GEOLOGICAL
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DATA ACQUISITION
CONSULTANCY

Phase 2 Intrusive Site Investigation Report

LOCATION	Land at Mill Street, Frizington CA26 3SL
ISSUE DATE	August 2022
FOR	Laurie Crayson
CLIENT REF.	
OUR REF.	G22250(b)

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1. Introduction

In accordance with your instruction, Geoinvestigate Ltd. has carried out an intrusive site investigation of a plot of land at Mill Street, Frizington CA26 3SL, which is the current location of a number of farm buildings/barns.

A Phase 1 Desk Study has been carried out by Geoinvestigate Limited (Ref: G22250(a) July 2022), which concluded the potential sources of contamination were the construction and demolition of a number of barns and buildings onsite. Additionally, there is the possibility of a ground gas risk from the known capped mine shaft in proximity to the development.

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. No slope stability assessment is provided as part of this report.

A Coal Mining Risk Assessment CMRA has been carried out by Geoinvestigate Limited (Ref: G22250(a) July 2022), which concluded that although there was no risk to the site from very shallow or shallow coal seams that may contain coal mine-workings, owing to the proximity of a coal mine shaft to the development the client has been advised to carry out longer term monitoring. This was recommended to be undertaken in line with the shallow geoenvironmental and geotechnical investigation at the site.

It is proposed to construct a residential dwelling. The cottage will have a rainwater storage tank and ground source heating. The boundary of the current study area and proposed layout is shown on the site plan presented in 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 excavated at the site to depths of between 3.00m and 3.50m below ground level (bgl) with associated soil sampling. The boreholes were undertaken using windowless sampling techniques with a Dando Terrier 2002 mini drilling rig.

- Three (3) hand excavated trial pits (TPA to TPC) to provide additional information on the ground and soil sampling in the areas surrounding the proposed dwelling.

- The installation of three (3) gas monitoring wells in boreholes BH1, BH2 and BH3 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 nineteen (19) moisture determinations and two (2) attempted Atterberg Limit plasticity tests to provide information with regard to soil conditions and shrinkage potential of clay soils at the site.

- Contamination analyses of four (4) samples of near-surface topsoil and natural clay recovered at depths between 0.20m and 0.50m to investigate the potential presence and concentrations of various potential contaminants are present within acceptable limits (including metals/metalloids, asbestos, polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons. Chemical analyses based on the attending engineer's assessment of soils and ground conditions at the site. Leachate from two (2) samples was tested to check the mobility of the contaminants. Three (3) samples were also tested for asbestos identification.

- Water Soluble Sulphate and pH Testing on selected samples to provide information on appropriate concrete design.

- Provision of a factual and interpretative report including site plan, borehole and trial pit logs, geotechnical and contamination soil analysis results, together with advice on the contamination and gas in relation to the coal mine shaft in proximity to the site.

The trial pit and 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 and shear strength profiles are included in Appendix 2.

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

The results of the Water-Soluble Sulphate and pH 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. The hand excavated trial pit positions were chosen to target external areas surrounding the proposed dwelling.

3. Phase 2 Investigation Findings

3.1 Windowless Sample Boreholes

The ground conditions were relatively uniform across the site and comprised a thin layer of made ground (topsoil -like material) underlain by natural cohesive deposits with mudstone bedrock commencing at the base of each borehole.

The made ground comprised of loose very sandy gravelly clay (topsoil) containing sandstone and coal fragments to depths between 0.10m (BH2) and 0.40m (BH1).

Below the made ground the natural strata comprised an initial horizon of firm to stiff very sandy slightly gravelly clay containing sandstone and mudstone fragments to depths between 1.90m (BH1) and 2.50m (BH3). Beneath the upper clay weathered mudstone bedrock commenced and was confirmed to the base of each borehole.

In-situ SPT Testing was carried out with a solid cone sampler in the cohesive material and the weathered bedrock in each of the boreholes. SPT 'N' values of between N=12 and N=18, were recorded within the cohesive deposits indicating generally firm becoming stiff with depth conditions. The weathered mudstone bedrock recorded SPT 'N' values between N=18 and N=60.

The boreholes remained open and dry on completion and no significant roots were recovered from the excavations.

