



Phase 2 Intrusive Site Investigation Report

LOCATION	45 – 47 Bridge Avenue, Hanwell W7 3DJ
ISSUE DATE	August 2023
FOR	GG Holding (Hanwell) Ltd
CLIENT REF.	
OUR REF.	G23244b

Prepared by



Jason Pratt BSc (Hons)
Senior Geoenvironmental Engineer

Checked by



Stuart Howe BSc (Hons) FGS
Senior Geotechnical Engineer

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Units 3a and 4 Terry Dicken Industrial Estate
Ellerbeck Way
Stokesley
North Yorkshire
TS9 7AE
Tel. 01642 713779
Fax 01642713923
Email enquiries@geoinvestigate.co.uk

1. Introduction

In accordance with your instruction, Geoinvestigate Limited has carried out an intrusive site investigation at 45 – 47 Bridge Avenue, Hanwell W7 3DJ.

A Phase 1 Desk Study has previously been completed by Geoinvestigate Limited (G23244, July 2023), which concluded that onsite development and demolition, together with the adjacent residential housing and landfill were the potential sources of contamination to the site.

The purpose of this Phase 2 investigation was to establish the true nature of the ground conditions at the site with regard to the potential for contamination, hazardous gas sources on site and determining appropriate foundation types.

It is proposed to develop the site with residential housing with soft landscaping as gardens and hardstanding access roads and parking. The boundary of the current study area and the proposed developmental layout are presented on the site plan included within Appendix 1 of this report.

2. Scope of Phase 2 Investigation

2.1 Scope of Works

Given the above, the following investigation was carried out to assess the potential risks to the proposed development:

- Three (3) boreholes (BH1 to BH3) were undertaken at the site to depths of 3.00m below ground level (bgl) with associated soil sampling. The boreholes were commenced using windowless sampling techniques with a Dando Terrier 2002 mini drilling rig.
- The installation of three (3) gas monitoring wells in boreholes BH1, BH2 and BH4 with allowance for up to six (6) gas monitoring visits over a period of up to three (3) months (if appropriate), including readings below 1000mb and where possible following a sharp drop in atmospheric pressure.
- Geotechnical testing comprising eighteen (18) moisture content determinations and three (3) Atterberg Limit plasticity tests to provide information with regard to soil conditions and shrinkage potential of any clay soils.
- Contamination analyses of four (4) samples of near-surface topsoil/made ground recovered from depths between 0.20m and 1.00m bgl to investigate the potential presence and concentrations of various potential contaminants (including metals/metalloids, asbestos, polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPHs). Additionally, Leachate testing (to check for mobility of contaminants) were also completed. Chemical analysis is based on the attending engineer's descriptions of the ground conditions.
- Provision of a factual and interpretative report including site plan, borehole logs, geotechnical and contamination soil analysis results, together with advice on the contamination and gas situation at the site.

The borehole positions are shown on the plan provided in Appendix 1.

The excavations were sampled and logged at site by a geoenvironmental engineer and the ground conditions encountered are described on the borehole logs also provided in Appendix 1.

The results of geotechnical soil testing and soil moisture profiles are included in Appendix 2.

The results of the contamination testing are included in Appendix 3.

2.2 Sampling Rationale

The borehole positions were chosen to give an indication of the ground conditions generally throughout the site, both in terms of geotechnical appraisal and assessment of soil contamination. The soils encountered in the boreholes are considered to be broadly representative of soils throughout the site.

3. Phase 2 Investigation Findings

3.1 Encountered Ground Conditions

3.1.1 Windowless Sample Boreholes

The ground conditions were relatively uniform across the site and made ground underlain by firm to stiff clay to termination.

The made ground comprised loose clayey gravelly sand with fragments of brick, sandstone and concrete to 0.30m in each case.

Below the made ground the natural strata comprised firm to stiff clay to termination at 3.00m in each borehole.

Hand shear vane tests returned values between 35kN/m² and 55kN/m² from between 0.50m and 1.00m bgl indicating generally firm conditions, then values between 48kN/m² and 70kN/m² from between 1.50m and 2.00m bgl indicating generally firm stiff conditions, then values between 50kN/m² and 90kN/m² from between 0.50m and 1.00m bgl indicating generally firm to conditions.

No significant roots or standing water was recorded during the works.

3.2 Soil Moisture, Plasticity Testing and Vegetation Influence.

Borehole moisture profiles are presented in Appendix 2. Moisture contents between 20.8% and 32.7% were reported within the natural strata.

Atterberg Limit testing returned Plasticity Indices (PIs) between 48.8% and 51.8%. The onsite cohesive soils are classified as Clay of Very High (CV) Plasticity according to BS 5930. According to NHBC Section 4.2 Building Near Trees, the clay soils are noted to be of High Shrinkage Soils (volume change potential).

Although no roots were recovered from the boreholes, the moisture profiles indicate that vegetation related moisture depletion may extend to depths of between 1.50m and 2.00m currently.

Therefore, given the above, it is considered that there is a high risk of seasonal soil volumetric changes attributable to vegetation. Therefore, it is recommended that foundations are designed to mitigate against this accordingly.

4. Contamination Testing

As mentioned in Section 1, it is considered that onsite development and demolition, together with the adjacent residential housing and landfill might provide the most viable source of contamination to the site.

Potential contaminants could possibly occur throughout the full thickness of the made ground which was recovered from the boreholes to a maximum depth of 0.30m. Soils close to surface would be the most relevant regarding human health risk assessment though analysis of deeper soils would also be appropriate to ensure no risk to local ground and surface waters exists through potential contaminant leaching and mobilisation. Other than the presence of occasional brick and pot fragments, the topsoil showed no obvious visual or olfactory evidence of potential contamination or contaminative materials. However due to the presence of the adjacent dwelling and site history, potential contamination risk existed at the site.

Based on the findings of the site works, four (4) samples of topsoil and made ground from depths of between 0.20m and 1.00m recovered from across the site were tested for a range of substances. These included common contaminants such as Arsenic, Lead and Cadmium which are normally included in a general human health contamination suite together with analysis for Speciated PAHs (2 samples), petroleum hydrocarbons, and Asbestos (2 samples).

The results of the contamination testing are included in Appendix 2 of this report (Chemtech Environmental Ltd. Report 124843 and have been used in the contamination risk assessment, set out in the following sections.

5. Risk Assessment

5.1 Method

Geoinvestigate Ltd. uses a combination of assessment criterion provided by the Environment Agency, DEFRA and by the Chartered Institute of Environmental Health in order to assess the presence of potentially harmful chemicals within soils and water. These include DEFRA category 4 screening levels (C4SLs), Environment Agency Environmental Quality Standards (EQSs), Site Specific Assessment Criteria (SSAC) generated using CLEA software version 1.06 site specific risk assessment modelling, and Land Quality Management / Chartered Institute of Environmental Health (LQM/CIEH) Safe for Use Limits (S4ULs).

As the site is to be developed as a residential dwelling, it falls within the residential end-use category. As it is possible that persons living on the site may cultivate vegetables / fruit for consumption, consideration to this end is also deemed necessary.

No site-specific assessment criteria (SSAC) have been created for the site as no unusual circumstances (i.e., occupation periods etc.) are considered to be present/likely at the site that would render the generic residential assessment criteria unsuitable.

