Nine samples classified as Non-Hazardous. No exceedances identified in groundwater samples.
Ground Gas Assessment	Ground gas mitigation measures are not required.
This sheet is intended to provide a summary only of the report. It does not provide a definitive engineering analysis for the purposes of costing or construction and is subject to the limitation of the agreed brief.	

2.0 INTRODUCTION

2.1 Background

A Site Investigation has been commissioned by Westchurch Homes (the Client), to examine ground conditions for a proposed new residential development at a site off Louisa Street, Openshaw, Manchester.

2.2 Previous Investigations

2.2.1 Earth Environmental & Geotechnical Ltd, Phase I GeoEnvironmental Desk Study (A4755/22/FDS), dated June 2022.

Historically the site was vacant land until it was occupied by an Iron Foundry from the early 1900's. The area was dominated by heavy industry including, iron and steel works, mills, stream hammer works, electric motor works and railway sheds and sidings. The majority of the buildings on site were demolished in 2017/2018.

Potential on-site sources of contamination include possible contaminants (heavy metals, mineral acids, arsenic, and PCBs) in the Made Ground related to the historical iron foundry and electricity substation on site, subsequent works, and storage of materials on the site. Potential ground gas associated with the Made Ground on site and nearby infilled pits. Asbestos may be present on the site.

The risk from soil contamination to residential end users was considered to be **MODERATE**. The risk to controlled waters was concluded to be **LOW**. The risk from ground gas to end users was considered to be **MODERATE**. The risk from asbestos containing materials to end users was considered to be **MODERATE to LOW**. The risk of groundwater flooding was **MODERATE.**

An intrusive investigation was recommended to establish geotechnical parameters for the design of foundations, floor slabs and pavement construction. As part of the geotechnical investigation, it was recommended that samples are recovered for contamination testing, as well as installing ground gas monitoring standpipes to assess ground gas risk.

2.2.2 Planning Application to Manchester City Council, F10502, dated March 1979.

A planning application was submitted to Manchester City Council (Reference: F10502) for the proposed storage of hygiene and pharmaceutical products at the former Louisa Street Foundry. However, the planning application was withdrawn.

2.2.3 Planning Application to Manchester City Council, 027619, dated September 1986.

A planning application was submitted to Manchester City Council (Reference: 027619) for the proposed positioning of an incinerator within the existing project workshop site. The application was deemed 'Not Proceeded With'.

No relevant applications or site investigations within the vicinity of the site made in the last five years were recorded on the Manchester City Council Planning Portal.

2.3 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) have been commissioned by the Client, to undertake a Site Investigation of the site in accordance with proposal A4755/22 dated 6th February 2022. The objectives of this investigation are as follows:

- *Provide factual information on the work undertaken including sampling location plan, borehole logs, geotechnical and chemical testing.*
- *Tier 1 (semi-quantitative) risk assessment will be undertaken. This will compare the concentrations of soil, water and ground gas contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g., existing/ future end users and site neighbours.*
- *Classification of potential surplus soils for offsite disposal.*
- *Assessment of ground conditions for foundation design.*

2.4 Report Scope

This report presents full factual records of the site work carried out, the ground conditions encountered in the exploratory holes, the in situ and laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on geotechnical design and potential ground contamination risks for the proposed development.

2.5 Limitations of the Study

The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information, improved practices or changes in legislation may require a reinterpretation of the report in whole or in part. EEG reserve the right to amend either conclusions or recommendations in light of any further information that may become available. The report is provided for the sole use by the client and is confidential to them.

Recommendations within this report are also based on exploratory records and examination of samples and, where applicable, laboratory tests. No liability can be accepted for conditions not revealed by the boreholes and trial pits particularly at intervening locations. Whilst every effort is made to ensure accuracy of data supplied, all opinions expressed as to the spatial distribution of strata between sampling locations is for guidance only and no responsibility is accepted as to its accuracy.

3.0 SITE LOCATION & DESCRIPTION

The site is located in Openshaw, Manchester, approximately 4.6km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SJ 88592 97635 (X:388592, Y: 397635), with the closest postcode being M11 1AD.

The site is a near rectangular shaped parcel of land with current access via two gates off Louisa Street to the east of the site. The maximum dimensions of the proposed site are 82m north to south and 120m east to west. The site occupies an area of approximately 0.93 hectares.

The surrounding area comprises predominantly of residential properties. Industrial land uses are located immediately north of the site and to the south and southeast of the site. An open green space is located immediately south of the site along the boundary.

The site location is shown in the aerial photograph presented as Figure 1, below.

Figure 1: Aerial Photograph Showing Site Location

General site photographs are presented in Figure 2 overleaf.

Figure 2: General Site Photographs

Photograph taken viewing west showing the northern part of the site

Photograph taken viewing north showing the eastern part of the site.

Photograph taken viewing west showing the southern part of the site
Photograph taken viewing northwest showing the northern part of the site

Photograph taken viewing north showing the western part of the site

Photograph taken of soils recovered in Exploratory Hole WS3

3.1 Proposed Development

It is understood that the client wishes to demolish the existing buildings on site and construct a combination of approximately 16 houses with private gardens and 3 apartment blocks, all with parking and soft landscaping.

Site access will be retained via Louisa Street to the east of the site, via a new access road.

The proposed development layout details are shown in Figure 3 below.

Figure 3: Proposed Development Plan

4.0 SITE INVESTIGATION

4.1 Exploratory Fieldwork

The fieldwork was carried out by EEG on the 25th April 2022 and comprised:

- Five window sample boreholes (designated WS1 – WS5 inclusive) were each sunk to a maximum depth of 5.00m below existing ground level. Window sampler boring is carried out with a small, track-mounted rig, which uses a chain-driven trip hammer to drive sampling tubes or penetrometers into the ground. These tools are coupled to the anvil of the hammer by solid drill rods. Sampling tubes comprise "windowless samplers", which are plain sampler tubes in which a continuous disturbed sample is recovered within a semi-rigid plastic liner. In order to reduce friction within the borehole, sampling tubes of progressively smaller diameter are used as the borehole depth increases. Sampler diameters generally range from between approximately 90mm to 50mm. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Groundwater observations were noted where possible. These observations relate to the time of the investigation only, and do not necessarily reflect seasonal fluctuations. Exploratory hole logs are included in Appendix 1.

- 50mm diameter standpipes were installed in all the window sample boreholes to a maximum depth of 5.00m below ground level. Installation and backfill details are shown with the appropriate borehole log sheet. EEG carried out groundwater/ground gas monitoring in standpipes after the fieldwork period, the results of which are presented in Appendix 2.

- One 150mm diameter borehole (designated CP1) was sunk to a depth of between 15.00m below existing ground level, using a light cable percussion boring rig. With this type of rig boreholes are advanced by the percussive action of drill tools suspended on a winch-driven steel cable. The tools generally include a clay-cutter for penetrating fine-grained soils, and a shell for use in coarse-grained, or "granular", soils. Representative disturbed samples were recovered as boring proceeded. In addition, "undisturbed" 100mm diameter samples (U100's) were recovered, as appropriate, using standard thick-walled, open-drive samplers, with a steel cutting shoe, dynamically driven by a sliding hammer. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Chiselling techniques, using a chisel or shell, were employed where necessary, to advance the boreholes through obstructions or into hard strata. Details of groundwater conditions were noted and are indicated on the attached borehole logs. These observations relate only to the time of boring, and do not necessarily reflect possible seasonal fluctuations. They may have been affected by the installation of casing, or the addition of water to aid boring. Borehole logs are included in Appendix 1.

- Six trial pits (designated TP1 to TP6 inclusive) were excavated by use of a JCB 3CX to a maximum depth of 3.50m bgl. Trial pits were backfilled immediately on completion of sampling and testing. Trial pit logs are presented in Appendix 1.

Exploratory hole locations were selected prior to the site works by an EEG engineer based on the proposed development layout and avoiding known services. Each exploratory location was scanned using a Cable Avoidance Tool (CAT) in order to locate unrecorded underground services, and the exploratory locations were repositioned if necessary.

On completion, samples recovered from the site were taken to specialist laboratories for chemical and geotechnical testing.

Soil samples were recovered in 250g glass amber jars and 1kg plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the DETS laboratory.

If collection was not possible the same day, then samples were stored in the sample storage fridge at the EEG offices below 4˚C.

Samples were tracked using appropriate Chain of Custody forms provided by DETS.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III).

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930(2015+A1:2020) except where superseded by the soil and rock description methodology in BS EN14688-1(2002), BS EN 14688-2(2004) and BS EN 14689-1(2003).

All sampling locations were surveyed by use of a hand-held Trimble GeoXH GPS instrument that is capable of surveying to an accuracy of less than 10mm depending on satellite coverage, proximity to trees and building structures.

The descriptive terminologies such as firm, etc formerly used within older versions of BS5930 to describe strength now solely relate to consistency. Shear strength is now defined related to results obtained in the field (using a hand vane for example) or in the laboratory (from triaxial tests), as detailed in Table 1 below.

Table 1: Shear Strength Definitions

Term based on measurement	Undrained Strength (c_u) definition in kN/m^2 (from BS EN ISO 14688-2: 2004, 5.3, Table 5)
Extremely Low Strength	<10
Very Low Strength	10 to 20
Low Strength	20 to 40
Medium Strength	40 to 75
High Strength	75 to 150
Very High Strength	130 to 300
Extremely High Strength	300 to 600

An Exploratory Hole Location Plan is presented as Figure 4, overleaf.

Figure 4: Exploratory Hole Location Plan

A summary of exploratory holes undertaken during the investigation are presented in Table 2 overleaf.

Table 2: Summary of Exploratory Holes Undertaken

Hole	Type*	Depth (m)	Date Started	Date Finished	Easting (m)	Northing (m)	Backfill Details**
CP1	CP	15.00	25/04/2022	25/04/2022	388587	397633	A
WS1	WS	4.00	25/04/2022	25/04/2022	388551	397588	SP
WS2	WS	2.50	25/04/2022	25/04/2022	388529	397624	SP
WS3	WS	5.00	25/04/2022	25/04/2022	388631	397646	SP
WS4	WS	4.50	25/04/2022	25/04/2022	388641	397616	SP
WS5	WS	5.00	25/04/2022	25/04/2022	388602	397604	SP
TP1	TP	2.60	25/04/2022	25/04/2022	388601	397648	A
TP2	TP	2.80	25/04/2022	25/04/2022	388630	397628	A
TP3	TP	3.20	25/04/2022	25/04/2022	388562	397633	A
TP4	TP	3.50	25/04/2022	25/04/2022	388556	397613	A
TP5	TP	3.30	25/04/2022	25/04/2022	388584	397611	A
TP6	TP	0.40	25/04/2022	25/04/2022	388542	397618	A

*CP = Cable Percussive Borehole, WS = Window Sample Borehole, TP = Trial Pit
**A = Arisings, SP = Standpipe

4.2 Laboratory Testing

4.2.1 *Geotechnical Testing*

A programme of laboratory testing was carried out on samples taken from the various strata to assist in classification and determine the engineering properties of the materials underlying the site. The tests were scheduled by EEG and carried out by Murray Rix. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 3, below.

