



e3p

Phase II Geoenvironmental Site Assessment
Kenyon Lane, Failsworth

Reference: 16-717-R1-1
Date: September 2023



PHASE II GEOENVIRONMENTAL SITE ASSESSMENT

Kenyon Lane
Moston
Manchester
M9 4PF

Prepared for:



Report Ref: 16-717-R1

Date Issued: 20 September 2023

Kenyon Lane, Failsworth

Phase II Geoenvironmental Site Assessment

September 2023

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EXECUTIVE SUMMARY

Site Address	Land to the south of Kenyon Lane, Manchester, M40 5FH	
Grid Reference	E 387656, N 401212.	
Site Area	Approximately 0.38 Ha.	
Proposed Development	Jigsaw Homes propose to construct a low-rise residential development with associated adopted estate roads, gardens and infrastructure at land to the south of Kenyon Lane, Manchester.	
Current Site Use	The site is irregular in shape and is located to the south west of Kenyon Lane and is predominantly occupied by grass surface cover with an area of mature trees present in the central sector of the site and a footpath that runs along the western boundary. The site slopes downwards towards Kenyon Lane to the north east. An electric junction box and three manhole covers are present to the east of the site.	
Site History	Earliest mapping (1848) shows the site was undeveloped until 1908 when two rows of terraced residential dwellings, one aligned along the northern boundary the other to the southwest site were constructed. From 1923 two additional buildings appear on site, one of which is demolished by 1932 and the other extended by 1952. Another two are shown by 1988 and by 1978 all buildings are absent from historical mapping. The Moston Brook flows roughly east to west, from 15 m south of the site and later, partially infilled to the south. Areas of cut and/or fill occupy most of the land to the south and northeast of the site from 1908 to 1978, with historical landfills noted in the area.	
Environmental Setting	Drift Geology	Glacial Till – CLAY
	Bedrock Geology	Collyhurst Sandstone Formation – SANDSTONE.
	Faults	Nearest fault is located 136 m north east.
	Hydrogeology	Secondary undifferentiated drift aquifer overlying Principal bedrock Aquifer. However, the site is not located within a Source Protection Zone and there are no recorded potable groundwater abstraction points within 500 m.
	Hydrology	The nearest surface water course is recorded to be the Moston Brook located c. 15 m south of the site. However, at its closest point to the site, this feature is recorded to be infilled. Flood mapping indicates the surface water course to open up c. 250 m south east of the site.
	Flood Risk	The site is not located in an area affected by river flooding (Flood Risk Zone 1).
Previous Reports	The following previous reports have been completed for the site: Curtins completed a Phase 1 Preliminary Risk Assessment for the site, prepared for Jigsaw Homes Group Ltd (Report Ref: 077873-CUR-00-XX-RP-GE-019, dated May 2021) and a summary of the pertinent information from this report is provided in Section 1.7.	



Utility Locations	A full ground penetrating radar (GPR) survey has not been undertaken for the site; however, a full review of the available service plans has identified the following services: ✳ A low pressure gas main and water distribution main enter the site in the northeastern corner and run northwest (following same route). ✳ Low voltage electric cables enter the site in the east and run north and south towards a junction box. A further low voltage cable enters the site in the southwest and runs northeast. ✳ Foul and combined sewers (150 mm and 825 mm diameter) enter the site in the northeast and run along the north eastern boundary. Other surface water (225 mm) and combined (225 mm) sewers run north east through the site to join sewers in the main road.
Landfill Sites and Ground Gases	There is an area of historical landfill which encroaches into the site from the south. The type of waste included inert and industrial waste. Input dates between May 1980 and December 1981.
Radon	The site is situated within an area of maximum radon potential of 1–3%.
Coal Mining/Land Stability	The site is located within a coal mining risk assessment, however, is not located within a Coal Authority deemed High-Risk Development Area. Additionally, there are no mine entries within 1km of the site, or probable/recorded workings in the site boundary or immediate surrounding area. The risk to of shallow coal mining is considered to be Low.
Hazardous Installations	No hazardous installations that could potentially prejudice the proposed construction of highly sensitive residential dwellings have been identified within influencing distance of the subject site.
Initial Conceptual Site Model	The previous Curtins Phase I (Report Ref: 077873-CUR-00-XX-RP-GE-019, dated May 2021) concluded the following: The risk from Made Ground posed to the site's end-users and groundwater is considered to be Moderate/Low due to the anticipated lack of contamination in potential Made Ground soils on site. The risk posed to groundwater and surface water receptors is considered to be Low and Very Low taking into account the lack of historical industrial land use on site. The risk posed to site end-users from ground generating gases arising from organic/putrescible soils on or near the site is considered to be Moderate.

GROUND INVESTIGATION

Ground Investigation Works	E3P has completed an intrusive ground investigation comprising: ✳ 11No. x mechanically excavated trial pits ✳ 6No. x window sample boreholes with environmental monitoring installations; and, ✳ 2No. x cable percussive boreholes.
Ground Conditions	MADE GROUND – 0.00 m bgl to 7.10 m bgl A reworked topsoil of a brown slightly gravelly clayey medium to coarse sand with frequent roots and gravel of brick and mudstone was encountered within each exploratory hole location to 0.20-0.40 m bgl.



In the northern sector, Made Ground generally comprised a reworked clay overlying brick fill, indicative of relict foundations/demolition materials to a maximum proven depth of 1.80 m.

In the southern sector (former landfill) Made Ground deposits were generally deeper than the north and comprised greyish brown clayey gravelly medium to coarse sand and gravelly clay, with frequent concrete and brick cobbles and boulders and inclusions of intact bricks, plastic, metal, wood, concrete and cloth.

The base of Made Ground was unproven in the southern sector in the majority of locations, except WS103 and CP102, where the Made Ground was proven at 2.00 m and 7.10 m bgl, respectively.

A hydrocarbon odour was noted within the Made Ground at four locations in the southern sector, WS105, TP102, TP104 and CP102;. A concrete slab obstruction was also encountered at 1.10 m bgl in TP102 (likely to be a large boulder rather than in-situ slab).

DRIFT – 1.00 m bgl to >12.35 m bgl

Drift deposits were encountered within nine out of the nineteen exploratory hole locations across the site, to a maximum depth of 12.35 m bgl (base not proven).

The shallow (<5.00 m bgl) soils generally comprised an orange/brown medium to coarse SAND overlying a greyish brown SILT.

A stiff medium strength CLAY was encountered in WS103 and WS104 to >5.45 m bgl with

Cable percussive boreholes encountered deeper soil horizons comprising a sandy SILT with CLAY bands to 6.00 m bgl in CP101 and a silty SAND within CP102 to 10.90 m bgl. A brown boulder CLAY was encountered underlying the silt and sand in both locations. CP101 refused in the CLAY, likely on a boulder at 8.41 m bgl, whereas CP102 refused within a brown sandy GRAVEL at 12.35 m bgl, that was encountered underlying the boulder CLAY.

SOLID

The solid bedrock geology was not encountered during the site investigation and BGS borehole records within 100 m of the site also did not encounter bedrock within boreholes advanced to 7.62 m bgl.

GROUNDWATER

Groundwater was not encountered during the fieldwork, however, during subsequent monitoring visits, groundwater was recorded between 2.54 m and 3.90 m bgl within WS105 and WS106.

Shallower water levels were recorded between 1.20 m and 1.50 m bgl within WS104, however this is likely perched and a result of heavy rainfall events, as the monitoring installation was installed at a shallow depth within Made Ground.