The results of the contamination testing that has been carried out have been compared to the soil quality values from the above sources. Where they fall below these limit values, they have been deemed safe for a residential end use. Had any results been found to be above the intervention values, an assessment of

the available pathways and receptors would have been carried out to determine whether further investigation or remediation might have been necessary.

An appraisal of the chemical results and relevant limits is set out in the Contamination Risk Assessment that follows.

5.2 Contamination Risk to Identified Receptors

5.2.1 Contamination Risk to Human Health

Made ground was encountered to a maximum depth of 0.30m, this was underlain by a cohesive clay.

No soils encountered at the site exhibited any noteworthy visual or olfactory evidence of possible contamination.

As discussed earlier in the report, levels of determinands have been compared to the soil assessment criteria for residential end-use, as published by the Environment Agency, DEFRA and LQM/CIEH.

The results of the analyses of four (4) samples of soil recovered from the site from depth of between 0.20m and 1.00m returned concentrations of a range of substances falling for the most part below respective assessment criteria adopted from the sources named above with no exceptions. Further discussion is presented in the following sections. A summary of the returned soil concentrations together with the adopted assessment criteria is presented in Table 1 on the following page.

A mean Total Organic Carbon Content (TOC) of 0.55% and mean Soil Organic Matter Content (SOM) of 0.98% (estimated from the TOC) were returned from the soil analyses. Therefore, the LQM/CIEH GAC for PAHs and Hydrocarbons were chosen using the lowest Soil Organic Matter (SOM) option of 1.00%, which is considered the most representative value for the samples returned.

Table 1: Chemical Determinands in Soils

	Range of Returned concentrations (mg/kg)	S4UL (LQM/ClEH)* (mg/kg)	C4SL (DEFRA)* (mg/kg)
Asbestos	None detected (both)	Any presence unacceptable	
Arsenic	8.8 – 13.0	37	37
Boron	0.7 – 2.0	290	
Cadmium	<0.2 – 0.4	11	26
Chromium VI	<1 (all)	6	21
Chromium III	27.6 – 54.7	910	
Copper	16 – 76.6	2,400	
Lead	14.8 – 77.9		200
Mercury (elemental)	<0.1 (all)	1.2	
Nickel	16.3 – 43.4	130	
Selenium	<1.0 (all)	250	
Zinc	45.6 – 142	2,700	
pH	8.1 – 10.2	See Report Section 7.3 "Concrete Design"	
Water Soluble SO ₄	96 – 1065		
Phenol	<0.5 (all)	120	
Total PAH	<0.34 – 3.59		
PAH Naphthalene	<0.02 (all)	2.3	
PAH Acenaphthylene	<0.02 (all)	170	
PAH Acenaphthene	<0.02 (all)	210	
PAH Fluorene	<0.02 (all)	170	
PAH Phenanthrene	<0.02 – 0.1	95	
PAH Anthracene	<0.02 – 0.05	2400	
PAH Fluoranthene	<0.02 – 0.34	280	
PAH Pyrene	<0.02 – 0.47	620	
PAH Benzo[a]anthracene	<0.02 – 0.32	7.2	
PAH Chrysene	<0.03 – 0.28	15	
PAH Benzo(b)fluoranthene	<0.02 – 0.65	2.6	
PAH Benzo(k)fluoranthene	<0.03 – 0.23	77	
PAH Benzo(a)pyrene	<0.02 – 0.48	2.2	5
PAH Dibenzo(a,h)anthracene	<0.02 – 0.07	0.24	
PAH Indeno(123-cd)pyrene	<0.02 – 0.32	27	
PAH Benzo(ghi)perylene	<0.02 – 0.30	320	
TPH Aromatic C5-C7	<0.01 (all)	70	0.87 (benzene)
TPH Aromatic C7-C8	<0.01 (all)	130	
TPH Aromatic C8-C10	<0.01 (all)	34	
TPH Aromatic C10-C12	<10 (all)	74	
TPH Aromatic C12-C16	<10 (all)	140	
TPH Aromatic C16-C21	<1 (all)	260	
TPH Aromatic C21-C35	<1 (all)	1100	
TPH Aromatic C35-C44	<1 (all)	1100	
TPH Aliphatic C5-C6	<0.1 (all)	42	
TPH Aliphatic C6-C8	<0.1 (all)	100	
TPH Aliphatic C8-C10	<0.1 (all)	27	
TPH Aliphatic C10-C12	<6 (all)	130 (48)*	
TPH Aliphatic C12-C16	<6 (all)	1100 (24)*	
TPH Aliphatic C16-C35	<15 (all)	65000 (8.48)*	
TPH Aliphatic C35-C44	<10 (all)	65000 (8.48)*	

*For residential use with allowance for cultivation of fruit/veg and at 1% organic matter where relevant.

**Figures in parentheses represent estimated soil saturation limits above which there may be some potential for free phase contamination to exist.

Exceedances of assessment criteria are shown in **BOLD**.

As can be seen from the results in Table 1 and the detailed results presented in Chemtech Environmental Ltd. report 96523 (Appendix 3) the returned results are below the adopted target values.

5.2.2 Contamination Risk to the Controlled Waters

Given the possible sources of historical contamination and nature of material, leachate was analysed from two (2) samples obtained from BH2 and BH3 at 0.50m and 0.20m respectively. This screening returned generally negligible concentrations and concentrations below detectable limits and/or safe levels for domestic water supply or the protection of aquatic life levels as published by the Environment Agency which were used as the assessment criteria. The results of the testing and the assessment criteria are shown Table 2 below.

Table 2: Chemical Determinands in Leachate

	Returned Concentrations (µg/l)	UK Standard for Surface Waters intended for Drinking Water Abstraction* (DW) and/or protection of Aquatic Life in surface waters* (Aq) (µg/l)
<i>Inorganic Chemicals</i>		
Arsenic	<0.5 – 4.2	50 (DW, range: 50-100) (No Aq standard)
Boron	17 – 21	1000 (DW & Aq)
Cadmium	<0.5 (each)	5 (DW & Aq)
Chromium	<0.5 – 1.8	50 (DW) / 5-250 (Aq, range: 5-250)
Copper	0.6 – 1.1	50 (DW) / 5-112 (Aq, range: 5-112)
Lead	<0.5 – 0.9	50 (DW) / 4-250 (Aq, range: 4-250)
Mercury (elemental Hg)	<0.05 – 0.07	1 (DW & Aq)
Nickel	<0.5 (each)	20** (DW) / 50-200 (Aq, range: 50-200)
Selenium	<1 (ach)	10 (DW) (No Aq standard)
Zinc	<1.2 (each)	3000 (DW, range: 3000-5000) / 30-2000 (Aq, range: 30-2000)
pH	7.9 – 8.8	Range 5.5 to 10 (UK drinking water standards)
<i>Organic Chemicals</i>		
Cyanide	<5 (each)	50 (DW) / 5 (Aq)
Phenols	<10 (each)	50** (DW) / 300 (Aq)
PAHs (total)		0.2 (DW, range: 0.2-1.0) (No Aq standard)
Individual PAH species:		
Acenaphthene	0.5 (each)	No applicable UK standard
Benzo(a)Anthracene	<0.1 – 0.6	No applicable UK standard
Fluorene	0.3 – 0.4	No applicable UK standard

*sourced from Environment Agency database at <http://evidence.environment-agency.gov.uk/ChemicalStandards/home.aspx>.