Table 3: Summary of Laboratory Geotechnical Tests Undertaken

TEST	STANDARD	No.
Moisture Content	BS1377:1990 Part 2, Clause 3.2	6
Liquid Limit, Plastic Limit, Plasticity Index	BS1377:1990 Part 2, Clause 4/5	5
Particle size distribution (wet)	BS1377:1990 Part 2, Clause 9.2	4
Sulphate content of 2:1 soil: water extract	BS1377:1990 Part 3, Clause 5	8
pH value	BS1377:1990 Part 3, Clause 9	8
Triaxial tests “Quick” undrained with multistage loading	BS1377:1990 Part 7, Clause 9	1

The results of the laboratory geotechnical tests are discussed in Section 6 and included in Appendix 3.

4.2.2 *Environmental Testing*

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by EEG, and carried out by DETS, a UKAS and MCERTS accredited laboratory.

Chemical analyses were carried out on ten soil samples and were submitted for the following suite of determinants:

Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO_4), Sulphide, pH, Soil Organic Matter, Extractable Petroleum Hydrocarbons (EPH), Speciated Total Petroleum Hydrocarbon (TPH) and Speciated Polyaromatic Hydrocarbons (PAH).

Waste Acceptance Criteria Testing (WAC) was also carried out on two soil samples.

Full results of the laboratory contamination tests are discussed in Section 8 and included in Appendix 4.

Chemical analyses were also carried out on two groundwater samples and were submitted for the following suite of determinants:

Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO_4), Sulphide, pH, Total Organic Carbon (TOC), Extractable Petroleum Hydrocarbons (EPH), Speciated Petroleum Hydrocarbon (TPH) and Speciated Polyaromatic Hydrocarbons (PAH).

Full results of the laboratory contamination tests are discussed in Section 9 and included in Appendix 5.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Soil Profile Encountered

BGS digital mapping shows the site is underlain by superficial deposits of Devensian Till, comprising Diamicton. The solid geology beneath the site is recorded as the Chester Pebble Beds Formation, comprising sandstone (Early Triassic Age). The eastern part of the site is also recorded to be underlain by artificial deposits of infilled ground. The sequence of strata encountered beneath the site was as follows:

- **Made Ground –** Variable Made Ground was encountered in all of the exploratory holes to a maximum depth of 2.90m bgl, comprising:
    - Asphalt Hardstanding
    - Concrete (with rebar in TP6 only)
    - Sandy GRAVEL containing gravel of sandstone, ash, clinker, slag, metal and redbrick with cobbles of red brick, metal, and timber (CP1 and WS1)
    - Gravelly SAND containing gravel of sandstone, plastic, concrete, and red brick with cobbles of redbrick
    - Gravelly CLAY containing gravel of ash and clinker
    - Sandy gravelly CLAY containing gravel of red brick and sandstone
    - SAND
    - Clayey sandy GRAVEL containing gravel of sandstone and red brick with cobbles of red brick and timber
    - Sandy CLAY
    - Sandy gravelly COBBLES containing gravel of red brick and yellow brick with cobbles of red brick and yellow brick

- **Superficial Deposits** –

  Sand was encountered in exploratory holes CP1, WS3, WS4, WS5, TP1 and TP2 to a maximum depth of 11.50m bgl, comprising:
    - Gravelly SAND containing gravel of sandstone
    - Silty gravelly SAND containing gravel of sandstone and carbonaceous fragments
    - Clayey gravelly SAND containing gravel of sandstone with cobbles of sandstone

  Clay was encountered in exploratory holes CP1, WS1, WS5, TP3, TP4 and TP5 to a maximum depth of 15.00m bgl, comprising:
    - Sandy CLAY
    - CLAY

The depths of the various materials encountered in the exploratory holes are summarised in Table 4, overleaf.

Table 4: Summary of Ground Conditions Encountered

Hole	Depth to Stratum (m bgl)				GROUNDWATER (m bgl)
	MADE GROUND		SUPERFICIAL DEPOSITS		
	Granular	Cohesive	SAND	CLAY	
CP1	GL – 1.10	-	1.10 – 2.30 2.80 – 11.50	2.30 – 2.80 11.50 – 15.00+	-
WS1	GL – 1.60 2.00 – 2.90	1.60 – 2.00	-	2.90 – 4.00+	-
WS2	GL – 1.20 1.50 – 2.50+	1.20 – 1.50	-	-	-
WS3	GL – 1.20	1.20 – 1.50	1.50 – 5.00+	-	4.00
WS4	GL – 0.55	0.55 – 1.60	1.60 – 4.50+	-	3.50
WS5	GL – 1.40 1.80 – 2.20	1.40 – 1.80 2.20 – 2.50	3.00 – 5.00+	2.50 – 3.00	-
TP1	GL – 0.20	0.20 – 0.60	0.60 – 2.60	-	-
TP2	GL – 0.50	0.50 – 1.20	1.20 – 2.80	-	-
TP3	GL – 2.50	-	-	2.50 – 3.20	-
TP4	GL – 2.70	-	-	2.70 – 3.50	-
TP5	GL – 2.40	2.40 – 2.90	-	2.90 – 3.30	-
TP6	GL – 0.40+	-	-	-	-
Depths in **red** indicate termination within the Made Ground.					

5.2 Observable Indications of Contamination

Gravel/cobbles of red brick, concrete, plastic, and yellow brick were observed in the Made Ground encountered on site, but these materials are generally considered inert.

However, gravel of clinker, ash, slag, metal, and timber were also encountered in the Made Ground.

A strong hydrocarbon odour was observed in TP1.

No other visual or olfactory indications of contamination were observed.

5.3 Obstructions and Voids

A basement was encountered in TP6 at 0.40m and the trial pit was terminated early. Photographs taken of the basement are presented in Figure 5, overleaf.

No Man-Made obstructions were encountered in any of the exploratory hole locations.

Figure 5: Photographs of Basement Encountered

5.4 Groundwater

Groundwater was only encountered in WS3 at 4.00m bgl and WS4 at 3.50m bgl during the fieldwork.

Subsequent monitoring in the standpipes encountered groundwater at depths between 2.68m bgl and 3.60m bgl.

On the first monitoring visit, samples of water were recovered for chemical testing from WS1 and WS4.

An attempt was made to recover water samples from the remaining boreholes on site. However due to the lack of water in the standpipes, no samples could be obtained for testing after purging of the wells.

5.5 Land Gas

Results obtained during six monitoring visits on the 16th, 23rd and 30th May and the 6th, 13th and 20th June 2022, indicated Methane (CH_4) levels of 0.0% by volume, Carbon Dioxide (CO_2) levels ranging from 0.1% to 6.6% by volume, and Oxygen (O_2) levels ranging from 12.4% to 21.3% by volume. Gas flows of -0.2l/hr to 0.1l/hr were recorded, together with atmospheric pressures between 993mb and 1016 mb.

It should be noted that the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained may therefore be representative of the conditions only at the time of sampling.

Full monitoring results are discussed in Section 10 and included as Appendix 2.

6.0 ENGINEERING PROPERTIES OF SOILS ENCOUNTERED

6.1 General

The following sections discuss the engineering properties of the strata encountered, based on results of in situ testing and laboratory testing obtained during this investigation.

The results of laboratory geotechnical testing are summarised in the following table.

Table 5: Summary of Laboratory Geotechnical Test Results

Location	Depth (m)	Strata*	CLASSIFICATION										STRENGTH	CHEMICAL	
			Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Modified Plasticity Index (%)	PSD Gravel (%)	PSD Sand (%)	PSD Silt/Clay (%)	Bulk Density Mg/m³)	Dry Density (Mg/m³)	Shear Strength (kN/m²)	pH Value	Water Soluble Sulphate SO_4 (mg/l)
CP1	15.00	CLAY	17	30	14	16	13	-	-	-	2.18	1.86	61/68/78	-	-
WS1	1.00	MG	-	-	-	-	-	-	-	-	-	-	-	7.6	250
WS1	3.70	CLAY	19	33	14	19	15	-	-	-	-	-	-	-	-
WS2	1.50	MG	-	-	-	-	-	-	-	-	-	-	-	7.3	180
WS3	1.50-2.20	SAND	-	-	-	-	-	4	82	14	-	-	-	7.4	200
WS4	3.50-4.00	SAND	-	-	-	-	-	1	73	26	-	-	-	-	-
WS5	2.20	MG	-	-	-	-	-	-	-	-	-	-	-	7.2	150
WS5	3.00-3.50	SAND	-	-	-	-	-	2	74	24	-	-	-	-	-
TP1	2.00-2.50	SAND	-	-	-	-	-	3	70	27	-	-	-	7.3	200
TP2	2.60-2.80	SAND	-	-	-	-	-	-	-	-	-	-	-	7.1	180
TP3	3.00	CLAY	22	35	15	20	17	-	-	-	-	-	-	7.2	180
TP4	3.20	CLAY	26	38	15	23	21	-	-	-	-	-	-	7.4	210
TP5	2.95	CLAY	36	36	14	22	21	-	-	-	-	-	-	7.4	210

6.2 Made Ground

Variable Made Ground was encountered in all of the exploratory hole locations between ground level and 2.90m below ground level.

SPT tests carried out in the Made Ground were corrected for drilling energy efficiency and overburden pressure and resulted in **N1(60) values** of between 4 and 53, as shown on the SPT v Depth Plot in Figure 6 (overleaf).

The **water-soluble sulphate** content of three Made Ground samples ranged between 150 mg/l and 250mg/l SO_4, with **pH values** of between 7.2 and 7.6.

Made Ground is not typically considered to be a suitable founding material, and as such, no geotechnical testing was carried out on the material.

6.3 Superficial Deposits

As discussed in Section 5, soils interpreted to represent the Devensian Till Deposits were encountered as variable SAND and CLAY in all of the exploratory hole locations.