CONTAMINATED LAND ASSESSMENT

Human Health	A Tier 2 human health risk assessment identified exceedances of residential end use with plant uptake GAC values for the following contaminants in samples taken from the southern sector of the site (associated with area of former landfill): ☛ Lead, arsenic and mercury [potentially volatile] ☛ Benzo(b)fluoranthene, Benzo(a)Pyrene and Dibenzo(a,h)Anthracene ☛ TPH Aromatic C12-C16 ☛ Chrysotile and Amosite asbestos fibres at 0.003% wt/wt and Chrysotile at 0.002% wt/wt Elevated total mercury encountered in the Made Ground in TP101 presents a potential volatilisation to indoor air risk (speciation required to confirm). Material deemed to have a potential vapour risk may require hotspot removal, resulting in the requirement to backfill the resulting void. Asbestos was detected within two samples of Made Ground. Remediation may include delineation as a hotspot and removal from site or placement at a depth of >1.00 m below finished level in residential plots, gardens or POS Risks associated with heavy metals, PAH compounds and heavy end TPH can be mitigated through installation of a clean cover system in gardens and soft landscaped areas. These have been encountered in samples taken from the southern sector of the site (associated with area of former landfill), however, given the sitewide spread of Made Ground, it would be considered prudent to apply a cover system to all plots where Made Ground remains at proposed development level. Chemical analysis of natural subsoils has indicated these soils to be acceptable for use as subsoil within the proposed garden areas; however, further chemical validation samples will be required to confirm this. Two samples of the reworked topsoil (noted to contain brick and anthropogenic inclusions) were also submitted for chemical analysis (TP102 and WS106). Chemical analysis has indicated these soils to be acceptable for use as topsoil within the proposed garden areas; however, further chemical validation samples will be required to confirm this. Should material be found to be chemically suitable, inspection of the soil composition should be undertaken along with suitable screening of unsuitable anthropogenic inclusions.
Controlled Waters	The primary receptor has been identified as the underlying Principal Aquifer (bedrock). No exceedances of DWS values have been found in the two leachate samples analysed. It has not been possible to obtain groundwater samples for a full appraisal due to boreholes either being dry or containing insufficient volumes of water. The drift deposits across the site are variable. Given the presence of lower permeability fine grained soils which will reduce downward migration of contamination and the absence of any exceedances in the leachate, or shallow groundwater to mobilise soil contamination, the overall risk may be considered low. Given the absence of a groundwater abstraction point or surface watercourse within close proximity to the site, there is not considered to be a complete pollutant linkage.



	However, given the nature of the site and presence of deep Made Ground / landfill materials, it would be prudent to obtain water samples for assessment if resting water levels are found to rise over the monitoring period.
Ground Gas	The southern part of the site forms part of a larger historical landfill and deep Made Ground (up to 7.10 m bgl in CP102), with degradable inclusions of wood and timber have been encountered. Other degradable organic materials may be present at intervening locations and cannot be discounted. WS102, WS103, WS104 and WS106, predominantly in the south of the site and area of former landfill, have recorded carbon dioxide above 5% v/v threshold, however the GSV is noted to be within a CS1 classification due to the absence of flow. A precautionary allowance for CS2 gas protection measures is recommended at this stage. The final classification will be confirmed on completion of the full ground gas monitoring programme.
Potable Water Infrastructure	Barrier pipe likely to be required. This will need to be confirmed following the completion of a UKWIR risk assessment. Post-remediation and enabling works ground conditions may be different from those identified during this site investigation.

GEOTECHNICAL ASSESSMENT

Underground Obstructions	Frequent concrete and brick obstructions have been identified, indicative of historical landfilling in the southern sector of the site and relict foundations in the northern sector. During a phase of cut-and-fill enabling works to create a developable platform, all obstructions (including redundant services) will require grubbing out to enable the construction of proposed plots.
Allowable Bearing Pressure	Shallow soils (beneath the Made Ground) are variable and comprise CLAY, SILT and SAND deposits. The suitable target founding stratum has been identified as the underlying firm to stiff CLAY (60-110 kN/m² at 2.00 m bgl). However, it should be noted that in a number of locations this stratum is underlain by soft/low strength SILT. Deeper CLAY strata beyond 6.00 m bgl is anticipated to offer an ABP in the region of >300 kN/m².
Foundation Options	Based on existing levels, the depth to suitable founding strata is generally greater than 2.50 m bgl due to the presence of deep Made Ground and unsuitable soft low strength SILT deposits underlying medium dense SAND deposits. However, prior to the detailed design of suitable foundations solutions, a programme of remediation and enabling works will be required to remove the extensive buried obstructions and cut/fill the site to provide suitable development platform levels. Enabling works will also be required to locate/delineate the highwall of the landfill in the southern sector.



	At this time it is not possible to accurately define the foundation types due to the absence of a detailed tree survey and final development levels; however, given the ground conditions encountered and considering future potential cut/fill works to create a development platform, foundation options may include: ✿ Piled foundations in areas of tree influence where cohesive soils are present and in area of former landfill in the southern sector where fill extends to depths >7.0 m bgl. ✿ Ground improvement using VSC in areas of deep Made Ground outside of tree influence or landfill area. ✿ Raft foundations for plots straddling the landfill highwall to mitigate risks of potential differential settlement. ✿ In the centre of the northern sector, it may be possible to utilise deep mass trench foundations, where firm CLAY is present at depths shallower than 2.50 m bffl, outside of tree influence.
Building Floor Slabs	Ground-bearing floor slabs are unlikely to be viable given the anticipated depths of reworked Made Ground > 600 mm and shallow cohesive soils.
Heave Precautions	The CLAY soils are of low volume change potential. Heave precautions will be required for foundations in clay within tree influence.
Soakaway Drainage	The presence of deep Made Ground will preclude the use of soakaway drainage.
Sulphate Assessment	Concrete classification will be DS1 AC1s.
CBR Design %	Granular soils can be re-engineered to ensure 5% within the subgrade during favourable climatic conditions. Natural clay soils will provide a CBR in the order of 3–5% during drier climatic periods. However, if water is allowed to shed onto the formation, the CBR will reduce to < 2%, which will require specialist engineering of the subgrade.
Cut/Fill	Development levels unknown at this time; however, significant cut-and-fill works will be required to prepare the development platform.
Civil Engineering Excavations	The E3P Intrusive Ground Investigation has not identified the presence of weathered/competent bedrock at a shallow depth of less than 2.00 m bgl.
Waste Characterisation	Any material that is to be disposed off-site should undergo assessment using Technical Guidance WM3: <i>Waste Classification – Guidance on the classification and assessment of waste</i> .

RECOMMENDATIONS

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



- ✿ Further investigation in centre of site following tree removal (if proposed).
- ✿ Completion of ground gas monitoring and ground water monitoring (subject to water levels).
- ✿ Location/delineation of landfill highwall in southern sector.
- ✿ Plot-specific foundation schedule (upon receipt of the final development levels).
- ✿ Arboricultural survey.
- ✿ Geotechnical earthworks strategy (infrastructure).
- ✿ Remediation and enabling works strategy.



Table of Contents

EXECUTIVE SUMMARY	1
1. INTRODUCTION	10
1.1. Background	10
1.2. Proposed Development.....	10
1.3. Objectives	10
1.4. Scope of Works.....	10
1.5. Limitations	11
1.6. Confidentiality.....	11
1.7. Previous Reports	11
2. GROUND INVESTIGATION.....	14
2.1. General Overview	14
2.2. Limitations of the Investigation	14
2.3. Scope of Investigation.....	14
2.4. In-Situ Standard Penetration Testing (SPT).....	15
2.5. Laboratory Analysis.....	15
3. GROUND AND GROUNDWATER CONDITIONS	17
3.1. Summary of Ground Conditions	17
3.2. Made Ground	17
3.3. Drift Deposits	18
3.4. Solid Geology.....	18
3.5. Groundwater	18
3.6. Visual and Olfactory Evidence of Contamination	18
3.7. Soil Consistency	19
3.8. Side Stability and Ease of Excavation	19
3.9. Particle Size Distribution	24
3.10. Soil Density/Moisture Content Relationship	24
3.11. Soil Plasticity	24
3.12. pH and Sulphate	25
4. TIER 2 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT	26
4.1. Deviating Samples.....	26
4.2. Human Health Risk Assessment.....	26
4.2.1. Summary of Results.....	28
4.2.2. Discussion	29
4.3. Controlled Waters Risk Assessment	31
4.3.1. Summary of Results.....	36
4.3.2. discussion	36
4.4. Ground Gas Risk Assessment Methodology	36
4.5. Monitoring Methodology	37
4.6. Summary of Monitoring Results	40
4.6.1. Groundwater.....	40
4.6.2. Barometric pressure	40
4.6.3. Gas Flow.....	40
4.6.4. Gas Concentrations	40
4.7. CONCLUSION.....	40
4.8. Potable Water Supply	41
4.9. Conceptual Site Model	43
5. GEOTECHNICAL ASSESSMENT	47
5.1. Site Preparation	47
5.2. Foundation Assessment	47



5.3.	Ground Floor Slabs	50
5.4.	Heave Precautions	50
5.5.	Highways Construction	51
5.6.	Drainage	51
5.7.	Concrete Durability	52
5.8.	Excavations	52
5.9.	Construction Activity and Inspection	53
5.10.	Geotechnical Risk Register	54
5.11.	Further Works	58
6.	CONCLUSIONS AND RECOMMENDATIONS.....	59
6.1.	Contaminated Land Assessment	59
6.2.	Geotechnical Assessment	61
APPENDIX I LIMITATIONS.....		62
APPENDIX II GLOSSARY		64
APPENDIX III DRAWINGS		67
APPENDIX IV PHOTOGRAPHS		69
APPENDIX V E3P EXPLORATORY HOLE LOGS		76
APPENDIX VI CHEMICAL TESTING RESULTS		77
APPENDIX VII ORIGIN OF TIER 2 GENERIC ASSESSMENT CRITERIA.....		78
APPENDIX VIII GEOTECHNICAL TESTING RESULTS.....		80

DRAWING LIST

16-717-001 - Site Location Plan
16-717-004 - Site Features Plan
16-717-003 - Historical Features Plan
16-717-005 - Exploratory Hole Location Plan
16-717-006 - Depth of Made Ground Plan
16-717-008 - Depth to Founding Strata Plan
16-717-010 - Conceptual Site Model
16-717-015 - Development Constraints Plan



1. INTRODUCTION

1.1. BACKGROUND

E3P has been commissioned by Jigsaw Homes to undertake a detailed Phase II Geoenvironmental Site Assessment for a parcel of land to the south of Kenyon Lane in Failsworth, Manchester.