If more than one option is available (dependant on other water properties or environmental setting) applicability is discussed later.

**Standard for water supply as no standard available for surface water abstraction for drinking water.

Exceedances of assessment Criteria shown in **BOLD** type

As can be seen from Table 2 and the detailed results presented in Chemtech Environmental Ltd report 96523 (Appendix 2), levels of potential contaminants in analysed leachates returned negligible concentrations with no exceptions.

5.3 Review of Results

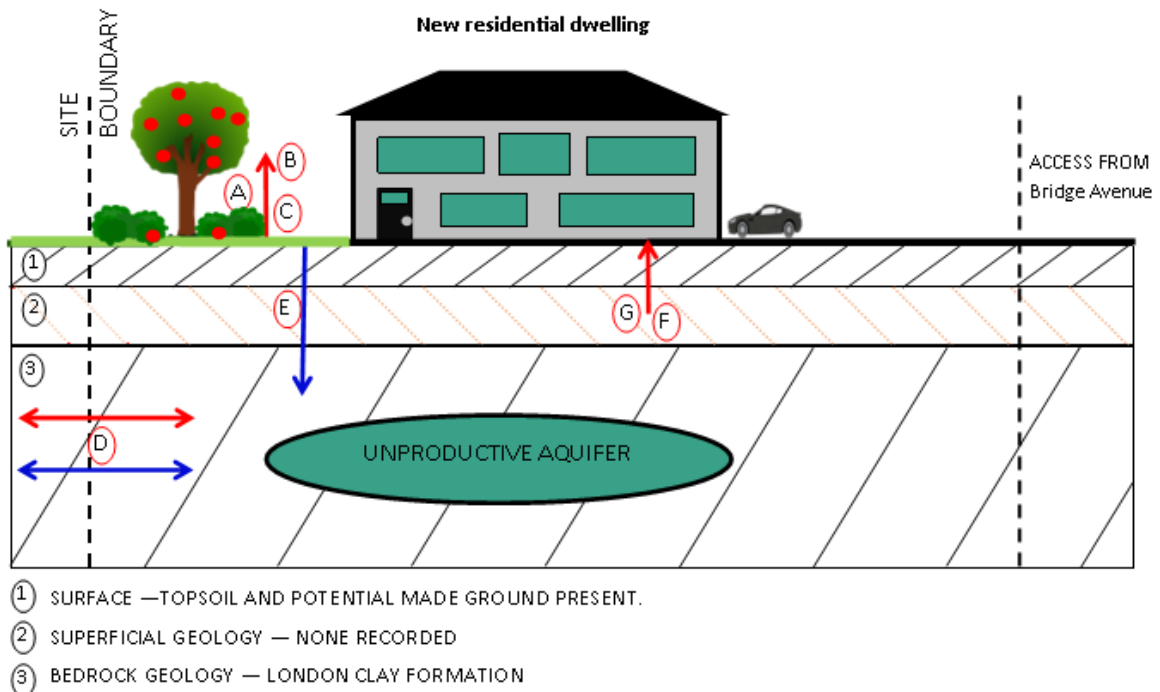
The data presented in Tables 1 and 2 and the associated discussion show that returned concentrations of potential contaminants in the soils and leachates analysed generally fall below the adopted assessment criteria in Table 2 and always fall below adopted assessment criteria in table 1. Due to the minor level of exceedance and the cautious nature of the thresholds chosen it is considered to not be of risk to end site users.

As such, no significant risk has been identified from the soils on site directly or indirectly to end users or to ground and surface waters through leaching. No remediation will be necessary.

5.3.1 CGHM

The conceptual ground hazard model (CGHM) presented on the following page shows the potential hazards and pollutant linkages which have been considered at the site and those which may still be complete, or would be complete, if the site were to be developed as a residential unit in its current condition.

Figure 1: CGHM – Conceptual cross section of site including a Source, Pathway and Receptor Model



IDENTIFIED HAZARDS Including Potential CONTAMINATION SOURCES

- Construction (materials) and use of existing and previous building and neighbouring site
- Nearby landfill site.

IDENTIFIED RECEPTORS and ASSOCIATED PATHWAY

- A**— End Users through Direct Contact / Inhalation / Ingestion. Buildings and hard standing will encompass some of the site, removing any pathway to end users through direct contact in these areas.
- B**— Plants and Trees through uptake, likely given the intended end use of the site.
- C**— End Users through cultivation and consumption of vegetables / fruit. Likely given the intended end use of the site.
- D**— Neighbouring Sites through lateral migration (in soil and water, including surface water run off).
- E**— Groundwater through leaching of sub-soil.
- F**— Buildings and services through direct contact. Buildings and hard standing will encompass some of the site, removing any pathway to end users through direct contact in these areas.

Linkages A to F broken due to the acceptable contaminant levels returned from the soils testing at the site.

- G**— End users and buildings through ground gas migration—unlikely, given the apparent absence of viable sources

Linkages G broken due to the minimal levels of Methane and Carbon Dioxide returned from the limited gas monitoring exercise.

6 Hazardous Gas

6.1 Gas Regime

Given the proximity to the historical landfill west of the site, allowance was made in the investigation for a ground gas monitoring exercise to be undertaken at the site. Gas monitoring wells were installed in boreholes BH1, BH2 and BH3.

The results of two (2) initial gas monitoring visit at the site are presented in Table 4 below. A further set of up to four measurements may be required to complete the gas risk assessment at the site.

Table 4 Summary of Gas Monitoring Data

Borehole	Number of Visits	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Flow Rate (l/hr)	Atmospheric Pressure (mb)
BH1	2	<0.1	19.1-19.2	0.2-0.3	<0.1	1004 (steady)
BH2		<0.1	19.0	<0.1		to
BH3		<0.1	20.5	<0.1		989 (falling)

The gas monitoring visit carried out to date at atmospheric pressures of 989mb to 1004mb returned:

- Low and marginally elevated levels of CO₂.
- Below detectable / negligible levels of CH₄.
- Near-normal oxygen levels.
- Consistently negligible H₂S and CO below detectable limits (<1ppm).
- Negligible flow rates, below detectable limits (<0.1 l/hr) were recorded on each monitoring occasion.

6.2 Radon Gas

In terms of radon gas, the site lies in a radon affected area where <1% of the properties are above the action level. Therefore, no radon protection measures are required.

7. Conclusions

7.1 Contamination

Analysis of the ground conditions at the site and an assessment of the potential pathways have confirmed that soils at the site are generally uncontaminated and fit for purpose in the proposed commercial end use of the site.

Furthermore, no discernible risk can be identified to local ground and surface waters through leaching and contaminant mobility.

As such no remedial works will be required at the site in this regard prior to the commencement of the development.

7.2 Hazardous Gas

Notwithstanding the presence of impermeable clay strata encountered in the boreholes, given the nearby potential gas source of the landfill some 110m west of the site, it was considered prudent to carry out some limited gas monitoring at the site. This testing has returned no elevated carbon dioxide or methane and no depleted oxygen levels.