6.3.1 Sand

Sand was encountered in exploratory hole locations CP1, WS3, WS4, WS5, TP1 and TP2 at depths between ground level and 11.50m below ground level.

The **water-soluble sulphate** content of three sand samples ranged between 180 mg/l and 200mg/l SO_4, with **pH values** of between 7.1 and 7.4.

SPT tests carried out in the sand were corrected for drilling energy efficiency and overburden pressure and resulted in **N1(60) values** of between 17 and 61, as shown on the SPT v Depth Plot in Figure 6 (overleaf).

Four **Particle Size Distribution** (PSD) tests were carried out on the sand samples. A breakdown of results can be observed in Table 5, above. The laboratory generally described the material as a brown silty SAND with rare gravel.

Recommended N values and derived design values for the granular soils are summarised in Table 6, below.

Table 6: Summary of Design Parameters (Sand)

Depth	SPT N1(60) Value Range	Average N1(60) Value	Design N1(60) Value*	Equivalent Soil Density	Angle of Internal Friction (degrees^{O})**
1.50 – 2.00	20-24	22	21	Medium Dense	33.4
3.00	23-49	32	24	Medium Dense	34.3
4.00 – 4.50	20-63	46	46	Very Dense	40.1
5.00	50-61	56	53	Very Dense	41.6
6.00	17	17	17	Medium Dense	32.2
7.50	28	28	28	Dense	35.5
9.00	53	53	53	Very Dense	41.6
10.50	52	52	52	Very Dense	41.4

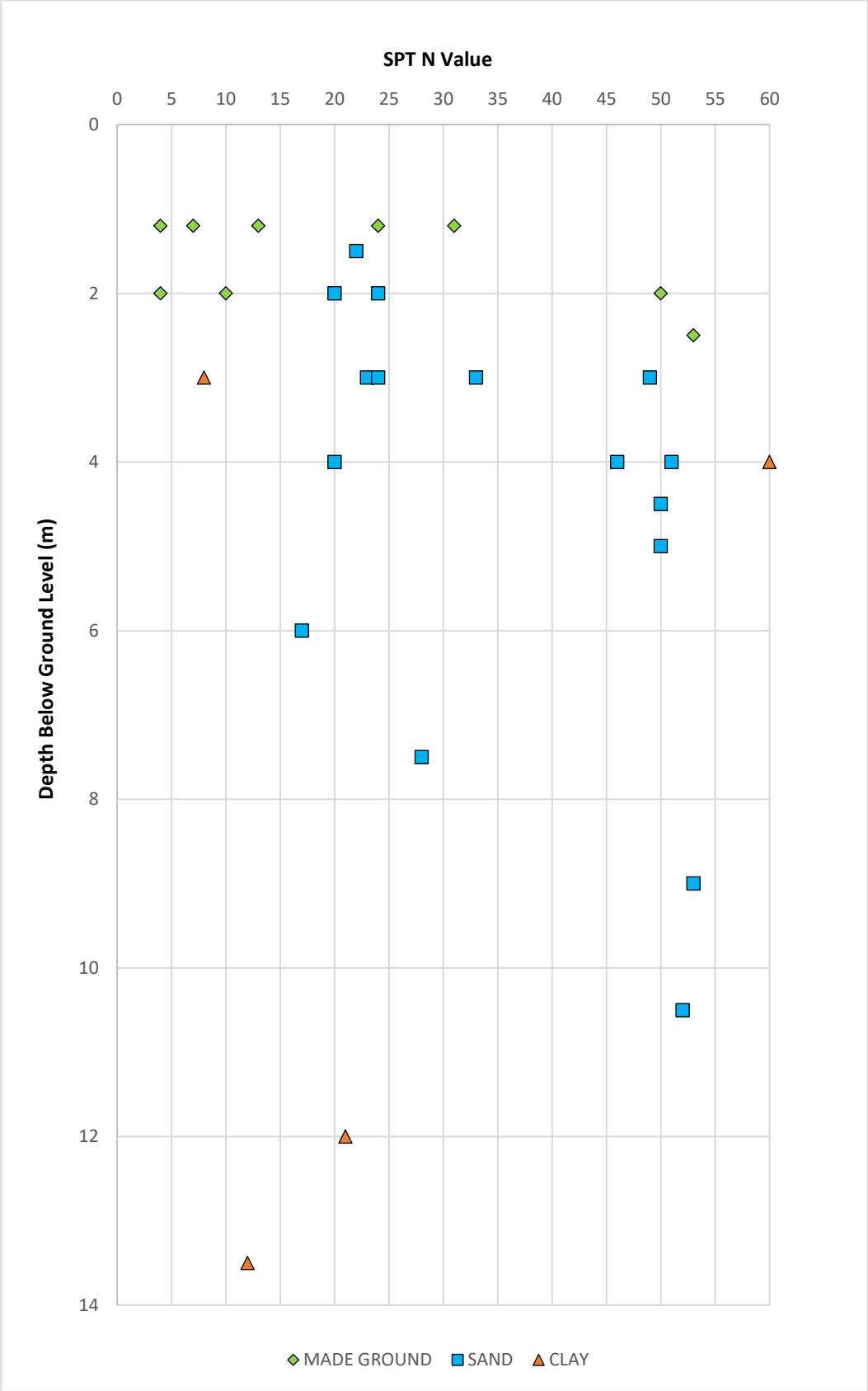
*Based on lower quartile N value
**Based on the correlation by Peck, Hanson and Thornburn (1974)

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used. For design purposes, a value of 21 seems reasonable based on the N1(60) values encountered between 1.50m to 2.00m depth.

Based on the correlation by Peck, Hanson and Thornburn (1974), this gives an **angle of shearing resistance** of ϕ=33.4 at 1.50m to 2.00m bgl.

For assessing settlements average ground conditions will give a more realistic value of settlements, and the average of N values should be used.

Figure 6: SPT v Depth Plot



6.3.2 Clay

Clay was encountered in exploratory holes CP1, WS1, WS5, TP3, TP4 and TP5 between 2.30m and 15.00m below ground level.

SPT tests carried out in the clay were corrected for drilling energy efficiency and overburden pressure and resulted in **N1(60) values** of between 8 and 60, as shown on the SPT v Depth Plot in Figure 6 (overleaf). The results suggest the clay is firm to very stiff.

In-situ **hand penetrometer** (HP) tests have given results of shear strength in the range 24kN/m^2 to 132kN/m^2, suggesting the clay is low strength to high strength at the depths tested, in accordance with Table 1.

In-situ **hand shear-vane** (HSV) tests have given results of shear strength in the range 8kN/m^2 to 175kN/m^2, suggesting the clay is extremely low strength to very high strength at the depths tested, in accordance with Table 1.

The **undrained shear strength** in triaxial compression (U100) was carried out on two samples of the clay. Results of the test showed shear strength values in the range 61kN/m^2 to 78kN/m^2 at a depth of 15.0m bgl, suggesting the clay tested is medium to high strength.

Recommended N values and derived design values for the cohesive soils are summarised in Table 7, below.

Table 7: Summary of Design Parameters (Clay)

Depth	SPT N1(60) Value Range	Average N1(60) Value	Design N1(60) Value*	Equivalent Shear Strength** (kN/m^2)	Coefficient of Volume Compressibility** (mv)
3.00	8	8	8	41 (Medium Strength)	0.24
12.00	21	21	21	108 (High Strength)	0.09
13.50	12	12	12	62 (Medium Strength)	0.16

*Based on lower quartile N value and correlations by Peck Hanson and Thornburn (1974)
**Based on correlation by Stroud & Butler (1975)

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used. Based on the N Values in the above table, the equivalent shear strength values range between 41kN/m^2 and 108kN/m^2, suggesting the clay is medium strength to high strength at the depths tested, in accordance with Table 1.

Atterberg Limit tests were carried out on five samples of the clay. Results of the tests reported **liquid limit** values in the range 30% to 38% and **plastic limit** values in the range 14% to 15%, resulting in values of **plasticity index** in the range 16% to 23%. These results suggest the samples of clay tested are of **intermediate to low plasticity** as shown on the Plasticity Chart in Figure 7, overleaf.

For design purposes, a value of plasticity index = 22% is recommended, based on the upper quartile of the results.

The **coefficient of volume compressibility (mv)** has been estimated using the following correlation by Stroud and Butler (1975): for a clay with a plasticity index of 22%, mv = 1 / (0.515 x N value).

This correlation gives values of the coefficient of volume compressibility of between 0.09m^2/MN and 0.24m^2/MN, as shown in Table 7, above. The results suggest the clay has **very low to medium compressibility**.

In accordance with NHBC Chapter 4.2 Building Near Trees (2003) soils can be classified in terms of volume change potential, using the relationship:

$$I_{p'} = I_p \times \frac{\text{\% less than 425µm}}{100\%}$$

$I_{p'}$ = modified plasticity index,
I_p = plasticity index.

Based on the laboratory test results, the above relationship and Table 1 of NHBC Chapter 4.2, the samples of Clay are shown to have a **low to medium volume change potential**.