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

1.2. PROPOSED DEVELOPMENT

Jigsaw Homes intend to construct a low-rise residential development with associated gardens, estate roads and infrastructure.

A proposed development layout has not been provided at the time of writing this report.

1.3. OBJECTIVES

The objectives of the geoenvironmental assessment are as follows:

- ✦ Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available in order to complete a desk study in line with Environment Agency (EA) document *Land Contamination: Risk Management (LCRM)* (July 2023).
- ✦ Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified.
- ✦ Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors.
- ✦ Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs.
- ✦ Provide recommendations regarding future works required.

1.4. SCOPE OF WORKS

The scope of work includes the following elements:

- ✦ Detailed review of historical information;
- ✦ Design of suitable intrusive ground investigation;
- ✦ 6 No. window sample probeholes with, and construction of, environmental monitoring installations;
- ✦ 2 No. deep cable percussive boreholes;



- ✦ 11 No. Mechanically excavated trial pits;
- ✦ In-situ geotechnical testing;
- ✦ Chemical and geotechnical laboratory analysis;
- ✦ Groundwater monitoring and sampling;
- ✦ Ground gas monitoring;
- ✦ Contamination risk assessment and conceptual site model;
- ✦ Geotechnical assessment and interpretation; and
- ✦ Factual and interpretive reporting.

1.5. LIMITATIONS

The limitations of this report are presented in Appendix I.

1.6. CONFIDENTIALITY

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

1.7. PREVIOUS REPORTS

E3P have been provided the following reports for the site:

- ✦ **Curtins** - Phase 1 Preliminary Risk Assessment, Kenyon Lane (REF; 077873-CUR-00-XX-RP-GE-019-V01, dated 10 May 2021). Prepared for Jigsaw Homes Group Ltd

A summary of the pertinent information from this report is provided below:

Site Setting

- ✦ The site is located southwest of Kenyon Lane. The site is currently occupied by well-kept grass surface cover and trees along the site boundary running northeast to southwest. A public footpath extends along the western boundary.

Site History

- ✦ Earliest mapping (1848) shows that the site was undeveloped until 1908 when two rows of terraced residential dwellings, one aligned along the northern boundary the other to the southwest site were constructed. From 1923 two additional buildings appear on site, once of which is demolished by 1932 and the other extended by 1952. Another two appear by 1988 and in 1978 all buildings are absent from historical mapping.



- ✚ The Lancashire and Yorkshire Railway orientated northeast to southwest, 123m south of the site, later accompanied by the Newton Heath Station in 1893. This is expanded from 1908 and reduced in size again by 1978. The surrounding area is continuously developed through into the 1980's with various terraced housing and residential properties constructed in all directions from site. Other buildings like the Mill Dye Works are noted 217m east of site (demolished by 1923) and a school 243m southeast of the site.
- ✚ The Moston Brook flows roughly east to west, from 15m south of the site and later, partially infilled to the south. Areas of cut and/or fill occupy most of the land to the south and northeast of the site from 1908 to 1978, with historical landfills noted in the area.

Environmental Setting

- ✚ There is an area of historical landfill which encroaches into the site from the south. The type of waste included inert and industrial waste. Input dates between May 1980 and December 1981.
- ✚ BGS mapping indicates the site is underlain by Glacial Till superficial deposits and Collyhurst Sandstone Formation bedrock (principal aquifer). The site is not located within a source protection zone.
- ✚ BGS borehole records located within 100 m of the site record made ground underlain by clay and sand deposits, with bedrock deeper than 7.62 m bgl.
- ✚ The site is located within an area assessed as being within at moderate risk from UXO. A preliminary risk assessment was undertaken by Curtins as part of the Phase 1 report and summarised the following:

"A review of the available post-WWII historic mapping (Ref. 1) identified that the majority of terraced properties to the northeast of the site were demolished post-WWII. However, a review of available online bomb damage mapping for Manchester (Ref. 8) does not record any explosive bombs in the area. Considering the above, the risk of encountering potential UXO as part of future intrusive works is considered **Low** and no specialist information is required prior to any intrusive works."

Initial Conceptual Model

- ✚ The Curtins Phase I concluded the following: The risk from Made Ground posed to the site's end-users and groundwater is considered to be Moderate/Low due to the anticipated lack of contamination in potential Made Ground soils on site. The risk posed to groundwater and surface water receptors is considered to be Low and Very Low taking into account the lack of historical industrial land use on site. The risk posed to site end-users from ground generating gases arising from organic/putrescible soils on or near the site is considered to be Moderate.

Coal Mining Geology

- ✚ A review of the Coal Authority interactive mapping (Ref. 4) for the area indicates that the site is located within a Coal Mining Reporting Area, however, it is not located within a Development High-Risk Area.
- ✚ There are no recorded mine entries within 500 m of the site.



- ✚ There are no recorded coal workings and no probable coal workings within 850 m of the site.
- ✚ Consequently, the risk to development from historic coal mining is considered to be Low. No further actions are required to further assess the risk to development from historic coal mining.
- ✚ The closest recorded BGS mineral site is located 420 m northeast of the site, an opencast site known as Moston Hall Sand Pit which extracted sand from superficial soils (Till) and is recorded to have ceased works.



2. GROUND INVESTIGATION

2.1. GENERAL OVERVIEW

A ground investigation has been designed based on the findings of the desk study, with exploratory holes advanced to target specific potential contaminant sources identified within the previous site investigations. The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development.

Exploratory fieldwork was completed between 22nd June 2023 and 3rd July 2023. The works are summarised in Table 2.1.

2.2. LIMITATIONS OF THE INVESTIGATION

Several services (gas, electricity and drainage networks) are present within the site boundary, therefore safe easements were applied, and exploratory hole locations were not advanced within these areas.

An area of woodland is also present in the centre of the site, occupying approximately 35-40% of the total site area and dividing the site into two; the northern sector and southern sector and. Exploratory hole locations could only be advanced within the woodland and so investigation was limited to the north and south.

2.3. SCOPE OF INVESTIGATION

TABLE 2.1 SUMMARY OF FIELDWORK

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (m bgl)	MONITORING WELLS RESPONSE ZONE (m bgl)
Northern Sector				
Former Terraced Housing in North of Site	TP106	Mechanically Excavated Trial Pit	3.50	N/A
	TP107		3.00	
	TP108		2.80	
	TP111		1.60	
	WS105	Window Sample Probehole	5.45	2.50–4.50
	WS106		5.45	2.00–4.00
Deeper Ground Conditions and Former Terraced Housing in North of Site	CP101	Cable Percussive Borehole	8.41	N/A
General Ground Conditions in North of Site	TP109	Mechanically Excavated Trial Pit	1.20	
	TP110		3.00	
	WS104	Window Sample Probehole	5.45	0.50–2.00



POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (m bgl)	MONITORING WELLS RESPONSE ZONE (m bgl)
Southern Sector				
Former Landfill in South of Site	WS102	Window Sample	2.26	1.00–2.00
	WS103	Probehole	5.45	2.00–5.00
	TP102	Mechanically Excavated Trial Pit	1.20	N/A
	TP103		2.50	
	TP104		2.90	
	TP105		4.00	
Deeper Ground Conditions and Former Landfill in South of Site	CP102	Cable Percussive Borehole	12.35	N/A
General Ground Conditions in South West of Site	WS101	Window Sample Probehole	5.45	1.00–4.00
	TP101	Mechanically Excavated Trial Pit	3.60	N/A

Mechanically excavated trial pits were advanced to investigate ground conditions and to retrieve environmental samples, spatially distributed to offer the maximum site coverage whilst also being advanced to target specific contaminant sources.