Based the data, the property is likely to fall into “Green” of the NHBC Traffic Light System for low rise housing and therefore, gas protection measures are likely **not considered necessary** for the proposed building.

Therefore, it is considered that the two gas monitoring visits carried out at the site are deemed sufficient to quantify the ground gassing regime, especially given the presence of >100m of impermeable natural clay strata between the potentially viable source and the site. No further monitoring is deemed necessary.

No Radon Protective Measures are required for the new development.

7.3 Foundation Design

The ground conditions were relatively uniform across the site and comprised a of shallow topsoil/made ground underlain by firm to stiff cohesive deposits. Based on the soil moisture profile there is moisture depletion recorded to depth of 2.00m, and Very High Shrinkage Soils present.

Therefore, is considered that deep trench fill foundations are required at the site, to mitigate against any potential damage from the above. It would be considered necessary to extend the foundations below the moisture depletion, below circa 2.25m at the site.

At the above depth, based on the lowest vane shear strength test results, foundations at the above depth may be designed to a net bearing pressure of 150kN/m². Providing the safe bearing capacity is not exceeded settlement has been calculated to be less than 25mm.

Given the high risk of heave at the site, a suspended floor incorporating a 150mm void should be adopted, as should the placement of anti-heave protection to the internal faces of the external walls of the proposed development as well as any anti heave protection in line with NHBC Chapter 4.2 standards.

Groundwater was not encountered during the investigation; therefore, it is not likely that groundwater ingress will pose an issue during the forming of foundation excavations. However, all excavations should be monitored during construction for groundwater ingress, particularly after periods of heavy and/or prolonged rainfall, and mitigated accordingly, i.e., via sumps and pumping.

7.4 Concrete Design

The results of chemical analyses of the fill returned Water Soluble Sulphate levels of between 96mg/l¹ and 1056mg/l¹ and pH levels of between 8.1 and 10.2 Additionally, the site is inferred to classify as natural soils with static water.

On this basis concrete in contact with the ground may be designed to ACEC Class DS-1 AC-1s of “BRE Special Digest 1 – Concrete in aggressive ground”.

END OF REPORT

The findings and contents of this (intrusive) Site Investigation Report pertain solely to the study area(s) outlined herein and are based solely on the findings of the excavations undertaken as part of the current exercise unless otherwise stated. The findings and/or recommendations of this report do not take into account any ground conditions that may be present but have hitherto not been encountered and as such further investigation and/or a reconsideration of the findings of this report should be undertaken if such conditions are subsequently encountered or an alternative development plan or land use is subsequently proposed.

This report considers various environmental and/or geological risks posed to the site and/or proposed development and offers advice accordingly as guidance only. The findings of this report will remain valid provided no change of ground or groundwater conditions, either natural or anthropogenic, take place and no warrantee is offered or implied.

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Units 3a and 4 Terry Dicken Industrial Estate
Ellerbeck Way
Stokesley
North Yorkshire
TS9 7AE

Tel. 01642 713779

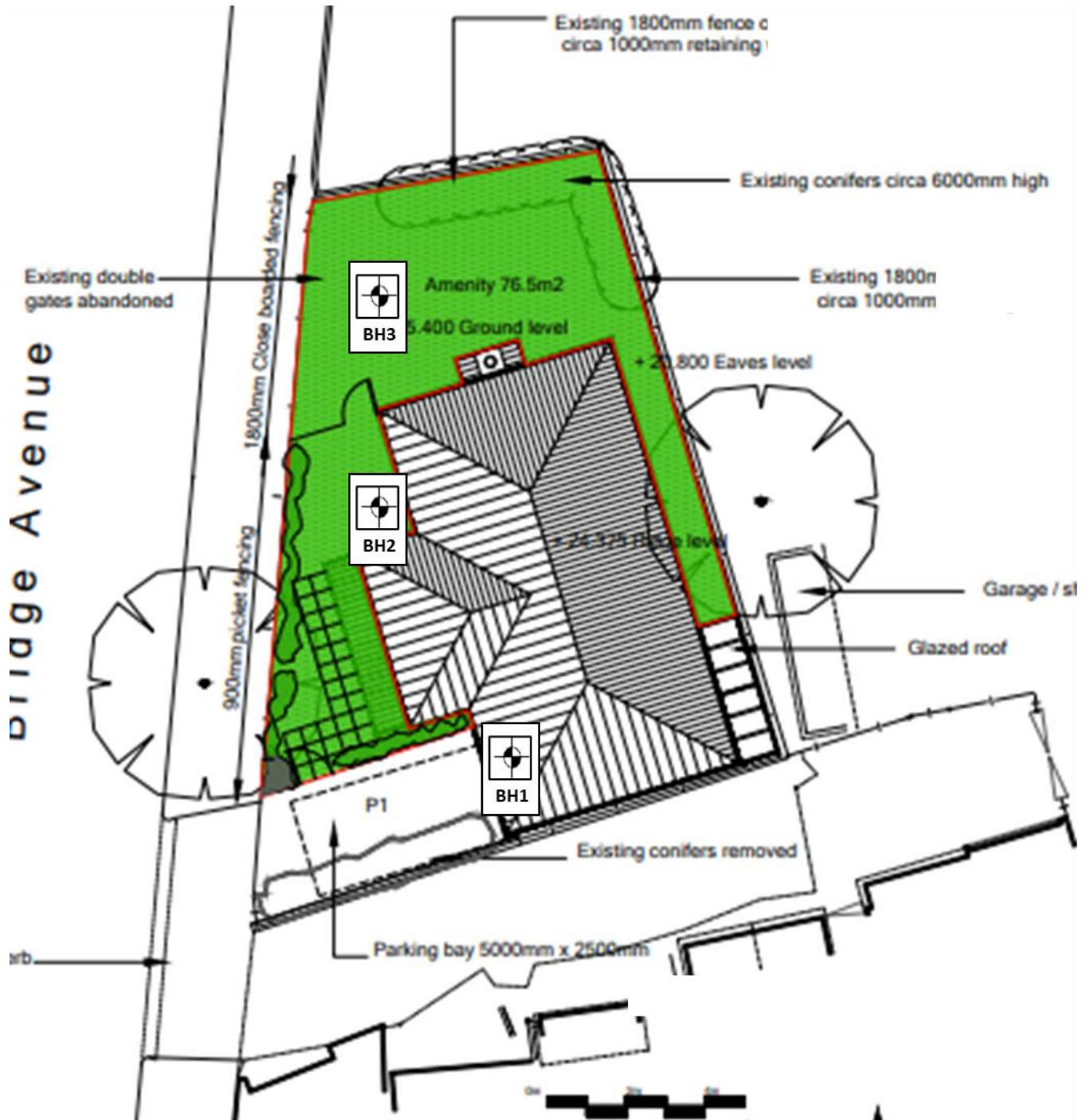
Fax 01642713923

Email enquiries@geoinvestigate.co.uk

APPENDIX 1
Site Plan
and
Borehole Logs

GEOINVESTIGATE Ltd.