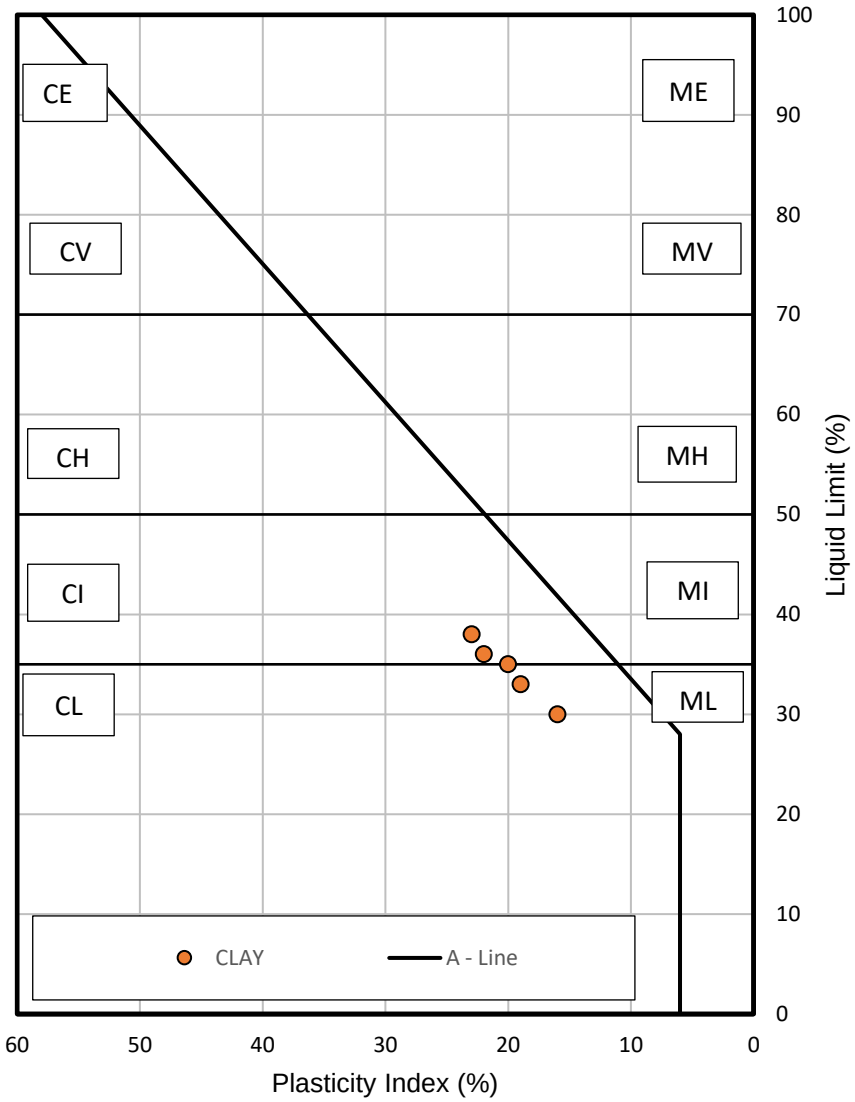
The **Natural Moisture Content** (NMC) and **Liquid Limit** (LL) of the soil can be used to give an indication of **soil desiccation**, i.e., where the NMC is less than 40% of the LL, the soil is inferred to be desiccated, as summarised in Table 8, below.

Table 8: Soil Desiccation Indicators in the Clay

Location	Depth (m)	Liquid Limit (%)	40% Liquid Limit (%)	Natural Moisture Content (%)	Desiccation
CP1	15.00	30	12	17	**No**
WS1	3.70	33	13	19	**No**
TP3	3.00	35	14	22	**No**
TP4	3.20	38	15	26	**No**
TP5	2.95	36	14	36	**No**

The results in the above table show that the samples tested show no evidence of desiccation.

Figure 7: Plasticity Chart



7.0 GEOTECHNICAL ASSESSMENT

7.1 Proposed Development

It is understood that the client wishes to demolish the existing buildings on site and construct a combination of approximately 16 houses with private gardens and 3 apartment blocks, all with parking and soft landscaping. Site access will be retained via Louisa Street to the east of the site, via a new access road.

Detailed information regarding structural loadings and proposed foundation type was not available, however, we anticipate the loadings of the houses to be similar to those of a typical two-storey house (up to 75kN/m^2).

7.2 Ground Conditions Encountered

The exploratory holes generally encountered Made Ground to a maximum depth of 2.90m. Underlying the Made Ground in all exploratory boreholes were superficial deposits of variable Clay and Sand to a maximum depth of 15.00m bgl.

Groundwater was encountered in WS3 at 4.00m bgl and WS4 at 3.50m bgl during the fieldwork and encountered during subsequent monitoring visits.

7.3 Foundation Considerations

Based on the ground conditions encountered, conventional shallow strip/pad foundations are considered suitable for the houses included in the proposed development, bearing into the superficial deposits, providing the anticipated structural loadings are relatively low and subject to tolerance of structure to settlement. Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered, such as ground improvement and piles.

The shallow strip/pad foundations are discussed below in 7.3.1.

Conventional shallow strip/pad foundations are not considered suitable for the apartment buildings included in the proposed development. Depending on the structural loadings, alternative foundations options may need to be considered, such as ground improvement and piles.

Further foundation options are discussed overleaf in 7.3.2 and 7.3.3.

7.3.1 *Conventional Shallow Depth Strip/Pad Foundations*

Strip/Pad foundations should be taken down below any Made Ground and placed in the superficial deposits beneath at a minimum depth of 1.50m. If any Made Ground, particularly loose or soft material, is encountered at foundation level this should be excavated and replaced with suitable granular fill or the foundation extended at least 150mm into suitable natural strata.

Foundations should be placed in materials of similar bearing and consolidation characteristics to avoid potential differential settlement occurring. Should foundations cross from cohesive to granular soils, nominal reinforcement should be incorporated to avoid the effects of differential settlement.

Table 9 below summarises anticipated allowable bearing pressures for strip/pad foundations placed in the superficial deposits. The bearing capacities are calculated based on Hansen's (1978) method and assuming a factor of safety against bearing capacity failure of 3. For the purpose of the calculation, groundwater has been assumed to be at 6.00m bgl.

Due to the limited amount of clay encountered at foundation depth, the design value for clay at 3.00m bgl has been used for foundation calculations at 2.50m depth.

Table 9: Summary of Allowable Bearing Pressures

Foundation Strata	Design Value (Section 6)	Foundation Depth (m bgl)	Foundation Type	Foundation Size (m)	Allowable Bearing Pressure (kN/m²)
SAND	ϕ = 33.4°	1.5	Strip	0.4	385
				0.9	408
			Pad	1.0 x 1.0	594
				2.0 x 2.0	605
	ϕ = 33.4°	2.0	Strip	0.4	508
				0.9	530
			Pad	1.0 x 1.0	795
				2.0 x 2.0	793
	ϕ = 33.4°	2.5	Strip	0.4	631
				0.9	652
			Pad	1.0 x 1.0	997
				2.0 x 2.0	979
CLAY	c_u=41kN/m²	2.5	Strip	0.4	125
				0.9	120
			Pad	1.0 x 1.0	139
				2.0 x 2.0	129

Table 10 below summarises anticipated settlements of the above foundations in sand based on design values discussed in Section 6. The foundation loading assumed as equal to 75kN/m².

Table 10: Summary of Anticipated Settlement (Granular)

Foundation Depth (m bgl)	Foundation Strata	Foundation Type	Foundation Size (m)	Pad Foundation Loading (kN/m²)	Settlement* (mm)		
					Lower Limit	Upper Limit	**Best Estimate**
1.5	SAND	Strip	0.4	75	<5	<5	**<5**
			0.9	75	<5	5-10	**<5**
		Pad	1.0 x 1.0	75	<5	<5	**<5**
			2.0 x 2.0	75	<5	5-10	**<5**
2.0		Strip	0.4	75	<5	<5	**<5**
			0.9	75	<5	5-10	**<5**
		Pad	1.0 x 1.0	75	<5	<5	**<5**
			2.0 x 2.0	75	<5	5-10	**<5**
2.5		Strip	0.4	75	<5	<5	**<5**
			0.9	75	<5	5-10	**<5**
		Pad	1.0 x 1.0	75	<5	<5	**<5**
			2.0 x 2.0	75	<5	5-10	**<5**
*Immediate settlement							

Table 11 below summarises anticipated settlements of the above foundations in clay based on design values discussed in Section 6. Settlement in cohesive soils typically comprises a small amount of immediate settlement as loads are applied and a larger proportion of consolidation

settlement, which will occur over a longer period of time. For the purposes of the calculations, the strata over the depth of influence of the foundation is assumed as the same type and the foundation loading assumed as equal to 75kN/m^2.

Table 11: Summary of Anticipated Settlement (Cohesive)

Foundation Depth (m bgl)	Foundation Strata	Foundation Type	Foundation Size (m)	Pad Foundation Loading (kN/m^2)	Settlement (mm)		
					At Centre	At Corner	Average
2.5	CLAY	Strip	0.4	75	-	-	**<5**
			0.9	75	-	-	**<5**
		Pad	1.0 x 1.0	75	5-10	<5	**5-10**
			2.0 x 2.0	75	5-10	<5	**5-10**

Floor slabs should be designed as suspended if Made Ground of 600mm thickness or greater is present. Made Ground is not considered an appropriate bearing stratum due to its variable nature. Floor slabs may be designed as ground bearing where Made Ground is excavated and replaced with suitable granular fill.

The presence of trees within site boundaries indicates that foundations could be within their influence zone. In order to avoid possible excessive settlement due to water removal by trees during dry periods or ground heave due to tree removal, the recommendations of the National House Building Council Practice Standard “Building Near Trees”, should be closely followed. In this context clays near surface should be considered as having a low to medium volume change potential.

All foundation excavations should be inspected by a suitable qualified engineer to prove that the founding strata is suitable and uniform along the length of the foundation, and capable of taking the anticipated structural loadings. If foundations cross from granular to cohesive soils, nominal reinforcement should be incorporated.

7.3.2 *Ground Improvement*

Ground treatment (e.g., vibro displacement) may be an option, subject to environmental and noise/vibration constraints.

For example, vibro stone columns are often used to solve a wide range of static, dynamic, and seismic foundation problems by using powerful depth vibrators to densify soils of form stone columns that compact or reinforce soils in situ. Vibro systems can be used to treat granular deposits, fills, made ground and soft clays/silts.

Soils treated by vibro could offer an allowable bearing pressure in the range 100kN/m^2 to 200kN/m^2, depending on column spacings and ground encountered.

Once the treatment has been carried out, spread foundations may be adopted across the site, and designed to the loadings given above. Providing that any imported fill material between the tops of the columns and the underside of the floor slab is placed in a controlled manner, floor slabs may be ground bearing. Positive assurances should be sought from an experienced specialist contractor that the proprietary system proposed can provide the required working loads in the ground conditions encountered, with a guarantee on maximum settlement for both footings and floor slabs.

7.3.3 *Piled Foundations*

In areas of deep made ground or unfavourable bearing capacities, foundation loading may be transferred via piles taken down to depth to a suitable founding stratum.

A variety of pile types may be used, including bored and continuous flight auger (CFA) piles. Driven piles may be suitable, subject to environmental and noise/vibration constraints.

Because of the various advantages and limitations of each pile type, and the cost implications, advice should be sought from specialist piling contractors to determine the most suitable and cost-effective type. They should also be able to give recommended pile diameters and depths and likely pile capacities, with guaranteed performance. It is recommended a pile test be carried out to confirm pile capacities. In assessing the pile capacities, contractors should make an allowance for the effects of negative skin friction, particularly in the made ground and soft clays.