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

Cable percussive boreholes were advanced to undertake in-situ detailed geotechnical testing and to investigate the deeper soil horizons.

The sampling locations are illustrated in Drawing 16-717-005 (Appendix III). The ground conditions encountered are indicated on the logs, which are provided in Appendix V.

Return visits were made to monitor installations for groundwater level and gas concentrations.

2.4. IN-SITU STANDARD PENETRATION TESTING (SPT)

In-situ geotechnical testing was conducted using the standard penetration test (SPT) and, where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the probehole logs in Appendix V and presented in Table 3.3 and discussed in Section 6.

2.5. LABORATORY ANALYSIS

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



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

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

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

- ✦ Liquid and plastic limit (Atterberg);
- ✦ Natural moisture content;
- ✦ Particle Size Distribution;
- ✦ 2.5 kg compaction (OMC/MDD ratio).

Laboratory analysis sheets are included in Appendix VIII and are summarised in Section 3.



3. GROUND AND GROUNDWATER CONDITIONS

3.1. SUMMARY OF GROUND CONDITIONS

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

TABLE 3.1 SUMMARY OF STRATA

HOLE	DEPTH TO STRATUM (m bgl)						
	MADE GROUND / TOPSOIL	MADE GROUND	CLAY	SAND	SILT	GRAVEL	NO RECOVERY
TP101	0.00–0.30	0.30–3.60*	–	–	–	–	–
TP102	0.00–0.30	0.30–1.20*	–	–	–	–	–
TP103	0.00–0.25	0.25–2.50*	–	–	–	–	–
TP104	0.00–0.25	0.25–2.90*	–	–	–	–	–
TP105	0.00–0.30	0.30–4.00*	–	–	–	–	–
TP106	0.00–0.40	0.40–1.20	–	1.20–3.00	3.00–3.50	–	–
TP107	0.00–0.25	0.25–1.00	1.00–1.40	1.40–2.70	2.70–3.00	–	–
TP108	0.00–0.25	0.25–1.80	–	1.80–2.40	2.40–2.80	–	–
TP109	0.00–0.30	0.30–1.20*	–	–	–	–	–
TP110	0.00–0.30	0.30–2.10	2.10–2.70	2.70–2.80	2.80–3.00	–	–
TP111	0.00–0.35	0.35–1.60*	–	–	–	–	–
WS101	0.00–0.30	0.30–5.45*	–	–	–	–	–
WS102	0.00–0.25	0.25–2.26*	–	–	–	–	–
WS103	0.00–0.30	0.30–2.00	3.00–5.45	–	–		2.00–3.00
WS104	0.00–0.20	0.20–1.50	4.80–5.45	1.50–1.60 2.70–2.80	1.60–2.70 2.80–4.80	–	–
WS105	0.00–0.35	0.35–1.20	–	1.20–2.50	2.50–5.45	–	–
WS106	0.00–0.25	0.25–1.80	1.80–3.00	–	3.00–5.45	–	–
CP101	0.00–0.20	0.20–1.30	6.00–8.41	–	1.30–6.00	–	–
CP102	0.00–0.20	0.20–7.10	10.90–11.60	7.10–10.90	–	11.60–12.35	–

*Base of Made Ground unproven

3.2. MADE GROUND

Made Ground was encountered across the entirety of the site from ground level to a maximum proven depth of 7.10 m bgl (CP102).

A reworked topsoil of a brown slightly gravelly clayey medium to coarse sand with frequent roots and gravel of brick and mudstone was encountered within each exploratory hole location to 0.20–0.40 m bgl.



In the northern sector, Made Ground generally comprised a reworked clay overlying brick fill, indicative of relict foundations/demolition materials from the former terraced residential properties to a maximum proven depth of 1.80 m. The base of Made Ground was unproven in TP109 due to encountering a concrete slab. TP111 was also terminated due to the presence of a potential drain/service encountered at 1.20 m bgl.

In the southern sector (former landfill) Made Ground deposits were generally deeper than the north and comprised greyish brown clayey gravelly medium to coarse sand and gravelly clay, with frequent concrete and brick cobbles and boulders and inclusions of intact bricks, plastic, metal, wood, concrete and cloth.

Within TP101 and WS101 located to the very south west of the site, the Made Ground deposits differed and comprised a slightly gravelly clayey sand with pockets of clay and gravel of brick and clinker to 3.40 m bgl, with a gravelly reworked ashy clay underlying the sand with inclusions of wood and organic matter in TP101 and a grey sandy gravel of clinker and concrete within WS101.

The base of Made Ground was unproven in the southern sector in the majority of locations, except WS103 and CP102, where the Made Ground was proven at 2.00 m and 7.10 m bgl, respectively.

A hydrocarbon odour was noted within the Made Ground at four locations in the southern sector, WS105, TP102, TP104 and CP102;. A concrete slab obstruction was also encountered at 1.10 m bgl in TP102 (likely to be a large boulder rather than in-situ slab).

A Depth of Made Ground Plan is presented as Drawing 16-717-006 in Appendix III.

3.3. DRIFT DEPOSITS

Drift deposits were encountered within nine out of the 19No. exploratory hole locations across the site, to a maximum depth of 12.35 m bgl (base not proven).

The shallow (<5.00 m bgl) soils generally comprised an orange/brown medium to coarse SAND overlying a greyish brown SILT.

A stiff medium strength CLAY was encountered in WS103 and WS104 to >5.45 m bgl.

Cable percussive boreholes encountered deeper soil horizons comprising a sandy SILT with CLAY bands to 6.00 m bgl in CP101 and a silty SAND within CP102 to 10.90 m bgl. A brown boulder CLAY was encountered underlying the silt and sand in both locations. CP101 refused in the CLAY, likely on a boulder at 8.41 m bgl, whereas CP102 refused within a brown sandy GRAVEL at 12.35 m bgl, that was encountered underlying the boulder CLAY.

3.4. SOLID GEOLOGY

The solid bedrock geology was not encountered during the site investigation and BGS borehole records within 100 m of the site also did not encounter bedrock within boreholes advanced to 7.62 m bgl.

3.5. GROUNDWATER

Groundwater was not encountered during the site investigation.

3.6. VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

Visual and olfactory evidence of potential contamination has been identified during the site investigation as summarised in Table 3.2.



TABLE 3.2 SUMMARY VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

LOCATION	DEPTH (m)	STRATUM	NOTES
WS105	0.70–1.00	Made Ground	Slight hydrocarbon odour and black band
TP102	0.70	Made Ground	Strong hydrocarbon odour
TP104	0.50–2.90	Made Ground	Slight hydrocarbon odour
WS101	1.00–4.95	Made Ground	Clinker
WS103	0.30–2.00	Made Ground	Clinker

3.7. SOIL CONSISTENCY

Results of the standard penetration tests, including undrained shear strengths derived from SPTs are included in Table 3.3.

3.8. SIDE STABILITY AND EASE OF EXCAVATION

The sides of the exploratory trial pit excavations appeared to be generally stable during excavation.

The presence of brick and concrete cobbles within the Made Ground deposits meant that in certain places, excavation was slow through the Made Ground and in some places, Made Ground could not be fully penetrated. The natural strata was excavated with relative ease.