OUR REF: G23244	YOUR REF:	SITE PLAN (NOT TO SCALE)
DATE: 04/07/23	LOCATION: 45 – 47 Bridge Avenue, Hanwell W7 3DJ	



Key



Windowless sample borehole with Gas Well

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G23244

BH No.1 Sheet No. 1 of 1
Location: 45-47 Bridge Avenue, Hanwell W7 3DJ

DATE: 04/07/23

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)		
0.30	MADE GROUND. Loose brown clayey, gravelly sand. Gravel is fine to coarse of brick, sandstone and concrete.	300			O	Cv kN/m ²			0.25		
	Firm to stiff brown CLAY.	2700			O	35			0.50		
											0.75
					O	53			1.00		
									1.25		
					O	61			1.50		
									1.75		
					O	69			2.00		
									2.25		
	O	82			2.50						
					2.75						
3.00					O	90			3.00		
	Borehole terminated at 3.00m										

Remarks:

Casing to 1.00m
 Dynamic windowless sampling by Terrier Rig to 3.00m
 Borehole remained open and dry on completion
 Gas well installed to 3.00m with gas bung and cover

Key:

	Slotted Pipe		Disturbed sample
	Plain Pipe		Cv Shear vane
	Bentonite		W Water sample
	Gravel Filter		S Standard Penetration Test
			C Cone Penetration Test

BH1

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Your Ref.
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BH No.2 Sheet No. 1 of 1
Location: 45-47 Bridge Avenue, Hanwell W7 3DJ

DATE: 04/07/23

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.30	MADE GROUND. Loose brown clayey, gravelly sand. Gravel is fine to coarse of brick, sandstone and concrete.	300			O	Cv kN/m ²			0.25
	Firm to stiff brown CLAY.	2700			O	45			0.50
					O	35		0.75	
					O	35		1.00	
					O	48		1.25	
					O	48		1.50	
					O	65		1.75	
					O	50		2.00	
					O	50		2.25	
3.00					O	62			2.50
					O	62			2.75
					O	62			3.00
	Borehole terminated at 3.00m								

Remarks:

- Casing to 1.00m
- Dynamic windowless sampling by Terrier Rig to 3.00m
- Borehole remained open and dry on completion
- Gas well installed to 3.00m with gas bung and cover

Key:

- | | |
|--|---|
| <ul style="list-style-type: none"> Slotted Pipe Plain Pipe Bentonite Gravel Filter | <ul style="list-style-type: none"> Disturbed sample Shear vane Water sample Standard Penetration Test Cone Penetration Test |
|--|---|

BH2

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BH No.3 Sheet No. 1 of 1
Location: 45-47 Bridge Avenue, Hanwell W7 3DJ

DATE: 04/07/23

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.30	MADE GROUND. Loose brown clayey, gravelly sand. Gravel is fine to coarse of brick, sandstone and concrete.	300			O	Cv kN/m ²			0.25
	Firm to stiff brown CLAY.				O	40			0.50
									0.75
					O	55			1.00
									1.25
					O	60			1.50
		2700							1.75
					O	70			2.00
									2.25
					O	65			2.50
									2.75
3.00					O	55			3.00
	Borehole terminated at 3.00m								

Remarks:

Casing to 1.00m
 Dynamic windowless sampling by Terrier Rig to 3.00m
 Borehole remained open and dry on completion
 Gas well installed to 3.00m with gas bung and cover

Key:

	Slotted Pipe		Disturbed sample
	Plain Pipe		Cv Shear vane
	Bentonite		W Water sample
	Gravel Filter		S Standard Penetration Test
			C Cone Penetration Test

BH3

APPENDIX 2

Geotechnical Testing

GEOINVESTIGATE Ltd.