There may be differential settlement between piled structures and the surrounding ground level. Provision should, therefore, be made to make up ground levels at threshold positions, loading bays, vehicle access doorways, etc. Alternatively, these materials should be removed and replaced in a controlled manner by suitable existing materials or imported engineered fill.

It is essential the advice of a specialist piling contractor is sought and that positive assurances are provided by the piling contractor that their proprietary system can provide the required working loads in the ground conditions encountered.

7.4 Pavement Design

The ground investigation identified the soil type at the subgrade level to typically be Made Ground.

A conservative design CBR value of 1% should be adopted in areas where Made Ground is encountered at subgrade level, where encountered.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable made ground. In this context a flexible pavement design may be required.

Consideration should also be given to the use of geotextiles to allow reduction of capping thickness. For examples biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce capping thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site. For guidance, the following table gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

Table 12: Comparison of Capping Thickness with and without Geotextile

CBR	Unreinforced			Reinforced with Tensar Geogrid				
	Sub-base	Capping	Total	Sub-base	Capping	No. of grids	Total	Thickness saving
0.5%	Design not suitable			200mm	400mm	2	600mm	-
1.0%	150mm	600mm	750mm	400mm	0	1	400mm	350mm
1.5%	150mm	600mm	750mm	310mm	0	1	310mm	440mm
2.0%	150mm	600mm	750mm	260mm	0	1	260mm	490mm
3.0%	150mm	350mm	500mm	210mm	0	1	210mm	290mm
4.0%	150mm	300mm	450mm	175mm	0	1	175mm	275mm
5.0%	150mm	250mm	400mm	160mm	0	1	160mm	240mm
These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements, the advice of specialist contractor should be sought.								

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

7.5 Chemical Attack on Buried Concrete

Chemical tests (see Appendices) show low levels of water-soluble sulphates and near neutral conditions. Based on these conditions, it is recommended that for concrete placed in natural strata the Design Sulphate Class for the site, as defined in BRE Special Digest 1[(2005)], be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s. The recommendations of BRE Special Digest 1 should be followed for concrete foundations and ground bearing floor slabs.

7.6 Suitability of Excavated Materials

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer once these have been prepared by the relevant parties.

Granular Made Ground and natural sand could be suitable for re-use as structural fill, providing it is not contaminated and does not contain excessive amounts of clay and providing moisture contents are controlled during placement. The control of moisture contents will be important as the cohesive content of this stratum is likely to be sensitive to moisture content changes.

7.7 Temporary Works

Formations will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations in Made Ground are likely to be unstable and should be battered back to an angle of 1 in 2, or a system of close sheeting and shoring adopted to ensure stability, and in particular where personnel are required to enter excavations. All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered near surface within excavations, particularly during the wetter months of the year. Pumping of excavations from a suitable located sump is likely to be required to keep excavations dry.

All natural materials on site should be capable of being excavated using conventional excavating machinery.

8.0 SOIL CONTAMINATION RISK ASSESSMENT

8.1 Tier I Human Health Soil Risk Assessment – Groundworkers During Development

To assess the risk of soil contamination to construction and ground workers during development, guidelines from the HSE Document 'Protection of workers and the general public during development of contaminated land' (1991) are used. The document assesses soil contamination test results and classifies the site as being uncontaminated or contaminated with varying degrees of contamination from 'slight' to 'unusually heavy'. The guideline values and laboratory test results are summarised in the following table:

Table 13: Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land

Contaminant	Typical Values* for:					Test Results	Class
	Uncontaminated Soils	Slight Contamination	Contaminated	Heavy Contamination	Unusually Heavy Contamination		
	Class A	Class B	Class C	Class D	Class E		
pH (acid)	6 - 7	5 - 6	4 - 5	2 - 4	<2	5	B
pH (alkaline)	7 - 8	8 - 9	9 - 10	10 - 12	12	7.5 – 9.2	A - C
Arsenic	0 - 30	30 - 50	50 - 100	100 - 500	500	6 - 32	A - B
Cadmium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 0.2	A
Chromium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	8 – 51	A
Copper	0 - 100	100 - 200	200 - 500	500 - 2500	2500	15 – 457	A - C
Lead	0 - 500	500 - 1000	1000 - 2000	2000 – 1%	1.0%	21 – 160	A
Mercury	0 - 1	1 - 3	3 - 10	10 - 50	50	< 1	A
Nickel	0 - 20	20 - 50	50 - 200	200 - 1000	1000	5 – 42	A - B
Zinc	0 - 250	250 - 500	500 - 1000	1000 - 5000	5000	27 – 136	A
Boron	0 - 2	2 - 5	5 - 50	50 - 250	250	< 1	A
Selenium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 3	A
Barium	0-500	500-1000	1000-2000	2000-1.0%	1.0%	43 – 478	A
Beryllium	0 - 5	5 - 10	10 - 20	20 - 50	50	< 0.5 – 3.8	A
Vanadium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	17 – 84	A
Sulphate	0 - 2000	2000 - 5000	5000 – 1%	1% - 5%	5.05%	525 – 5412	A - C
Sulphide	0 - 10	10 - 20	20 - 100	100 - 500	500	< 5	A
Cyanide (free)	0 - 1	1 - 5	5 - 50	50 - 100	100	< 2	A
Phenol	0 - 2	2 - 5	5 - 50	50 - 250	250	< 2	A

Based on the above results, the soils are ranging from contaminated to uncontaminated. A contaminated concentration of pH (alkaline), copper and sulphate were observed. A slightly contaminated concentration of pH (acid), arsenic and nickel were also observed. The remaining values are present in uncontaminated concentrations.

Therefore, there is a **MODERATE to LOW** potential risk from soil contamination to construction workers, ground workers and members of the public during construction. Appropriate measures, such as PPE, site health plans, and appropriate disposal of material arisings will further mitigate this risk.

8.2 Tier I Human Health Soil Risk Assessment – Future Site Users

The following section provides a Human Health Soil Assessment for future site users. Based on the proposed development type, the following section compares the results of contamination analyses to residential types of end development as specified by Defra/LQM/CIEH. As part of

the contamination assessment, the chemical results obtained by EEG have been screened against accepted compliance criteria, namely:

- Defra C4SL Health Criteria Values (March 2014), where available; and
- Tier 1 assessment values - based on LQM/CIEH Suitable 4 Use Levels (2015) (S4ULs).

The soil chemical testing results are summarised in Table 14, below.

Table 14: Soil Results Comparison with C4SL/S4UL Values

Parameter	C4SL/S4UL Levels Residential with Plant Uptake (mg/kg)	WS1 0.30m	WS2 0.50m	WS3 1.00m	WS4 1.20m	WS5 0.65m	TP1 0.40m	TP2 0.25m	TP3 0.90m	TP4 0.70m	TP5 0.45m	No of Exceedances
		MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	
Metals												
Arsenic	37	32	20	10	7	29	27	11	16	15	6	0
Boron	290	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Cadmium	22	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0
Chromium	910	51	26	15	18	16	17	27	13	18	8	0
Chromium VI	21	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Copper	2400	83	70	38	17	398	457	37	27	34	15	0
Lead	200	120	160	110	21	101	126	24	44	110	42	0
Mercury	1.2	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	42	24	10	12	27	33	39	12	16	5	0
Selenium	250	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Vanadium	410	84	31	36	23	63	54	30	37	41	17	0
Zinc	3700	134	136	48	45	46	71	45	27	32	28	0
Petroleum Hydrocarbons												
Benzene	0.087	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Toluene	130	0.016	< 0.005	0.010	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0
Ethylbenzene	47	0.008	< 0.002	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
o-xylenes	60	0.008	< 0.002	0.021	< 0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
m-xylenes	59	0.013	< 0.002	0.021	< 0.002	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
p-xylenes	56	0.013	< 0.002	0.021	< 0.002	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Aliphatic EC >5-6	42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aliphatic EC >6-8	100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aliphatic EC >8-10	27	< 2	< 2	< 2	< 2	< 2	11	< 2	< 2	< 2	< 2	0
Aliphatic EC >10-12	130	< 2	< 2	< 2	< 2	< 2	34	< 2	< 2	< 2	< 2	0
Aliphatic EC >12-16	1100	8	< 3	< 3	< 3	< 3	140	< 3	< 3	< 3	< 3	0
Aliphatic EC >16-21	65000	29	< 3	< 3	< 3	7	136	< 3	< 3	< 3	< 3	0
Aliphatic EC >21-35	65000	263	< 10	< 10	< 10	15	31	< 10	< 10	< 10	< 10	0
Aromatic EC >5-7	70	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aromatic EC >7-8	130	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aromatic EC >8-10	34	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >10-12	74	8	< 2	< 2	< 2	3	12	< 2	< 2	< 2	< 2	0
Aromatic EC >12-16	140	36	< 2	5	< 2	26	96	< 2	< 2	< 2	< 2	0
Aromatic EC >16-21	260	116	14	21	< 3	69	**577**	< 3	9	< 3	< 3	**1**
Aromatic EC >21-35	1100	331	< 10	14	< 10	97	580	< 10	< 10	< 10	< 10	0

Parameter	C4SL/S4UL Levels Residential (mg/kg)	WS1 0.30m	WS2 0.50m	WS3 1.00m	WS4 1.20m	WS5 0.65m	TP1 0.40m	TP2 0.25m	TP3 0.90m	TP4 0.70m	TP5 0.45m	No of Exceedances
		MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	
Polycyclic Aromatic Hydrocarbons												
Naphthalene	2.3	**3.48**	< 0.1	0.36	< 0.1	1	1.72	< 0.1	0.4	< 0.1	< 0.1	**1**
Acenaphthylene	210	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.27	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	170	2.54	0.21	0.31	< 0.1	0.9	1.21	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluorene	170	1.9	0.15	0.25	< 0.1	0.59	1	< 0.1	0.2	< 0.1	< 0.1	0
Phenanthrene	95	11.5	1.52	2.4	< 0.1	5.39	37.6	< 0.1	1.53	0.3	< 0.1	0
Anthracene	2400	4.36	0.37	0.49	< 0.1	1.45	7.22	< 0.1	0.5	< 0.1	< 0.1	0
Fluoranthene	280	10.6	1.91	3.12	< 0.1	6.99	86.7	< 0.1	1.37	0.43	< 0.1	0
Pyrene	620	9.62	1.86	3.26	< 0.1	6.18	91.9	< 0.1	1.3	0.44	< 0.1	0
Benzo(a)anthracene	7.2	3.91	0.66	1.46	< 0.1	3	**51.6**	< 0.1	0.98	0.22	< 0.1	**1**
Chrysene	15	3.91	0.79	1.64	< 0.1	3.38	**46.9**	< 0.1	1.06	0.3	< 0.1	**1**
Benzo(a)pyrene	5	3.58	0.52	1.36	< 0.1	3.01	**44.2**	< 0.1	1.3	0.25	< 0.1	**1**
Benzo(b)fluoranthene	2.6	**4.03**	0.61	1.53	< 0.1	**3.52**	**52.2**	< 0.1	1.08	0.25	< 0.1	**3**
Benzo(k)fluoranthene	77	1.48	0.26	0.61	< 0.1	1.37	8.45	< 0.1	0.53	0.12	< 0.1	0
Indeno(1,2,3-cd) pyrene	27	1.88	0.27	0.77	< 0.1	1.8	23.7	< 0.1	0.65	0.14	< 0.1	0
Dibenz (a, h) anthracene	0.24	**0.39**	< 0.1	0.23	< 0.1	**0.38**	**4.38**	< 0.1	0.18	< 0.1	< 0.1	**3**
Benzo(ghi)perylene	320	1.64	0.26	0.67	< 0.1	1.6	22.6	< 0.1	0.52	0.14	< 0.1	0
Phenols												
Phenol	280	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	0
Concentrations in **red** are above the assessment criteria based on Residential End Use with Plant Uptake.												