TABLE 3.3 STANDARD/CONE PENETRATION TEST RESULTS

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS101	1	MADE GROUND: Black gravelly fine to medium sand.	6	6.05	Loose	N/A	N/A	N/A	60.49
WS101	2	MADE GROUND: Black gravelly fine to medium sand.	5	4.57	Loose	N/A	N/A	N/A	45.68
WS101	3	MADE GROUND: Grey sandy clayey gravel.	4	3.48	Very Loose	N/A	N/A	N/A	34.79
WS101	4	MADE GROUND: Grey sandy clayey gravel.	3	2.53	Very Loose	N/A	N/A	N/A	25.35
WS101	5	MADE GROUND: Orangish brown sandy clay.	4	3.32	N/A	Very low strength	Soft	16.59	34.11
WS102	1	MADE GROUND: Greyish brown slightly silty gravelly reworked clay with frequent cobbles.	15	15.12	N/A	High strength	Very Stiff	75.61	155.46



BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS102	2	MADE GROUND: Greyish brown slightly silty gravelly reworked clay with frequent cobbles.	50	45.68	N/A	Very high strength	Very Stiff	228.38	469.56
WS103	1	MADE GROUND: Greyish brown sandy gravelly reworked clay.	10	10.08	N/A	Medium strength	Stiff	50.41	103.64
WS103	2	No recovery.	2	1.83	N/A	Extremely low strength	Very Soft	9.14	18.78
WS103	3	Greyish brown silty CLAY.	12	10.44	N/A	Medium strength	Stiff	52.18	107.28
WS103	4	Greyish brown silty CLAY.	12	10.14	N/A	Medium strength	Stiff	50.69	104.22
WS103	5	Greyish brown silty CLAY.	13	10.79	N/A	Medium strength	Stiff	53.93	110.87
WS104	1	MADE GROUND: Black slightly gravelly sandy clay.	40	40.33	N/A	Very high strength	Very Stiff	201.63	414.55



BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS104	2	Brown sandy SILT.	11	10.05	N/A	Medium strength	Stiff	50.24	103.30
WS104	3	Greyish brown SILT.	5	4.35	N/A	Low strength	Firm	21.74	44.70
WS104	4	Greyish brown SILT.	11	9.29	N/A	Medium strength	Stiff	46.47	95.54
WS104	5	Greyish brown CLAY.	13	10.79	N/A	Medium strength	Stiff	53.93	110.87
WS105	1	MADE GROUND: Greyish brown reworked clay.	6	6.05	N/A	Low strength	Firm	30.24	62.18
WS105	2	Greyish brown silty fine to medium SAND.	6	5.48	Loose	N/A	N/A	N/A	54.81
WS105	3	Greyish brown sandy SILT.	9	7.83	N/A	Low strength	Firm	39.13	80.46
WS105	4	Greyish brown sandy SILT.	12	10.14	N/A	Medium strength	Stiff	50.69	104.22
WS105	5	Greyish brown sandy SILT.	13	10.79	N/A	Medium strength	Stiff	53.93	110.87



BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING PRESSURE (kN/m ²)*
WS106	1	MADE GROUND: Greyish brown slightly sandy gravelly reworked clay.	9	9.07	N/A	Medium strength	Stiff	45.37	93.27
WS106	2	Orangish brown sandy CLAY.	7	6.39	N/A	Low strength	Firm	31.97	65.74
WS106	3	Orangish brown sandy SILT.	9	7.83	N/A	Low strength	Firm	39.13	80.46
WS106	4	Greyish brown SILT.	11	9.29	N/A	Medium strength	Stiff	46.47	95.54
WS106	5	Greyish brown SILT.	12	9.96	N/A	Medium strength	Stiff	49.78	102.34

Notes

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

The interpretation of in situ mass undrained shear strength (cu) data from SPT Blow Count (N) results and the influence of the Plasticity Index (PI) was reported in Standard Penetration Test in Insensitive Clays and Soft Rocks. Stroud (1974). The standard penetration test and the engineering properties of glacial materials subsequently. Stroud and Butler (1975) and (1989).

Allowable bearing pressure on sands. Soil Mechanics in Engineering Practice Terzaghi, K. & Peck, R.B. 1996.



3.9. PARTICLE SIZE DISTRIBUTION

Particle Size Distribution Tests have been undertaken on selected samples of granular material via wet sieve to obtain information on the soil fractions.

The results of the tests are summarised in Table 3.4. The full results can be found in Appendix VIII.

TABLE 3.4 SUMMARY OF PARTICLE SIZE DISTRIBUTION TEST RESULTS

LOCATION	DEPTH (m)	SOIL FRACTION (%)			
		COBBLES	GRAVEL	SAND	SILT/CLAY
TP105	1.50 (Natural)	0	47	17	30
TP106	2.00 (Natural)	0	1	53	46

3.10. SOIL DENSITY/MOISTURE CONTENT RELATIONSHIP

Maximum dry density / optimum moisture content relationship analysis has been conducted on soils using via utilising compaction tests utilising a 2.5 kg rammer.

The results of the tests are summarised in Table 3.5. The full test results can be found in Appendix VIII.

TABLE 3.5 SUMMARY DRY DENSITY AND MOISTURE CONTENT

LOCATION	LABORATORY DESCRIPTION	TOP DEPTH (m)	METHOD OF COMPACTION	INITIAL MOISTURE CONTENT (%)	OPTIMUM MOISTURE CONTENT (%)	MATERIAL RETAINED ON 37.5 mm SIEVE (%)	MAX DRY DENSITY (mg/m ³)	MATERIAL RETAINED ON 20.0 mm TEST SIEVE (%)
TP105	Brown clay bound silty SAND and GRAVEL	1.50	2.5 kg	10.3	14	26	1.86	33

The compaction tests have indicated that the granular soils from TP105 to be dry of the optimum.

3.11. SOIL PLASTICITY

The Atterberg limits determinations, summarised in Table 3.6, show the clay to be of low volume change potential.

TABLE 3.6 SUMMARY OF PLASTICITY INDEX TEST RESULTS

LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 µm SIEVE (%)	MODIFIED PLASTICITY INDEX	NHBC VOLUME CHANGE POTENTIAL
WS103	2.00	17.9	14	38	24	79	18.96	Low



LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 µm SIEVE (%)	MODIFIED PLASTICITY INDEX	NHBC VOLUME CHANGE POTENTIAL
WS103	3.00	18.8	16	40	24	68	16.38	Low
WS106	2.00	19.1	14	39	25	78	19.50	Low

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

3.12. pH AND SULPHATE

Chemical analyses for pH and soluble sulphate content are summarised in Table 3.7. Full results are included in Appendix VI.

Results show that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE *Special Digest 1* (2005).

TABLE 3.7 SUMMARY OF pH AND SULPHATE DATA

LOCATION	DEPTH (m)	SO ₄ IN 2:1 WATER/SOIL (g/l)	pH VALUE	CLASSIFICATION
TP101	1.20	0.14	5.5	DS-1, AC-1s
TP102	0.20	0.047	7.6	DS-1, AC-1s
TP102	0.80	0.37	8.9	DS-1, AC-1s
TP104	0.80	0.25	8.3	DS-1, AC-1s
TP105	1.00	0.061	8.5	DS-1, AC-1s
TP108	1.00	0.011	8.3	DS-1, AC-1s
WS106	0.20	0.096	8.4	DS-1, AC-1s



4. TIER 2 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 2 quantitative risk assessment to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

4.1. DEVIATING SAMPLES

Deviating samples were avoided during the ground investigation by using best practice sampling procedures including use of appropriate sampling containers and adhering to the laboratory holding times for each contaminant analysis undertaken. No deviations were noted in the soil samples.

4.2. HUMAN HEALTH RISK ASSESSMENT

At Tier 2 stage, the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published in LQM/CIEH S4UL (S4UL3267).

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



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

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PATH-WAY	ASSESSMENT
Arsenic	mg/kg	37	9	130 70	TP101 1.20 m TP104 0.80 m	1	Further Action
Cadmium	mg/kg	11	9	0.8	N/A	1	No Further Action
Chromium (VI)	mg/kg	6.0	9	<1.8	N/A	1	No Further Action
Lead	mg/kg	200	9	560 260 320	TP101 1.20 m TP104 0.80 m TP105 1.00 m	1	Further Action
Mercury	mg/kg	1.2	9	3.3	TP101 1.20 m	4	Further Action
Nickel	mg/kg	130	9	24	N/A	1	No Further Action
Selenium	mg/kg	250	9	25	N/A	1	No Further Action
Copper	mg/kg	2400	9	130	N/A	1	No Further Action
Zinc	mg/kg	3700	9	580	N/A	1	No Further Action
Cyanide – Total	mg/kg	791	9	1.7	N/A	1	No Further Action
Phenols – Total	mg/kg	120	7	<1	N/A	1	No Further Action
Asbestos	Fibres	NFD	7	0.003% wt/wt (Chrysotile & Amosite) 0.002% wt/wt (Chrysotile)	TP102 0.80 m TP105 1.00 m	3	Further Action
Naphthalene	mg/kg	2.3	9	0.77	N/A	4	No Further Action
Acenaphthylene	mg/kg	170	9	0.25	N/A	2	No Further Action
Acenaphthene	mg/kg	210	9	1.8	N/A	1	No Further Action
Fluorene	mg/kg	170	9	1.4	N/A	1	No Further Action
Phenanthrene	mg/kg	95	9	12	N/A	2	No Further Action
Anthracene	mg/kg	2400	9	2.9	N/A	2	No Further Action
Fluoranthene	mg/kg	280	9	16	N/A	2	No Further Action
Pyrene	mg/kg	620	9	15	N/A	2	No Further Action
Benzo(a)Anthracene	mg/kg	7.2	9	6.9	N/A	2	No Further Action
Chrysene	mg/kg	15	9	6.3	N/A	2	No Further Action
Benzo(b)Fluoranthene	mg/kg	2.6	9	4.8 5.5 8.0 2.8	TP102 0.20 m TP102 0.80 m TP104 0.80 m TP105 1.00 m	2	Further Action
Benzo(k)Fluoranthene	mg/kg	77	9	2.4	N/A	2	No Further Action
Benzo(a)Pyrene	mg/kg	2.2	9	4.2 4.7 5.9	TP102 0.20 m TP102 0.80 m TP104 0.80 m	2	Further Action



DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PATH-WAY	ASSESSMENT
				2.4	TP105 1.00 m		
Indeno(123-cd)Pyrene	mg/kg	27	9	3.3	N/A	2	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	0.24	9	0.67 0.62 0.60 0.34	TP102 0.20 m TP102 0.80 m TP104 0.80 m TP105 1.00 m	2	Further Action
Benzo(ghi)Perylene	mg/kg	320	9	3.6	N/A	2	No Further Action
TPH C5-C6 (aliphatic)*	mg/kg	42	20	1	N/A	4	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	100	20	0.1	N/A	4	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	27	20	0.1	N/A	4	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	74	20	7.8	N/A	4	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	140	20	150	TP102 0.80 m	4	Further Action
TPH C16-C21 (aromatic)*	mg/kg	260	20	210	N/A	1	No Further Action
TPH C21-C35 (aromatic)*	mg/kg	1100	20	130	N/A	1	No Further Action

Notes

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

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

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

4.2.1. SUMMARY OF RESULTS

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

Results have been compared to residential end use with plant uptake GAC values (S4UL and C4SL) with 1% soil organic matter in the first instance.

This comparison indicates that the data exceeds the GAC values for the following:

- ☛ Heavy metals (lead, arsenic and mercury [potentially volatile])
- ☛ PAHs (Benzo(b)fluoranthene, Benzo(a)Pyrene and Dibenzo(a,h)Anthracene)



☼ TPH (TPH Aromatic C12-C16)

☼ Asbestos (Chrysotile and Amosite fibres at 0.003% wt/wt and Chrysotile at 0.002% wt/wt)

VOC analysis was also undertaken on one sample of Made Ground from TP102 in which the strongest hydrocarbon odour was observed. SVOC and VOC concentrations were reported to be below the laboratory limit of detection (LOD).

It should be noted that the exceedances were identified in samples taken from the southern sector of the site (associated with area of former landfill).

4.2.2. DISCUSSION

MERCURY

The elevated total mercury encountered in the Made Ground in TP101 presents a potential volatilisation to indoor air risk. It should be noted that only the elemental proportion of the total mercury is potentially volatile, and speciation of this mercury may conclude the elemental proportion to be lower than the GAC value of 1.2 mg/kg. However, speciation was outside of the scope of this investigation.

Alternatively, given the elevated concentration of total mercury has only been identified within one isolated area of the site (TP101 at 1.20 m bgl), it is therefore considered to be a localised hotspot. Therefore, during a process of cut-and-fill enabling works, hotspot removal may be undertaken where these soils may be chemically validated to assess chemical suitability for retention on site in an area of no future sensitivity.

ASBESTOS

Asbestos was detected within two of the seven samples of Made Ground submitted for chemical analysis. Quantification confirmed the following concentrations:

☼ TP102 at 0.80 m bgl: 0.003% wt/wt (Chrysotile& Amosite)

☼ TP105 1.00 m bgl: 0.002% wt/wt (Chrysotile)

Impacted soil should be managed according to the asbestos risk mitigation conceptual site model (Figure 4.1). This may include delineation as a hotspot and removal from site or placement at a depth of >1.00 m below finished level in residential plots, gardens or POS.



FIGURE 4.1 ASBESTOS RISK MITIGATION CONCEPTUAL SITE MODEL



Notes

ND None Detect

0.001% Soils may contain $\leq 0.001\%$ asbestos using composite testing to ensure there is no potential risk to human health. This value is present within areas where there may be a short term low level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (dust suppression)

0.1% Soils at a depth of $>1.00\text{m}$ bgl may contain $<0.1\%$ asbestos using composite testing where they will not be likely to be disturbed in the future and will therefore be in an area of low sensitivity. Risk assessment completed in accordance with Asbestos JIWG risk assessment tools.

Undefined- this will be dependent upon soils encountered during earthworks, which may be placed at these depths to ensure no potential risk to human health.

HEAVY METALS, PAH COMPOUNDS AND HEAVY END TPH

The identified elevated concentrations of heavy metals, PAH compounds and heavy end TPH have primary exposure pathways related to dermal contact and ingestion, soil ingestion and consumption of homegrown produce.

These exceedances can be mitigated by the installation of a chemically suitable cover system within all proposed private garden areas, landscaping and public open space.

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

Although the identified contamination exceedances were only identified in samples taken from the southern sector of the site (associated with area of former landfill), given the sitewide spread of Made Ground, it would be considered prudent to apply the cover system to all plots where Made Ground remains at proposed development level.



Two samples of natural deeper drift deposits were submitted for chemical analysis (TP108 and TP110). Chemical analysis has indicated these soils to be acceptable for use as subsoil within the proposed garden areas; however, further chemical validation samples will be required to confirm this.

Two samples of the reworked topsoil (noted to contain brick and anthropogenic inclusions) were also submitted for chemical analysis (TP102 and WS106). Chemical analysis has indicated these soils to be acceptable for use as topsoil within the proposed garden areas; however, further chemical validation samples will be required to confirm this. Should material be found to be chemically suitable, inspection of the soil composition should be undertaken along with suitable screening of unsuitable anthropogenic inclusions.

4.3. CONTROLLED WATERS RISK ASSESSMENT

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

TABLE 4.2 CONTROLLED WATERS CONCEPTUAL MODEL AND SENSITIVITY PROFILE

DISCUSSION		SENSITIVITY RATING
Contaminant Source		
Made Ground / Former Landfill Elevated concentrations of heavy metals, PAH and heavy end TPH fractions have been found in the former landfill area in the south of the site, which may leach to underlying shallow groundwater and migrate towards nearby watercourses and waterbodies.		High
Pathway		
Vertical Migration Ground conditions comprise predominantly silt and sand with deeper clay layers to depths in excess of 8.00 m. The presence of fine grained lower permeability soils will reduce the potential for downward migration of leachable contaminants.		Medium
Lateral migration Lateral migration of contaminants is considered possible via granular layers of Made Ground and natural strata.		Low
Receptor		
Aquifer Classification in Superficial Drift Deposits	Secondary undifferentiated aquifer	Low
Aquifer Classification in Bedrock	Principal aquifer	High
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not affected	Low
Distance to the Closest Groundwater Abstraction Point	None identified within a 500 m radius.	Low
Is the Site Located Within 50 m of a Surface Watercourse?	The nearest surface water course is recorded to be the Moston Brook located c. 15 m south of the site. However, at its closest point to the site, this feature is recorded to be infilled. Flood mapping indicates the surface water course to open up c. 250 m south east of the site.	Low
The ICSM developed within the context of the site setting has viable pollutant pathway, which would be the downward migration of potentially mobile phase-soluble contaminants towards the underlying principal aquifer.		



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

TABLE 4.3 QUALITATIVE RISK TO CONTROLLED WATERS FROM SOIL ANALYTICAL RESULTS

CONTAMINANT	ASSESSMENT RATING	DISCUSSION
BTEX > 1 mg/kg	The soil data analysis has not identified any detectable concentrations of VOCs above 1mg/kg or TPH C5 to C6 that might otherwise be indicative of VOC impact.	None
Total VOC > 1 mg/kg		
Total SVOC > 1 mg/kg	SVOC analysis recorded concentrations of speciated PAH above 2 mg/kg within TP102 at 0.80 m bgl. SVOCs have not been found above the LOD.	None
C5-C10 > 5 mg/kg	All concentrations are below the laboratory LOD.	None
C10-C12 > 10 mg/kg	All concentrations of C10-C12 have been recorded below 10 mg/kg.	None
C12-C16 > 50 mg/kg	Concentrations of C12-C16 have been recorded above 50 mg/kg within TP102 at 0.80 m bgl with a concentration 150 mg/kg.	Further discussion
Phenols > 2 mg/kg	All concentrations are below the laboratory LOD.	None
Naphthalene > 2 mg/kg	Concentrations of Naphthalene above 2 mg/kg have not been recorded on site.	None
Total PAH > 10 mg/kg	Total concentrations of low-solubility PAH compounds greater than 10 mg/kg have been detected in four locations, with a maximum concentration recorded in TP104 at 87 mg/kg.	Further discussion
PCB > 1 mg/kg	No potential sources of PCB have been identified	None
Heavy metals > 500 mg/kg	Concentrations of heavy metals above 500 mg/kg have been recorded in TP101 and TP105.	Further discussion

It should be noted that it has not been possible to obtain groundwater samples due to boreholes either being dry or containing insufficient volumes of water.