Atterberg Limit Test Results

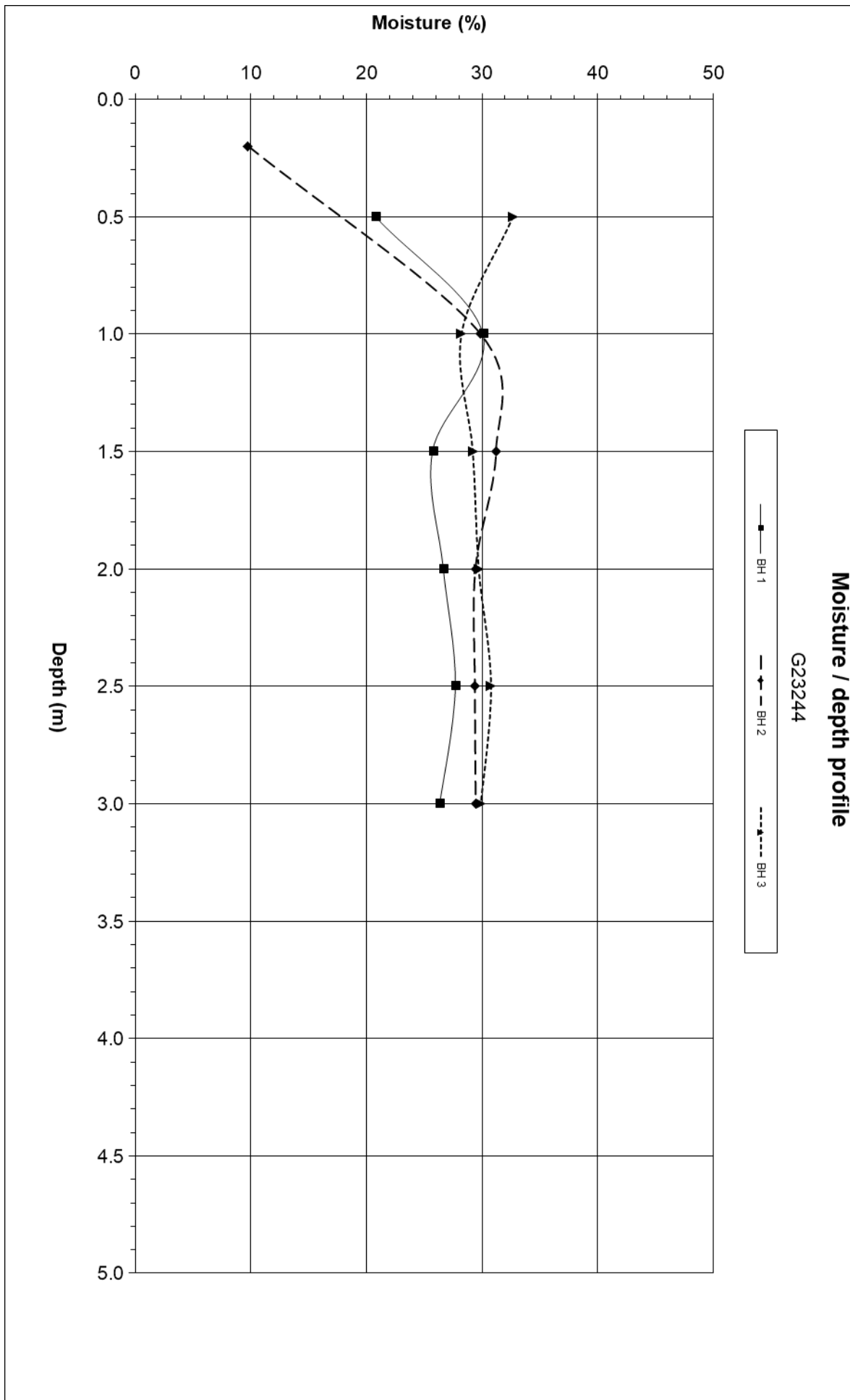
Our ref. G23244

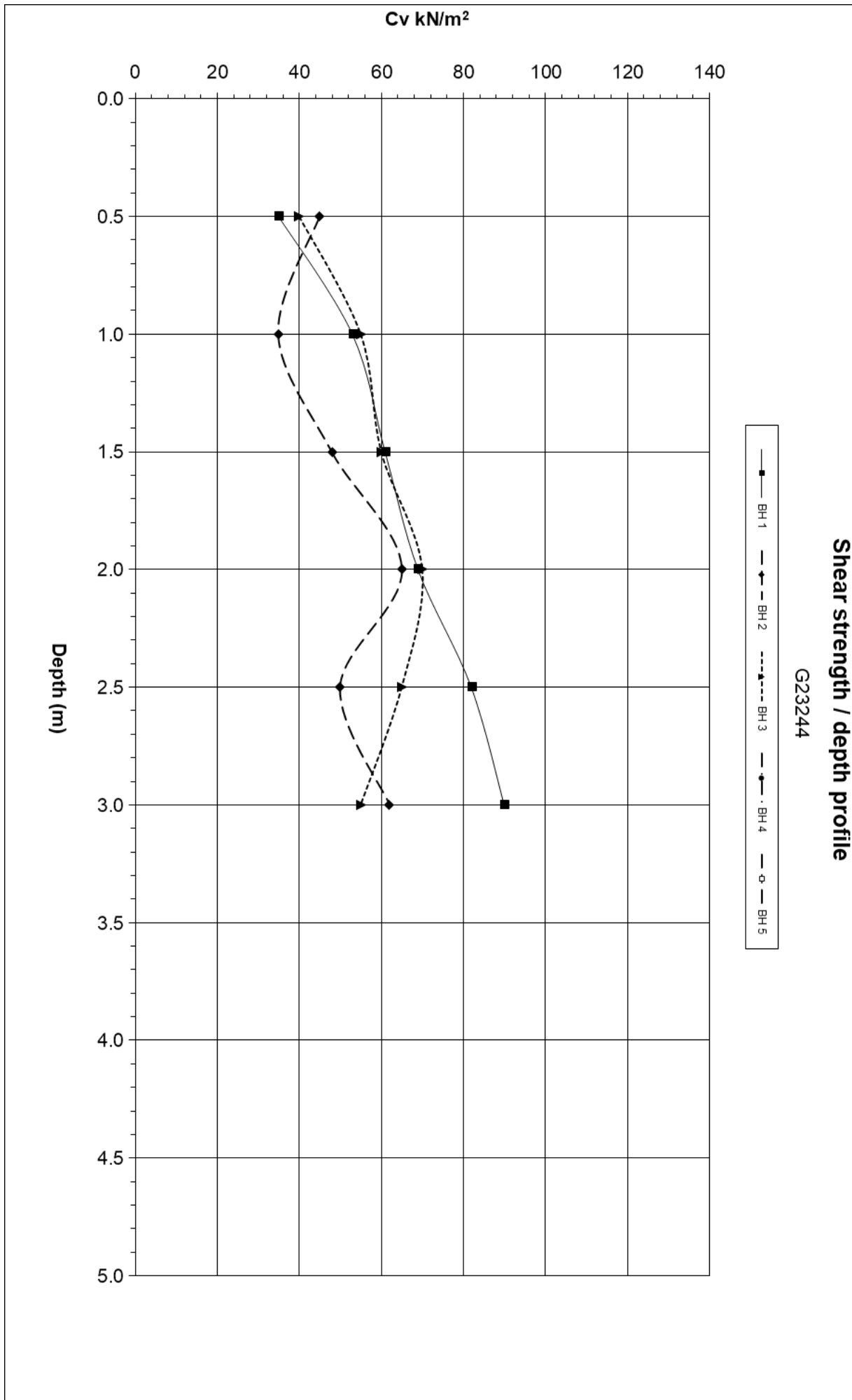
Table 1

Your ref.

Location: 45-47 Bridge Avenue, Hanwell W7 3DJ

TP / BH No.	Sample Depth (m)	Insitu Moisture Content (%)	% Passing BS 425 Micron Sieve	Corrected Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Soil Classification BS5930 [1999]
1	0.50	20.8						
	1.00	30.1	>95	30.1	26.9	78.2	51.3	CV
	1.50	25.8						
	2.00	26.7						
	2.50	27.7						
	3.00	26.4						
2	0.20	9.8						
	1.00	29.9						
	1.50	31.3	>95	31.3	29.1	80.9	51.8	CV
	2.00	29.5						
	2.50	29.4						
	3.00	29.5						
3	0.50	32.7						
	1.00	28.2	>95	28.2	25.3	74.1	48.8	CV
	1.50	29.2						
	2.00	29.7						
	2.50	30.8						
	3.00	29.9						





APPENDIX 3
Chemtech Analytical Test Report



ANALYTICAL TEST REPORT

Contract no: 124843

Contract name: 45-47 Bridge Avenue, Hanwell, W7 3DJ

Client reference: G23244

Clients name: Geo Investigate

Clients address: Units 3a & 4 Terry Dicken Industrial Estate
Ellerbeck Way, Stokesley
North Yorkshire
TS9 7AE

Samples received: 17 July 2023

Analysis started: 17 July 2023

Analysis completed: 27 July 2023

Report issued: 27 July 2023

Key

- U UKAS accredited test
- M MCERTS & UKAS accredited test
- \$ Test carried out by an approved subcontractor
- I/S Insufficient sample to carry out test
- N/S Sample not suitable for testing
- NAD No Asbestos Detected

Approved by:

Abbie Neasham-Boum
Senior Reporting Administrator

Chemtech Environmental Limited

SAMPLE INFORMATION

MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
124843-1	BH1	0.20	Clayey Sand with Gravel	-	-	8.9
124843-2	BH2	0.50	Clay with Gravel	-	-	17.3
124843-3	BH3	0.20	Sandy Clay with Gravel	-	-	11.4
124843-4	BH3	1.00	Sandy Clay	-	-	18.5