Based on the above tables, eleven contaminant concentrations were found in exceedance of the screening criteria relevant to a Residential End Use.

The samples with identified contaminant exceedances include WS1 at 0.30m, WS5 at 0.65m, and TP1 at 0.40m.

The locations of these exceedances can be observed in Figure 8 overleaf.

The contaminants found in exceedance of the screening criteria relevant to a Residential End Use with Plant Uptake include Petroleum Hydrocarbon Aromatic EC >16-21 and several Polycyclic Aromatic Hydrocarbons: Benzo(a)anthracene, Chrysene, Benzo(a)pyrene, Benzo(b)fluoranthene and Dibenz (a, h) anthracene.

Elevated Naphthalene, which is volatile, has also been identified at WS1 (0.30m).

Asbestos was identified in two of the samples tested, see Table 15 below.

Table 15: Summary of Asbestos Encountered

Location	Depth (m bgl)	Asbestos Type	Sample Matrix	Quantification
WS1	0.30	Chrysotile	Loose Fibres	<0.001%
WS2	0.50	Chrysotile	Loose Fibres	0.001%

Figure 8: Chemical Exceedance Location Plan

8.3 Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of June 2018, "Guidance on the classification and assessment of waste" has been carried out on soils recovered from the site, using HazWasteOnline.

The results are summarised in Table 16 below and presented in full in Appendix 6.

Table 16: Waste Classification of Soils

Location	Depth (m bgl)	WM3.1 Classification	Comments
WS1	0.30	Non-Hazardous	-
WS2	0.50	Non-Hazardous	-
WS3	1.00	Non-Hazardous	-
WS4	1.20	Non-Hazardous	-
WS5	0.65	Non-Hazardous	-
TP1	0.40	Hazardous	Elevated TPH
TP2	0.25	Non-Hazardous	-
TP3	0.90	Non-Hazardous	-
TP4	0.70	Non-Hazardous	-
TP5	0.45	Non-Hazardous	-

Table 16 above shows that the ten soil samples collected from the window sample boreholes were classified as **Non-Hazardous** in accordance with WM3.1.

Further Waste Acceptance Criteria (WAC) testing may prove that this material is acceptable as inert waste.

Table 16 also identifies the sample taken from TP1 at 0.40m was classified as **Hazardous** in accordance with WM3.1, due to elevated TPH, and soils recovered from this area need to be disposed of at the correct facility.

Asbestos can affect the waste classification of soil, if the concentration is greater than 0.1%, the soil will automatically be classified as Hazardous waste. As asbestos quantification of the sample taken from WS1 at 0.30m revealed a value of <0.001% and the sample from WS2 at 0.50m revealed a value of 0.001%, this does not affect the Waste Classification as stated above.

9.0 GROUNDWATER CONTAMINATION RISK ASSESSMENT

In the absence of specific UK guidelines regarding groundwater quality in the UK, chemical results obtained by EEG have been compared with the following statutory and non-statutory standards:

- Environmental Quality Standards (EQS); and
- UK Drinking Water standards [(2000)].

Many of the EQS values lie just above the method detection limit for parameters and as such, are extremely conservative. In the absence of EQS values, Drinking Water Standards have been used for comparison of results. Again, these standards are highly conservative, especially in this site context.

A direct comparison was made between the groundwater analyses results and the EQS and Drinking Water Standards, and the results are summarised in Table 17, overleaf.

From the below table there are no contaminant exceedances in the groundwater samples taken on 16th May 2022.

Given the environmental setting of the site, and no exceedances, the risk to groundwater from contamination is considered low.

Further detail on the water chemical testing results can be found in Appendix 5.

Table 17: Groundwater Results Comparisons with EQS/Drinking Water Quality Values

Determinand	EQS Value (1)	Drinking Water Quality (DWQ) Value (2)	WS1	WS4	No. of Exceedances
Arsenic	50	10	< 5	< 5	0
Cadmium	0.9	5	< 0.4	< 0.4	0
Chromium	50	-	< 5	< 5	0
Copper	10	2000	< 5	< 5	0
Lead	1.2 - 14	10	< 5	< 5	0
Mercury	0.07	1.0	< 0.05	< 0.05	0
Selenium	-	10	< 5	< 5	0
Nickel	50 - 200	20	7	< 5	0
Zinc	75	-	8	< 2	0
Cyanide	-	50	< 5	< 5	0
Phenol	7.7 - 46	-	< 10	< 10	0
Sulphate	400000	250000	112	24	0
pH	6 - 9	-	7.0	6.8	0
Naphthalene	10	-	0.03	0.02	0
Anthracene	0.1	-	< 0.01	< 0.01	0
Benzo(a)pyrene	0.27	0.01	< 0.01	< 0.01	0
Benzo(b)fluoranthene	0.017	0.10	< 0.01	< 0.01	0
Benzo(k)fluoranthene	0.017	-	< 0.01	< 0.01	0
Indeno(123cd) pyrene	-	0.10	< 0.01	< 0.01	0
Fluoranthene	0.12	-	0.03	0.02	0
Benzene	10 - 50	1	< 1	< 1	0
Toluene	50 - 380	-	< 5	< 5	0
Ethylbenzene	20 - 200	300 (WHO)	< 5	< 5	0
Xylenes	30	-	< 25	< 25	0
Total Petroleum Hydrocarbons Aro C6-C8	-	10	< 10	< 10	0
Total Petroleum Hydrocarbons Aro C8-C10	-	700	< 10	< 10	0
Total Petroleum Hydrocarbons Aro C10-C12	-	300	< 10	< 10	0
Total Petroleum Hydrocarbons Aro C12-C16	-	90	< 10	< 10	0
Total Petroleum Hydrocarbons Aro C16-C21	-	90	< 10	< 10	0
Total Petroleum Hydrocarbons Aro C21-C35	-	90	< 10	< 10	0
Total Petroleum Hydrocarbons Ali C6-C8	-	15000	< 10	< 10	0
Total Petroleum Hydrocarbons Ali C8-C10	-	15000	< 10	< 10	0
Total Petroleum Hydrocarbons Ali C10-C12	-	300	< 10	< 10	0
Total Petroleum Hydrocarbons Ali C12-C16	-	300	< 10	< 10	0

10.0 GROUND GAS AND RADON GAS CONTAMINATION RISK ASSESSMENT

10.1 Radon Gas

The site is not located within a Radon Affected Area as defined by the Health Protection Agency, and therefore radon protection measures are not necessary.

10.2 Analyses of Monitoring Results

The potential risk associated with gases being generated in the ground (whether from natural or man-made sources) depends on the concentrations of gas and its flow rate to the surface. These factors are assessed by monitoring of the gas installations in the boreholes. The variable nature of gas generation and the effect of barometric pressure on gas flow, means that the volume of gas potentially reaching the ground surface is normally inconsistent over time.

A total of six gas monitoring visits have been completed by Earth Environmental & Geotechnical Ltd. The monitoring visits were carried out between the 16th May and 20th June 2022. The results recorded methane (CH_4) levels of 0.0% (v/v) and carbon dioxide (CO_2) levels of 0.1% to 6.6% v/v. Oxygen concentrations of between 12.4% to 21.3% v/v were also recorded.

Regarding flow rates, for the purposes of the ground gas risk assessment BS8485 2015+A1 2019 states that *'steady state flow rates, rather than brief peak values on opening, should be used in screening risk assessment if these are representative of the conceptual site model'*.

Gas flow rates were recorded between -0.2l/hr to 0.1l/hr and a maximum flow rate of 0.1l/hr has been adopted for the below calculations. Atmospheric pressure was recorded to be between 993mb and 1016mb.

Full results of the monitoring are presented in Appendix 2.

Table 18 overleaf, adapted from CIRIA C665 "Assessing risks posed by hazardous ground gases to buildings", shows a summary of the current UK practice with respect to appropriate gas protection measures based upon a Gas Screening Value (GSV).

A GSV for the site has been obtained by multiplying the maximum concentration of gas by the steady flow rate of 0.1l/h adopted for assessment purposes.

- Carbon dioxide: steady flow rate = 0.1l/hr, max concentration = 6.6%
- Methane: steady flow rate = 0.1l/hr, max concentration = 0.0%.

Based on the above figures, the GSV is calculated as:

- **Carbon dioxide**: GSV = 0.1 x 5.1 / 100 = **0.0066 litres/hr**
- **Methane**: GSV = 0.1 x 0.0 / 100 = **0.0000 litres/hr**

Table 18: Characteristic Situations (Wilson et al 2006/2007 modified from Wilson and Card, 1999)

Characteristic Situation (CS)	*Risk Classification*	*Gas Screening Value CH_4 or CO_2 (l/hr)*	*Additional Factors*	*Typical source of generation*
1	Very Low	<0.07	Typically, < 1% methane Typically, < 5% carbon dioxide	Typical made ground
2	Low	<0.7	Borehole air flow rate to not exceed 70l/hr otherwise consider increase to Characteristic Situation 3	Typical made ground
3	Moderate	<3.5		Old landfill, inert waste, flooded mineworkings
4	Moderate to High	<15	Quantitative risk assessment	Mineworkings susceptible to flooding, completed landfill
5	High	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very High	>70		Recent landfill site

The CIRIA guidance document notes that '...the GSV is a guideline value and not an absolute threshold'.