The Tier II assessment has therefore included a comparison of leachate analysis from samples of the Made Ground to drinking water standards (DWS) due to the presence of a Principal bedrock Aquifer underlying the site. Results are presented in Table 4.4.



TABLE 4.4 COMPARISON OF GROUNDWATER AND LEACHATE ANALYSIS WITH TIER 2 SCREENING LEVELS

DETERMINAND	UNIT	EQS ^{1,2}	DWS _{3,4}	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA					
Arsenic	µg/l	50	10	2	2.1	N/A	No Further Action
Cadmium	µg/l	0.08-0.25	5	2	<0.08	N/A	No Further Action
Chromium (VI)	µg/l	3.4	–	2	<5.0	N/A	No Further Action
Chromium (III)	µg/l	4.7	50	2	3.3	N/A	No Further Action
Copper	µg/l	1	2000	2	7.3	N/A	No Further Action
Total Cyanide	µg/l	1	50	2	6.4	N/A	No Further Action
Lead	µg/l	1.2	10	2	6.3	N/A	No Further Action
Mercury	µg/l	–	1.0	2	<0.5	N/A	No Further Action
Nickel	µg/l	4	20	2	1.1	N/A	No Further Action
Selenium	µg/l	–	10	2	5.4	N/A	No Further Action
Zinc	µg/l	10.9	–	2	7.7	N/A	No Further Action
pH	6–9			2	8.4	N/A	No Further Action
Polycyclic Aromatic Hydrocarbons							
Naphthalene	µg/l	2	10*	2	0.51	N/A	No Further Action
Anthracene	µg/l	0.1	10*	2	<0.01	N/A	No Further Action
Benzo[b]fluoranthene	µg/l	0.00017*	10*	2	<0.01	N/A	No Further Action
Benzo[k]fluoranthene	µg/l	0.00017*	10*	2	<0.01	N/A	No Further Action
Benzo(a)pyrene	µg/l	0.00017*	10*	2	<0.01	N/A	No Further Action
Indeno(123-cd)pyrene	µg/l	0.00017*	10*	2	<0.01	N/A	No Further Action
Fluoranthene	µg/l	0.0063	10*	2	<0.01	N/A	No Further Action
Benzo(ghi)perylene	µg/l	1.7–4	10*	2	<0.01	N/A	No Further Action



DETERMINAND	UNIT	EQS ^{1, 2}	DWS _{3,4}	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA					
Aromatic Hydrocarbon							
TPH C5-C7 (benzene)	µg/l	10	1	2	<1.0	N/A	No Further Action
TPH C7-C8 (toluene)	µg/l	74	700	2	<1.0	N/A	No Further Action
TPH C8-C10 (xylene)	µg/l	30	300	2	<1.0	N/A	No Further Action
TPH C10-C12 (naphthalene)	µg/l	2	90	2	<10	N/A	No Further Action
TPH C12-C16	µg/l	–	90	2	<10	N/A	No Further Action
TPH C16-C35	µg/l	–	90	2	<10	N/A	No Further Action
Aliphatic Hydrocarbon							
TPH C5-C6	µg/l	–	1000 ⁵	2	<1.0	N/A	No Further Action
TPH C6-C8	µg/l	–	1000 ⁵	2	<1.0	N/A	No Further Action
TPH C8-C10	µg/l	–	300	2	<1.0	N/A	No Further Action
TPH C10-C12	µg/l	–	300	2	<10	N/A	No Further Action
TPH C12-C16	µg/l	–	300	2	<10	N/A	No Further Action
TPH C16-C21	µg/l	–	300**	2	<10	N/A	No Further Action
TPH C21-C35	µg/l	–	300**	2	<10	N/A	No Further Action
Volatile Organic Compounds							
Tetrachloroethylene	µg/l	0.4	10	3	N/A	N/A	No Further Action
Trichloroethylene	µg/l	10	10	3	N/A	N/A	No Further Action
Trichlorobenzene	µg/l	0.4	–	3	N/A	N/A	No Further Action
Trichloromethane	µg/l	2.5	–	3	N/A	N/A	No Further Action
Dichloromethane	µg/l	20	200	3	N/A	N/A	No Further Action



DETERMINAND	UNIT	EQS ^{1,2}	DWS _{3,4}	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA					
Carbon Tetrachloride	µg/l	12	3	3	N/A	N/A	No Further Action
Vinyl Chloride	µg/l	–	0.3	3	N/A	N/A	No Further Action

Notes

Solubility <0.01µg/l

AA – Annual Average

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

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

1. The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)
2. The Water Supply (Water Quality) Regulations 2018 (legislation.gov.uk)
3. Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum (who.int)
4. CL:AIRE publishes Petroleum Hydrocarbons in Groundwater guidance (claire.co.uk)
5. A total TPH criteria of 1000 mg/kg will act as a surrogate criterion for remaining aliphatic and aromatic TPH fractions.



4.3.1. SUMMARY OF RESULTS

Leachate analysis has not identified any exceedances when compared to Drinking Water Standards (DWS) GAC values.

4.3.2. DISCUSSION

The primary receptor has been identified as the underlying Principal Aquifer (bedrock). No exceedances of DWS values have been found in the two leachate samples analysed. It has not been possible to obtain groundwater samples for a full appraisal due to boreholes either being dry or containing insufficient volumes of water.

The drift deposits across the site are variable. Given the presence of lower permeability fine grained soils which will reduce downward migration of contamination and the absence of any exceedances in the leachate, or shallow groundwater to mobilise soil contamination, the overall risk may be considered low.

Given the absence of a groundwater abstraction point or surface watercourse within close proximity to the site, there is not considered to be a complete pollutant linkage.

However, given the nature of the site and presence of deep Made Ground / landfill materials, it would be prudent to obtain water samples for assessment if resting water levels are found to rise over the monitoring period.

4.4. GROUND GAS RISK ASSESSMENT METHODOLOGY

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in:

CIRIA Report 665 – Assessing risks posed by hazardous ground gases to buildings (2007)

BS8485:2015+A1:2019 – Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

BS8485 provides guidance on the level of gas protection requirements based upon the characteristic situation (CS) and the proposed development based on building type.

Therefore, in accordance with BS8485, based on the measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) shall be derived for each monitoring point, from which the site characteristic hazardous gas flow rate (Q_{hgs}), and then the Characteristic Situation (CS) can be determined.

The following equation should be utilised:

$$Q_{hg} = q \left(\frac{C_{hg}}{100} \right)$$

Where:

q is the measured flow rate (in litres per hour) of combined gases from the monitoring standpipe
 C_{hg} is the measured hazardous gas concentration (in percentage volume/volume).

The subsequent derived gas screening value (GSV) should be the maximum Q_{hg} (flow rate x concentration as a percentage volume) for all the monitoring events.



A 'worst case check' may be carried out using the maximum recorded flow in any hole with the maximum concentration in any hole to present the plausible worst case conditions. Adoption of the worst case Q_{hg} requires thorough justification and reference to the CSM.

The final derived GSV can then be used to characterise the site as summarised in Table 4.5.

TABLE 4.5 SITE CHARACTERISATION BY GSV (BS8485:2015)

CS	HAZARD POTENTIAL	GSV (l/hr) FOR METHANE AND CARBON DIOXIDE	ADDITIONAL FACTORS
CS1	Very Low	< 0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	< 0.70	Typical measured flow rate <70 l/h (otherwise consider an increase to CS3)
CS3	Moderate	< 3.5	N/A
CS4	Moderate to High	< 15	N/A
CS5	High	< 70	N/A
CS6	Very High	> 70	N/A

Notes

1. The CS is equivalent to the characteristic GSV in CIRIA C665.
2. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter should be considered.
3. Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, multiplied by the concentration in the air stream of the particular gas being considered.
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

4.5. MONITORING METHODOLOGY

Concentrations of methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) (hydrogen sulphide) were measured using a calibrated infrared gas analyser (GFM435) with gas flow rates measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 500 seconds at each location, at which point the maximum concentration of CH_4 and CO_2 , together with the lowest concentration of O_2 were recorded.