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SOILS

Lab number			124843-1	124843-2	124843-3	124843-4
Sample id			BH1	BH2	BH3	BH3
Depth (m)			0.20	0.50	0.20	1.00
Date sampled			04/07/2023	04/07/2023	04/07/2023	04/07/2023
Test	Method	Units				
Arsenic (total)	\$	mg/kg As	13.0	12.1	8.8	12.5
Boron (water soluble)	CE063 ^U	mg/kg B	2.0	1.3	0.7	1.4
Cadmium (total)	\$	mg/kg Cd	0.3	< 0.2	0.4	< 0.2
Chromium (total)	\$	mg/kg Cr	54.7	42.4	27.6	42.1
Chromium (III)	CE208	mg/kg CrIII	54.7	42.4	27.6	42.1
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1
Copper (total)	\$	mg/kg Cu	76.6	16.0	14.3	26.2
Lead (total)	\$	mg/kg Pb	77.9	14.8	43.3	16.6
Mercury (total)	\$	mg/kg Hg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel (total)	\$	mg/kg Ni	35.5	22.4	16.3	43.4
Selenium (total)	\$	mg/kg Se	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (total)	\$	mg/kg Zn	142	45.6	91.4	98.1
pH	CE004 ^M	units	10.4	8.1	9.1	8.2
Sulphate (2:1 water soluble)	CE061 ^U	mg/l SO ₄	1065	277	141	96
Sulphide	CE016	mg/kg S ²⁻	<10	<10	<10	<10
Cyanide (free)	CE077	mg/kg CN	<1	<1	<1	<1
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1
Thiocyanate	CE145 ^M	mg/kg SCN	<1	<1	<1	<1
Phenols (total)	CE078	mg/kg PhOH	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon (TOC)	CE197	% w/w C	0.8	0.4	0.7	0.3
Estimate of OMC (calculated from TOC)	CE197	% w/w	1.3	0.8	1.2	0.6
PAH						
Acenaphthene	CE087 ^M	mg/kg	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	CE087 ^M	mg/kg	<0.02	<0.02	<0.02	<0.02
Anthracene	CE087 ^U	mg/kg	0.05	<0.02	0.05	<0.02
Benzo(a)anthracene	CE087 ^U	mg/kg	0.32	<0.02	0.17	<0.02
Benzo(a)pyrene	CE087 ^U	mg/kg	0.48	<0.02	0.26	<0.02
Benzo(b)fluoranthene	CE087 ^M	mg/kg	0.65	<0.02	0.30	<0.02
Benzo(ghi)perylene	CE087 ^M	mg/kg	0.30	<0.02	0.21	<0.02
Benzo(k)fluoranthene	CE087 ^M	mg/kg	0.23	<0.03	0.13	<0.03
Chrysene	CE087 ^M	mg/kg	0.28	<0.03	0.18	<0.03
Dibenz(ah)anthracene	CE087 ^M	mg/kg	0.07	<0.02	0.04	<0.02
Fluoranthene	CE087 ^M	mg/kg	0.34	0.04	0.28	<0.02
Fluorene	CE087 ^U	mg/kg	<0.02	<0.02	<0.02	<0.02
Indeno(123cd)pyrene	CE087 ^M	mg/kg	0.32	<0.02	0.20	<0.02
Naphthalene	CE087 ^M	mg/kg	<0.02	<0.02	<0.02	<0.02
Phenanthrene	CE087 ^M	mg/kg	0.10	<0.02	0.12	<0.02
Pyrene	CE087 ^M	mg/kg	0.47	0.03	0.27	<0.02
PAH (total of USEPA 16)	CE087	mg/kg	3.59	<0.34	2.21	<0.34
TPH						
VPH Aromatic (>EC5-EC7)	CE067	mg/kg	-	<0.01	-	<0.01

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SOILS

Lab number			124843-1	124843-2	124843-3	124843-4
Sample id			BH1	BH2	BH3	BH3
Depth (m)			0.20	0.50	0.20	1.00
Date sampled			04/07/2023	04/07/2023	04/07/2023	04/07/2023
Test	Method	Units				
VPH Aromatic (>EC7-EC8)	CE067	mg/kg	-	<0.01	-	<0.01
VPH Aromatic (>EC8-EC10)	CE067	mg/kg	-	<0.01	-	<0.01
EPH Aromatic (>EC10-EC12)	CE250	mg/kg	-	<10	-	<10
EPH Aromatic (>EC12-EC16)	CE250	mg/kg	-	<10	-	<10
EPH Aromatic (>EC16-EC21)	CE250	mg/kg	-	<1	-	<1
EPH Aromatic (>EC21-EC35)	CE250	mg/kg	-	<1	-	<1
EPH Aromatic (>EC35-EC44)	CE250	mg/kg	-	<1	-	<1
VPH Aliphatic (>C5-C6)	CE067	mg/kg	-	<0.1	-	<0.1
VPH Aliphatic (>C6-C8)	CE067	mg/kg	-	<0.1	-	<0.1
VPH Aliphatic (>C8-C10)	CE067	mg/kg	-	<0.1	-	<0.1
EPH Aliphatic (>C10-C12)	CE250	mg/kg	-	<6	-	<6
EPH Aliphatic (>C12-C16)	CE250	mg/kg	-	<6	-	<6
EPH Aliphatic (>C16-C35)	CE250	mg/kg	-	<15	-	<15
EPH Aliphatic (>C35-C44)	CE250	mg/kg	-	<10	-	<10
Subcontracted analysis						
Asbestos (qualitative)	\$	-	NAD	NAD	-	-

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PREPARED LEACHATES

Lab number			124843-2L	124843-3L
Sample id			BH2	BH3
Depth (m)			0.50	0.20
Test	Method	Units		
Arsenic (dissolved)	\$	µg/l As	< 0.5	4.2
Boron (dissolved)	\$	µg/l B	21	17
Cadmium (dissolved)	\$	µg/l Cd	< 0.5	< 0.5
Chromium (dissolved)	\$	µg/l Cr	< 0.5	1.8
Copper (dissolved)	\$	µg/l Cu	0.6	1.1
Lead (dissolved)	\$	µg/l Pb	< 0.5	0.9
Mercury (dissolved)	\$	µg/l Hg	< 0.05	0.07
Nickel (dissolved)	\$	µg/l Ni	< 0.5	< 0.5
Selenium (dissolved)	\$	µg/l Se	< 1	< 1
Zinc (dissolved)	\$	µg/l Zn	< 1.2	< 1.2
pH	CE213 ^U	units	7.9	8.8
Sulphate	CE049 ^U	mg/l SO ₄	8.0	11
Sulphur (dissolved)	\$	mg/l S	<0.1	<0.1
Sulphide	CE249	µg/l S ²⁻	1231	<100
Cyanide (free)	CE147	µg/l CN	<5	<5
Cyanide (total)	CE147	µg/l CN	<5	<5
Thiocyanate	CE014	µg/l SCN	<200	<200
Phenols (total)	CE148	µg/l PhOH	<10	<10
PAH				
Acenaphthene	CE051	µg/l	0.5	0.5
Acenaphthylene	CE051	µg/l	<0.1	<0.1
Anthracene	CE051	µg/l	<0.1	<0.1
Benzo(a)anthracene	CE051	µg/l	<0.1	0.6
Benzo(a)pyrene	CE051	µg/l	<0.1	<0.1
Benzo(b)fluoranthene	CE051	µg/l	<0.1	<0.1
Benzo(ghi)perylene	CE051	µg/l	<0.1	<0.1
Benzo(k)fluoranthene	CE051	µg/l	<0.1	<0.1
Chrysene	CE051	µg/l	<0.1	<0.1
Dibenz(ah)anthracene	CE051	µg/l	<0.1	<0.1
Fluoranthene	CE051	µg/l	<0.1	<0.1
Fluorene	CE051	µg/l	0.4	0.3
Indeno(123cd)pyrene	CE051	µg/l	<0.1	<0.1
Naphthalene	CE051	µg/l	<0.1	<0.1
Phenanthrene	CE051	µg/l	<0.1	<0.1
Pyrene	CE051	µg/l	<0.1	<0.1
PAH (total of USEPA 16)	CE051	µg/l	<1.6	<1.6