The above results suggest the site can be given a Characteristic Situation 1, i.e., 'very low risk', in accordance with Table 18, above.

Protection Measures

Based on the foregoing preliminary assessment, ground gas protection measures are not considered necessary at the site in accordance with BS8485:2015 + A1 2019.

Table 19: Gas Protection Point Score Required (BS8485:2015 + A1 2019)

Characteristic Situation	Minimum gas protection score (points)			
	High Sensitivity		Medium	Low
	Type A building (private housing)	Type B building (multiple occupancy private or commercial)	Type C building (single occupancy commercial)	Type D building (large industrial)
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4.0	3.0	2.5
4	6.5	5.5	4.5	3.5

The proposed development is for a Type A and Type B buildings (private housing and multiple occupancy private or commercial), both a high sensitivity risk.

11.0 CONCLUSIONS & RECOMMENDATIONS

11.1 Soil Contamination

There is a **low to moderate** potential risk from soil contamination to construction workers and ground workers during development, and appropriate measures such as PPE, site health plans, appropriate disposal of material arisings will be required to mitigate this risk. The groundworks contractor must provide a soil management plan including methods of dealing with unanticipated soil contamination encountered during groundworks.

Based on the results of the chemical testing, eleven exceedances in contaminants were observed in the soil samples analysed, including Naphthalene in WS1 at 0.30m. Therefore, there is a **moderate** potential risk from soil contamination to residential end users.

The naphthalene hotspot should be further delineated.

To break potential pollutant linkages to future residential end users, it is recommended that landscaped areas should be capped with imported clean cover soils.

The exceedances in contamination found across the site should be further delineated and any impacted material removed offsite.

A Remediation Strategy is recommended to specify the design of the capping system and any following validation work.

11.2 Asbestos

Asbestos was identified in two of the samples tested with quantifications of 0.001% and <0.001%.

11.3 Foundations

Shallow strip/pad foundation placed in the superficial deposits at a minimum depth of approximately 1.50m bgl are considered appropriate for the houses included in the proposed development plan.

Within areas of deep made ground (WS1, WS2) foundation loadings will need to be transferred to deeper strata by use of piles or vibro-stone columns.

11.4 Soil Disposal

Soils should be disposed of at a suitable site, registered to take the levels of contamination encountered. The soils collected from nine borehole locations have been classified as Non-Hazardous for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

However, due to the elevated TPH observed in TP1 at 0.40m, this sample is classified as **Hazardous** waste.

11.5 Land Gas

Based on results of the gas monitoring, the risk of ground gas is negligible to very low and protection against the ingress of ground gas will not be required at the site.

11.6 Pavement Design

Based on the findings of the site investigation, the soil type at subgrade level was typically Made Ground. Based on the recommendations for design CBR values provided in Interim advice note 73/06, Revision 1 (2009), a conservative design CBR value of 1% should be adopted in areas where Made Ground is encountered at subgrade level, where encountered.

11.7 Groundwater

Groundwater was encountered in WS3 at 4.00m bgl and WS4 at 3.50m bgl during the fieldwork.

Ground water was also encountered during subsequent monitoring visits at depths between 2.68m bgl and 3.60m bgl.

Chemical testing was carried out on two groundwater samples and no exceedances in contaminants were observed.

11.8 Risk to Buried (Water) Services

It is considered that, due to the presence of hydrocarbon contamination in TP1, non-standard materials may be required for new water pipes. Further advice should be sought from the local water company.

Previous guidance on buried water pipes was contained in Water Regulations Advisory Scheme (WRAS) Guidance Note No. 9-04-03(2002), however this has been superseded by the UK Water Industry Research Report 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' Ref 10/WM/03/21 (January 2011).

11.9 Site Personnel

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on-site washing facilities should be available.

11.10 Other Matters

Due diligence is required during the construction period, and should any further evidence of contamination be found, appropriate investigation and / or action should be taken. The significance of any contamination not discovered by this investigation is outside the scope of this report.

APPENDIX 1

EXPLORATORY HOLE LOGS

APPENDIX 2

GROUND GAS MONITORING RESULTS

APPENDIX 3

GEOTECHNICAL TESTING RESULTS

APPENDIX 4

CHEMICAL TESTING RESULTS

APPENDIX 5

WATER CHEMICAL TESTING RESULTS

APPENDIX 6

SOIL WASTE ASSESSMENT

APPENDIX 7

REPORT LIMITATIONS

REPORT LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd on the basis of a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget, and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd provides no other representation or warranty whether express or implied, is made in relation to the services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of Earth Environmental & Geotechnical Ltd.

If a third party relies on this report, it does so wholly at its own and sole risk and Earth Environmental & Geotechnical Ltd disclaims any liability to such parties.

It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important factor in determining the scope and level of the services. Should the purpose for which the report is used, or the proposed use of the site change, this report will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2022 and should be read in light of any subsequent changes in legislation, statutory requirements, and industry best practices. Ground conditions can also change over time and further investigations, or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further Earth Environmental & Geotechnical Ltd was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the services. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.

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OUR REF: A4755/23 3rd October 2023
YOUR REF:

Mr. Paul Sinclair
Westchurch Homes
Kennedy House
31 Stamford Street
Altringham
WA14 1ES

By Email (paul.sinclair@westchurchhomes.co.uk)

Dear Paul,

Chemical Testing Letter Report
Louisa Street, Openshaw

Background

A follow up site investigation has been commissioned by to undertake soil sampling around areas of previously detected soil contamination.

The following report has previously been prepared for the site by Earth Environmental & Geotechnical Ltd and should be read in conjunction with this letter report:

- Earth Environmental & Geotechnical Ltd, Phase II Geo-Environmental Investigation Report (Reference: A4755/22/SI, June 2022).

Reference

Earth Environmental & Geotechnical Ltd were commissioned by the client, in accordance with proposal A4755/23 9th June 2023, to undertake a secondary environmental investigation of the site with the following objectives:

- *Assess the presence and likely extent of any potential environmental hazards (soil contamination) associated within the area of contamination.*

Site Location

The site is located in Openshaw, Manchester, approximately 4.6km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SJ 88592 97635 (X:388592, Y: 397635), with the closest postcode being M11 1AD.

The site is a near rectangular shaped parcel of land with current access via two gates off Louisa Street to the east of the site. The maximum dimensions of the proposed site are 82m north to south and 120m east to west. The site occupies an area of approximately 0.93 hectares.

The surrounding area comprises predominantly of residential properties. Industrial land uses are located immediately north of the site and to the south and southeast of the site. An open green space is located immediately south of the site along the boundary.

Proposed Development

It is understood that the client wishes to demolish the existing buildings on site and construct a combination of approximately sixteen houses with private gardens and three apartment blocks, all with parking and soft landscaping.

A site location plan has been provided as Figure 1 overleaf with a development plan shown in Figure 2.

Figure 1 Site Location Plan

Figure 2 Development Layout Plan

Summary of Previous Site Investigation

A summary of the locations where there is an exceedance of site-specific assessment criteria (for residential end use with gardens) is shown in Table 1.

Table 1 Summary of Contamination

Location	Land Use	Depth (m)	Soil Description	Contaminant
WS1	House Plot	0.3	Made Ground	Chrysotile asbestos fibres <0.001% Naphthalene Benzo(b) fluoranthene Dibenzo (a, h) anthracene
WS2	House Plot	0.50	Made Ground	Chrysotile asbestos fibres 0.001%
WS5	House Plot	0.65	Made Ground	Benzo(b) fluoranthene Dibenzo (a, h) anthracene
TP1	Landscaped Area	0.40	Made Ground	TPH Aromatic 16-21 Benzo(a)anthracene Chrysene Benzo(a)pyrene Benzo (b) fluoranthene Dibenzo (a, h) anthracene

Figure 3 below shows the location of the exceedances.

Figure 3 Exceedance of Soil Assessment Criteria

Fieldwork

A site investigation was conducted on the 8th September 2023 to retrieve samples from around the three identified hotspots at WS1 (0.3m), WS5 (0.65m) and TP1 (0.40m).

Eleven hand dug pits (designated HP1 to HP11 inclusive) were excavated around the three hotspots.

Three around WS1, three around the hotspot at WS5 and five around the hotspot at TP1.

Four samples were also taken from the onsite stockpiles (designated SP1 to SP4.)

Exploratory hole locations were selected prior to the site works by an EEG engineer based on the proposed development layout and avoiding known services. Each exploratory location was scanned using a Cable Avoidance Tool (CAT) in order to locate unrecorded underground services, and the exploratory locations were repositioned if necessary.

On completion, samples recovered from the site were taken to specialist laboratories for chemical and geotechnical testing.

Soil samples were recovered in 250g glass amber jars and 1kg plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the DETS laboratory.

If collection was not possible the same day, then samples were stored in the sample storage fridge at the EEG offices below 4˚C.

Samples were tracked using appropriate Chain of Custody forms provided by DETS.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III).

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930(2015+A1:2020) except where superseded by the soil and rock description methodology in BS EN14688-1(2002), BS EN 14688-2(2004) and BS EN 14689-1(2003).

Each excavation was sampled and backfilled upon completion.

Sampling locations are shown in Figure 4 overleaf.

Ground Conditions

BGS digital mapping shows the site is underlain by superficial deposits of Devensian Till, comprising Diamicton. The solid geology beneath the site is recorded as the Triassic Chester Pebble Beds Formation.

HP1-HP5 encountered Made Ground comprising black sandy GRAVEL comprising redbrick, sandstone and ash beneath a layer of asphalt.

HP6-HP11 encountered Made Ground comprising black gravelly SAND comprising redbrick and ash. These hand pits were sampled between 1.00m and 1.55m due to an archaeological excavation on the targeted hotspot area.

Material sampled from the stockpiles generally encountered Made Ground comprising black sandy GRAVEL comprising redbrick, ash and concrete fragments.

Aside from the made ground encountered, no notable visual and olfactory evidence of contamination was observed during the site sampling process.

Exploratory hole logs can be found as Appendix A.

Figure 4 Exploratory Hole Location Plan

Laboratory Testing

The environmental chemistry of the ground was investigated by specialist analysis of selected samples, scheduled by EEG, and carried out by DETS a UKAS/MCERTS accredited laboratory.