The results of the ground gas monitoring are presented in Table 4.6.

In addition to the raw data, the results for each individual standpipe have been assessed with reference to guidance provided in BS8485:2015. Based on the initial peak measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) have been derived for each monitoring point, from which an individual Characteristic Situation (CS) can ultimately be determined.



TABLE 4.6 SUMMARY OF GROUND GAS MONITORING RESULTS

WELL	STRATA	DATE	CH ₄ PEAK (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ Q _{hg} (l/hr)	CO ₂ PEAK (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ Q _{hg} (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	PEAK FLOW (l/hr)	STEADY FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS101	MADE GROUND	05/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.7	998	Rising	0.1	0.1	1.00-4.00	4.60	Dry
		25/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	998	Steady	0.1	0.1		4.60	Dry
		02/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	974	Falling	0.1	0.1		4.70	Dry
		08/08/2023	0.1	0.1	0.0001	0.8	0.6	0.0008	20.5	1002	Falling	0.1	0.1		4.70	Dry
		15/08/2023	0.1	0.1	0.0001	1.2	1.2	0.0012	19.3	1003	Rising	0.1	0.1		4.70	Dry
WS102	MADE GROUND	05/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.7	999	Rising	0.1	0.1	1.00-2.00	1.85	Dry
		25/07/2023	0.1	0.1	0.0001	5.4	5.4	0.0054	13.2	999	Steady	0.1	0.1		1.90	Dry
		02/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	999	Falling	0.1	0.1		1.94	Dry
		08/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.2	999	Falling	0.1	0.1		1.94	Dry
		15/08/2023	0.1	0.1	0.0001	6.3	6.3	0.0063	11.6	999	Rising	0.1	0.1		1.94	Dry
WS103	CLAY	05/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.8	998	Rising	0.1	0.1	2.00-5.00	Bung Stuck	
		25/07/2023	0.1	0.1	0.0001	5.3	5.3	0.0053	4.8	998	Steady	0.1	0.1			
		02/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	975	Falling	0.1	0.1			
		08/08/2023	0.1	0.1	0.0001	5.4	5.3	0.0054	12.1	1002	Falling	0.1	0.1			
		15/08/2023	0.1	0.1	0.0001	3.4	3.4	0.0034	14.3	1004	Rising	0.1	0.1			
WS104	MADE GROUND	05/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.5	1000	Rising	0.1	0.1	0.50-2.00	2.00	Dry
		25/07/2023	0.1	0.1	0.0001	8.2	8.1	0.0082	2.5	1000	Steady	0.1	0.1		1.90	Dry
		02/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	975	Falling	0.1	0.1		2.05	1.50
		08/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	1001	Falling	0.1	0.1		2.05	1.37
		15/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	1004	Rising	0.1	0.1		2.05	1.20



WELL	STRATA	DATE	CH ₄ PEAK (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ Q _{hg} (l/hr)	CO ₂ PEAK (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ Q _{hg} (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	PEAK FLOW (l/hr)	STEADY FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS105	SILT	05/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	1000	Rising	0.1	0.1	2.50-4.50	4.10	3.90
		25/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	19.8	1000	Steady	0.1	0.1		3.30	2.90
		02/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.1	976	Falling	0.1	0.1		3.25	2.54
		08/08/2023	0.1	0.1	0.0001	0.2	0.1	0.0002	20.1	1001	Falling	0.1	0.1		3.25	2.67
		15/08/2023	0.1	0.1	0.0001	0.3	0.1	0.0003	20.4	1005	Rising	0.1	0.1		3.25	2.75
WS106	CLAY/SILT	05/07/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.6	1000	Rising	0.1	0.1	2.00-4.00	3.70	3.40
		25/07/2023	0.1	0.1	0.0001	9.1	7.4	0.0091	4.9	998	Steady	0.1	0.1		3.60	3.20
		02/08/2023	0.1	0.1	0.0001	0.1	0.1	0.0001	20.4	974	Falling	0.1	0.1		3.70	3.26
		08/08/2023	0.1	0.1	0.0001	0.9	0.8	0.0009	15.3	1001	Falling	0.1	0.1		3.70	3.10
		15/08/2023	0.1	0.1	0.0001	7.7	7.7	0.0077	1.2	1005	Rising	0.1	0.1		3.70	3.10

Notes

CIRIA Characteristic Situation		Q _{hg}			
	CS1	<0.07	Typical Max CO ₂ <5 % Typical Max CH ₄ <1 %	Values in BOLD exceed CS1 Thresholds	
	CS2	<0.7	Flow rate not to exceed 70 l/hr otherwise consider increase to CS3	Values in BLUE denote water above level of response zone (flooded)	
	CS3	<3.5			
	CS4	<15	Quantitative Risk Assessment required to evaluate scope of protective measures		



4.6. SUMMARY OF MONITORING RESULTS

4.6.1. GROUNDWATER

Groundwater was recorded between 2.54 m and 3.90 m bgl within WS105 and WS106.

Shallower water levels were recorded between 1.20 m and 1.50 m bgl within WS104, however this is likely perched and a result of heavy rainfall events, as the monitoring installation was installed at a shallow depth within Made Ground.

WS101 and WS102 were recorded as dry throughout the monitoring visits to date.

It should be noted that although water has been recorded in the boreholes, the maximum depth of the water column recorded to date is 0.71 m in WS105.

4.6.2. BAROMETRIC PRESSURE

Visits 1 and 6 were undertaken during periods of relatively high/rising pressure, with pressure recorded to be 1000 mbar and 1005 mbar, respectively.

Visit 2 was undertaken during a period of relatively high, steady pressure.

Visits 3 and 4 were undertaken during periods of falling pressure and visit 3 was also undertaken during a period of relatively low pressure, with pressure recorded to be 974 mbar.

It is therefore considered that the visits have been undertaken over representative conditions.

4.6.3. GAS FLOW

Throughout the monitoring period, flow rates were recorded to be 0.1 l/hr (limit of detection of the analyser).

4.6.4. GAS CONCENTRATIONS

The maximum methane value recorded within the monitoring wells was 0.1% v/v (limit of detection of the analyser).

Carbon dioxide concentrations were recorded at concentrations ranging from 0.1% v/v to 9.1% v/v (WS106).

Concentrations of carbon dioxide have been recorded >5% in WS101, WS102, and WS106 on two occasions and WS104 on one occasion. Typically these occurred during Visit 2 (27/8/23 – steady low pressure 998-1000 mbar) and Visit 5 (15/8/23 – rapidly rising pressure 999-1005 mbar).

4.7. CONCLUSION

The determined Characteristic Situation for each standpipe for each visit indicates that based on the peak flow rates the majority of the monitoring visits classify as Characteristic Situation (CS)1 – Very Low Gas Risk. However, E3P has assessed the variables and come to the following conclusions:



- ✳ The southern part of the site forms part of a larger historical landfill and deep Made Ground (up to 7.10m bgl in CP102), with degradable inclusions of wood and timber have been observed. Other degradable organic materials may be present at intervening locations and cannot be discounted.
- ✳ WS102, WS103, WS104 and WS106, predominantly in the south of the site and area of former landfill, have recorded carbon dioxide above 5% v/v threshold, however the GSV is noted to be within a CS1 classification due to the absence of flow.
- ✳ Given the presence of the recorded historical landfill that encroaches on the south of the site, and the elevated carbon dioxide concentrations recorded, it is recommended that precautionary allowances be made for CS2 gas protection measures.
- ✳ The final classification will be confirmed on completion of the full ground gas monitoring programme to enable an appraisal of the full dataset. The assessment should also include a ternary gas assessment to assess the gas composition.

4.8. POTABLE WATER SUPPLY

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

TABLE 4.7 PIPELINE SELECTION PE THRESHOLD CONCENTRATIONS

Contaminant Group	PE-threshold (mg/kg)	Concentrations at <u>Current</u> pipeline depth (mg/kg)
Total VOC	0.5	<0.05
Total BTEX And MTBE	0.1	<0.05
Total SVOCs (Excluding PAH and those substances marked with an *)	2	0.5
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2	<1.2
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10	157.8 (TP102 0.80m)
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	351
Phenols (From SVOC Analysis)*	2	N/A
Cresols and Chlorinated Phenols (From SVOC Analysis)	2	N/A
Ethers*	0.5	N/A
Nitrobenzene*	0.5	N/A
Ketones*	0.5	N/A
Aldehydes*	0.5	N/A
Amines	Fail	N/A
Other Consideration		
Are there any exceedances of the PE threshold outside of the pipeline depth?	None	
Is free product present in soil and groundwater?	None	