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
\$	Arsenic (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg As
CE063	Boron (water soluble)	Hot water extract, ICP-OES	Dry	U	0.5	mg/kg B
\$	Cadmium (total)	Aqua regia digest, ICP-MS	Dry	M	0.2	mg/kg Cd
\$	Chromium (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cr
CE208	Chromium (III)	Calculation: Cr (total) - Cr (VI)	Dry		1	mg/kg CrIII
CE146	Chromium (VI)	Acid extraction, Colorimetry	Dry		1	mg/kg CrVI
\$	Copper (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cu
\$	Lead (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Pb
\$	Mercury (total)	Aqua regia digest, ICP-MS	Dry	M	0.5	mg/kg Hg
\$	Nickel (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Ni
\$	Selenium (total)	Aqua regia digest, ICP-MS	Dry	M	0.3	mg/kg Se
\$	Zinc (total)	Aqua regia digest, ICP-MS	Dry	M	5	mg/kg Zn
CE004	pH	Based on BS 1377, pH Meter	As received	M	-	units
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry	U	10	mg/l SO ₄
CE016	Sulphide	Distillation, Titration	Dry		10	mg/kg S ²⁻
CE077	Cyanide (free)	Extraction, Continuous Flow Colorimetry	As received		1	mg/kg CN
CE077	Cyanide (total)	Extraction, Continuous Flow Colorimetry	As received		1	mg/kg CN
CE145	Thiocyanate	Weak acid extraction, Colorimetry	Dry	M	1	mg/kg SCN
CE078	Phenols (total)	Extraction, Continuous Flow Colorimetry	As received		0.5	mg/kg PhOH
CE197	Total Organic Carbon (TOC)	Carbon Analyser	Dry		0.1	% w/w C
CE197	Estimate of OMC (calculated from TOC)	Calculation from Total Organic Carbon	Dry		0.1	% w/w
CE087	Acenaphthene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Acenaphthylene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Anthracene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(a)anthracene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(a)pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(b)fluoranthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(ghi)perylene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Benzo(k)fluoranthene	Solvent extraction, GC-MS	As received	U	0.03	mg/kg
CE087	Chrysene	Solvent extraction, GC-MS	As received	M	0.03	mg/kg
CE087	Dibenz(ah)anthracene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Fluoranthene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Fluorene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Indeno(123cd)pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Naphthalene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	Phenanthrene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Pyrene	Solvent extraction, GC-MS	As received	M	0.02	mg/kg
CE087	PAH (total of USEPA 16)	Solvent extraction, GC-MS	As received		0.34	mg/kg
CE067	VPH Aromatic (>EC5-EC7)	Headspace GC-FID	As received		0.01	mg/kg
CE067	VPH Aromatic (>EC7-EC8)	Headspace GC-FID	As received		0.01	mg/kg
CE067	VPH Aromatic (>EC8-EC10)	Headspace GC-FID	As received		0.01	mg/kg
CE250	EPH Aromatic (>EC10-EC12)	Solvent extraction, GCxGC-FID	As received		1	mg/kg
CE250	EPH Aromatic (>EC12-EC16)	Solvent extraction, GCxGC-FID	As received		1	mg/kg
CE250	EPH Aromatic (>EC16-EC21)	Solvent extraction, GCxGC-FID	As received		1	mg/kg

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE250	EPH Aromatic (>EC21-EC35)	Solvent extraction, GCxGC-FID	As received		1	mg/kg
CE250	EPH Aromatic (>EC35-EC44)	Solvent extraction, GCxGC-FID	As received		1	mg/kg
CE067	VPH Aliphatic (>C5-C6)	Headspace GC-FID	As received		0.1	mg/kg
CE067	VPH Aliphatic (>C6-C8)	Headspace GC-FID	As received		0.1	mg/kg
CE067	VPH Aliphatic (>C8-C10)	Headspace GC-FID	As received		0.1	mg/kg
CE250	EPH Aliphatic (>C10-C12)	Solvent extraction, GCxGC-FID	As received		6	mg/kg
CE250	EPH Aliphatic (>C12-C16)	Solvent extraction, GCxGC-FID	As received		6	mg/kg
CE250	EPH Aliphatic (>C16-C35)	Solvent extraction, GCxGC-FID	As received		15	mg/kg
CE250	EPH Aliphatic (>C35-C44)	Solvent extraction, GCxGC-FID	As received		10	mg/kg
\$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

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METHOD DETAILS

METHOD	PREPARED LEACHATES	METHOD SUMMARY	STATUS	LOD	UNITS
CE002	Leachate preparation (EA)	L:S 10:1		-	-
\$	Arsenic (dissolved)	ICP-MS	U	0.5	µg/l As
\$	Boron (dissolved)	ICP-MS		5	µg/l B
\$	Cadmium (dissolved)	ICP-MS	U	0.5	µg/l Cd
\$	Chromium (dissolved)	ICP-MS	U	0.5	µg/l Cr
\$	Copper (dissolved)	ICP-MS	U	0.5	µg/l Cu
\$	Lead (dissolved)	ICP-MS	U	0.5	µg/l Pb
\$	Mercury (dissolved)	ICP-MS	U	0.05	µg/l Hg
\$	Nickel (dissolved)	ICP-MS	U	0.5	µg/l Ni
\$	Selenium (dissolved)	ICP-MS	U	1	µg/l Se
\$	Zinc (dissolved)	ICP-MS	U	1	µg/l Zn
CE213	pH	Based on BS 1377, pH Meter	U	-	units
CE049	Sulphate	Ion Chromatography	U	1.7	mg/l SO ₄
\$	Sulphur (dissolved)	ICP-MS	U	0.1	mg/l S
CE249	Sulphide	Distillation, Titration		100	µg/l S ₂ -
CE147	Cyanide (free)	Continuous Flow Colorimetry		5	µg/l CN
CE147	Cyanide (total)	Continuous Flow Colorimetry		5	µg/l CN
CE014	Thiocyanate	Colorimetry		200	µg/l SCN
CE148	Phenols (total)	Continuous Flow Colorimetry		10	µg/l PhOH
CE051	Acenaphthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Acenaphthylene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Anthracene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(a)anthracene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(a)pyrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(b)fluoranthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(ghi)perylene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Benzo(k)fluoranthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Chrysene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Dibenz(ah)anthracene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Fluoranthene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Fluorene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Indeno(123cd)pyrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Naphthalene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Phenanthrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	Pyrene	Solvent extraction, GC-MS		0.1	µg/l
CE051	PAH (total of USEPA 16)	Solvent extraction, GC-MS		1.6	µg/l

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DEVIATING SAMPLE INFORMATION

Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
124843-1	BH1	0.20	N	
124843-2	BH2	0.50	N	
124843-3	BH3	0.20	N	
124843-4	BH3	1.00	N	

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ADDITIONAL INFORMATION

Notes

Opinions and interpretations expressed herein are outside the UKAS accreditation scope.

Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.

All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.

Methods, procedures and performance data are available on request.

Results reported herein relate only to the material supplied to the laboratory.

This report shall not be reproduced except in full, without prior written approval.

Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

For soils and solids, all results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.

For soils and solids, analytical results are inclusive of stones, where applicable.