Chemical analyses were carried out on fifteen soil samples and were submitted for the following suite of determinants:

Asbestos Screen, Arsenic, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO_4), Sulphide, pH, Sulphur, Soil Organic Matter, Speciated Polyaromatic Hydrocarbons (PAH) and Speciated Petroleum Hydrocarbons.

Soil Contamination Assessment

At a Tier I stage the long term (chronic) human health toxicity of the soil has been assessed with reference to DEFRA/Environment Agency Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV) for generic site land uses, soils, and exposure. Where Environment Agency generic guidance is absent, reference has been made to the Chartered Institute of Environmental Health (CIEH) S4ULs for human health risk assessment.

In the case of arsenic, cadmium, hexavalent chromium, lead, and benzo(a) pyrene DEFRA Category 4 Screening levels have been adopted.

For organic chemicals, a Soil Organic Matter (SOM) of 2.5% (range of 3% to 15%) has been adopted as the average concentration is 4.9%.

Full results of the chemical analyses are presented in Appendix B and summarised in Table 2 overleaf.

Based on the chemical results shown in Table 2, the sample collected from SP4 (stockpile material) contained a marginally elevated concentration of inorganic arsenic.

Asbestos was not identified in any of the tested samples.

EARTH ENVIRONMENTAL & GEOTECHNICAL

Table 2: Soil Results Comparison with C4SL/S4UL Values

Determinand	C4SL/S4UL Levels SOM 6% (mg/kg)	HP1 0.45m	HP2 0.40m	HP3 0.50m	HP4 0.45m	HP5 0.40m	HP6 1.10m	HP7 1.05m	HP8 1.10m	HP9 1.55m	No of Exceedances
Metals											
Inorganic Arsenic	40	16	37	29	22	28	31	15	13	17	0
Beryllium	1.7	1	1.3	0.7	0.6	0.6	< 0.5	< 0.5	< 0.5	0.8	0
Boron	11000	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Cadmium	150	< 0.2	< 0.2	< 0.2	< 0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2	0
Chromium	910	8	10	8	6	7	14	11	10	7	0
Chromium VI	21	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Copper	7100	29	135	92	9	20	8	7	7	28	0
Lead	310	18	11	30	28	44	13	14	101	34	0
Inorganic Mercury	56	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	8	9	7	6	5	8	7	6	14	0
Selenium	430	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Vanadium	1200	16	18	16	12	12	36	27	24	17	0
Zinc	40000	20	43	32	14	30	11	11	14	25	0
Petroleum Hydrocarbons											
Benzene	1.6	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Toluene	1900	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0
Ethylbenzene	190	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
o-xylenes	210	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
m-xylenes	190	0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	< 0.002	< 0.002	< 0.002	0
p-xylenes	180	0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	< 0.002	< 0.002	< 0.002	0
Aliphatic EC >5-6	78	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aliphatic EC >6-8	230	< 0.05	< 0.05	< 0.05	< 0.05	0.09	< 0.05	< 0.05	0.08	< 0.05	0
Aliphatic EC >8-10	65	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >10-12	330	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >12-16	2400	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >16-21	92000	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >21-35	92000	< 10	< 10	< 10	< 10	< 10	< 10	64	< 10	< 10	0
Aromatic EC >5-7	690	< 21	< 21	< 21	< 21	< 21	< 21	64	< 21	< 21	0
Aromatic EC >7-8	1800	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aromatic EC >8-10	110	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aromatic EC >10-12	590	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >12-16	2300	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >16-21	1900	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >21-35	1900	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Polycyclic Aromatic Hydrocarbons											
Naphthalene	5.6	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthylene	4600	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	4700	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluorene	3800	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Phenanthrene	1500	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Anthracene	35000	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluoranthene	1600	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Pyrene	3800	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(a)anthracene	14	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Chrysene	31	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(a)pyrene	5.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(b)fluoranthene	4.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(k)fluoranthene	110	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Indeno(1,2,3-cd)pyrene	46	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Dibenz(a,h)anthracene	0.32	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(ghi)perylene	360	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Phenols											
Phenol	690	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0

Table 2 continued: Soil Results Comparison with C4SL/S4UL Values

Determinand	C4SL/S4UL Levels Resi w/ HP SOM 6% (mg/kg)	HP10 1.45m	HP11 1.50m	SP1 0.15m	SP2 0.10m	SP3 0.10m	SP4 0.15m	No of Exceedances
Metals								
Inorganic Arsenic	40	9	11	7	6	8	42	1
Beryllium	1.7	0.7	1.1	< 0.5	< 0.5	0.6	1	0
Boron	11000	< 1	< 1	< 1	< 1	< 1	< 1	0
Cadmium	150	0.2	< 0.2	0.3	0.3	< 0.2	0.3	0
Chromium	910	9	8	12	11	10	17	0
Chromium VI	21	< 2	< 2	< 2	< 2	< 2	< 2	0
Copper	7100	26	41	55	42	29	72	0
Lead	310	39	46	145	88	60	233	0
Mercury	56	< 1	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	19	23	33	24	14	33	0
Selenium	430	< 2	< 2	< 2	< 2	< 2	< 2	0
Vanadium	1200	25	22	17	14	17	41	0
Zinc	40000	57	36	91	80	62	91	0
Petroleum Hydrocarbons								
Benzene	1.6	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Toluene	1900	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0
Ethylbenzene	190	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
o-xylenes	210	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
m-xylenes	190	0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0
p-xylenes	180	0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0
Aliphatic EC >5-6	78	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aliphatic EC >6-8	230	< 0.05	< 0.05	< 0.05	< 0.05	0.09	< 0.05	0
Aliphatic EC >8-10	65	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >10-12	330	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >12-16	2400	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >16-21	92000	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >21-35	92000	< 10	< 10	< 10	< 10	< 10	< 10	0
Aromatic EC >5-7	690	< 21	< 21	< 21	< 21	< 21	< 21	0
Aromatic EC >7-8	1800	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aromatic EC >8-10	110	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aromatic EC >10-12	590	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >12-16	2300	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >16-21	1900	< 2	< 2	< 2	< 2	< 2	< 2	0
Polycyclic Aromatic Hydrocarbons								
Naphthalene	5.6	< 0.1	< 0.1	0.44	0.22	0.15	0.22	0
Acenaphthylene	4600	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	4700	< 0.1	< 0.1	0.4	0.25	< 0.1	0.35	0
Fluorene	3800	< 0.1	< 0.1	0.22	0.15	< 0.1	0.19	0
Phenanthrene	1500	0.17	< 0.1	1.93	1.22	0.61	2.05	0
Anthracene	35000	< 0.1	< 0.1	0.41	0.23	0.14	0.54	0
Fluoranthene	1600	0.28	< 0.1	2.54	1.58	1.12	2.9	0
Pyrene	3800	0.28	< 0.1	2.16	1.51	1.03	2.46	0
Benzo(a)anthracene	14	0.22	< 0.1	1.47	1.01	0.84	1.76	0
Chrysene	31	0.24	< 0.1	1.15	0.95	0.75	1.37	0
Benzo(a)pyrene	5.3	0.28	< 0.1	1.46	1.05	0.73	1.35	0
Benzo(b)fluoranthene	4.0	0.4	< 0.1	1.69	1.38	1.1	1.51	0
Benzo(k)fluoranthene	110	< 0.1	< 0.1	0.44	0.32	0.37	0.49	0
Indeno(1,2,3-cd)pyrene	46	0.19	< 0.1	0.69	0.62	0.54	0.59	0
Dibenz(a,h)anthracene	0.32	< 0.1	< 0.1	< 0.1	0.13	0.12	0.15	0
Benzo(ghi)perylene	360	0.18	< 0.1	0.61	0.56	0.53	0.46	0
Phenols								
Phenol	690	< 2	< 2	3.4	< 2	< 2	< 2	0

Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of June 2018, "Guidance on the classification and assessment of waste" has been carried out on soils recovered from the site, using HazWasteOnline.

The results are summarised in Table 3 below and presented in full in Appendix C.

Table 3: Waste Classification of Soils

Location	Depth (m bgl)	Soil Description	WM3.1 Classification	Waste Acceptance Criteria Testing
HP1	0.45	Made Ground	Non-Hazardous	-
HP2	0.40	Made Ground	Non-Hazardous	-
HP3	0.50	Made Ground	Non-Hazardous	-
HP4	0.45	Made Ground	Non-Hazardous	-
HP5	0.40	Made Ground	Non-Hazardous	-
HP6	1.10	Made Ground	Non-Hazardous	-
HP7	1.05	Made Ground	Non-Hazardous	-
HP8	1.10	Made Ground	Non-Hazardous	-
HP9	1.55	Made Ground	Non-Hazardous	-
HP10	1.45	Made Ground	Non-Hazardous	-
HP11	1.50	Made Ground	Non-Hazardous	-
SP1	0.15	Stockpile	Non-Hazardous	-
SP2	0.10	Stockpile	Non-Hazardous	-
SP3	0.10	Stockpile	Non-Hazardous	-
SP4	0.10	Stockpile	Non-Hazardous	-

The above table shows that all of the soil samples collected during this investigation were classified as **Non-Hazardous** in accordance with WM3.1.

Further Waste Acceptance Criteria (WAC) testing may prove that his material is acceptable as inert waste.

Conclusions & Recommendations

The hotspot at WS1 needs to be excavated due to the presence of volatile naphthalene.

The other hotspots at WS2, WS5 are not significant as the material will be removed to construct the plots and there will be no plausible pollutant linkage.

All landscaped areas should be covered by imported topsoil.

Testing was carried out across the onsite stockpile containing material excavated on site.

The testing carried out on the sample taken at SP4 showed marginally elevated levels of inorganic arsenic.

The stockpiled material can be used on site, if required, or removed offsite to a non-hazardous waste facility. The material could be taken to an Inert Waste facility subject to Waste Acceptance Criteria testing.

Should you have any queries about this letter report please do not hesitate to contact me.

Yours Sincerely,

Adam Czarnecki

Adam Czarnecki
Company Owner

For and on behalf of Earth Environmental & Geotechnical Ltd

Enclosed: *Appendix A – Hand Dug Pit Logs*
Appendix B – Soil Chemical Testing Results
Appendix C – Soil Waste Assessment

APPENDIX A

EXPLORATORY HOLE LOGS

APPENDIX B

SOIL CHEMICAL TESTING RESULTS

APPENDIX C

SOIL WASTE ASSESSMENT