3.2 Hand Excavated Trial Pits

TPA to TPC encountered similar conditions to the boreholes. Made ground (topsoil) was encountered to the base of each trial pit at a depth of 0.30m bgl. The made ground consisted of dark brown very sandy gravelly clay with fragments of sandstone and coal.

The trial pits remained stable and dry on completion.

3.3. Soil Moisture, Plasticity Testing and Vegetation Influence

Borehole moisture profiles are presented in Appendix 2. Moisture in the natural clay were recorded between 4.9% and 20.7%, generally below the corresponding plastic limits.

Atterberg Limits were attempted on two (2) samples, however, during initial sieving, the material was classified as being too sandy and the tests were unable to be progressed further.

The moisture profiles show no evidence of any vegetation related moisture depletion, and no significant vegetation was present on site. In addition, no significant roots were recovered from the boreholes or pits.

Given the above and the presence of ostensibly granular soils at the site, together with the absence of significant vegetation/trees at the site and any roots in the excavations, it was considered that no special precautions are required with regard to foundation design and seasonal related vegetation influence.

4. Contamination Testing

As mentioned in section 1, it is considered that construction and demolition of a number of barns and buildings at the site might provide the most viable source of contamination to the site.

Potential contaminants could possibly occur throughout the full thickness of the made ground (topsoil) which was recovered from the boreholes and trial pits to a maximum depth of 0.40m bgl. 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 sandstone and coal fragments, the made ground (topsoil) showed no obvious visual or olfactory evidence of potential contamination or contaminative materials. However due to the demolition of a barn onsite historically and the presence of the current barn and adjacent building and their historical construction, a potential contamination risk existed at the site. In addition, the former mineshaft on site and associated activities might provide a viable source of contamination.

Based on the findings of the site works, four (4) samples of made ground (topsoil) from depths between 0.20m and 0.50m bgl, 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 (3 samples).

The results of the contamination testing are included in Appendix 2 of this report (Chemtech Environmental Ltd. Report 111351) 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 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 0.40m, this was underlain by a cohesive clay with mudstone bedrock below. 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 depths between 0.20m and 0.50m bgl returned concentrations of a range of substances falling below respective assessment criteria adopted from the sources named above. 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 3.1% and mean Soil Organic Matter Content (SOM) of 5.3% (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 2.5%, which is considered the most representative (and conservative) value for the samples returned.

Table 1: Chemical Determinands in Soils

	Range of Returned concentrations (mg/kg)	S4UL (LQM/CIEH)* (mg/kg)	C4SL (DEFRA)* (mg/kg)
Asbestos	None detected (all 3 samples)	Any presence unacceptable	
Arsenic	4.4 – 18	37	37
Boron	<0.5 – 0.6	290	
Cadmium	<0.2 (all 3 samples)	11	26
Chromium VI	<1.0 (all 3 samples)	6	21
Chromium III	51 – 68	910	
Copper	3.3 – 6.7	2,400	
Lead	7.0 – 16		200
Mercury (elemental)	<0.1 – <0.5	1.2	
Nickel	8.2 – 30	180	
Selenium	0.5 - <1.0	250	
Zinc	6.0 – 23	3,700	
pH	5.5 – 5.8	See Report Section 7.3 “Concrete Design”	
Water Soluble SO_4	<10 – 17		
Phenol	<0.5 (all 3 samples)	280	
Total PAH	<0.34		
PAH Naphthalene	<0.02	5.6	
PAH Acenaphthylene	<0.02	420	
PAH Acenaphthene	<0.02	510	
PAH Fluorene	<0.02	400	
PAH Phenanthrene	<0.02	220	
PAH Anthracene	<0.02	5400	
PAH Fluoranthene	<0.02	560	
PAH Pyrene	<0.02	1200	
PAH Benzo[a]anthracene	<0.02	11	
PAH Chrysene	<0.03	22	
PAH Benzo(b)fluoranthene	<0.02	3.3	
PAH Benzo(k)fluoranthene	<0.03	93	
PAH Benzo(a)pyrene	<0.02	2.7	5
PAH Indeno(123-cd)pyrene	<0.02	36	
PAH Dibenz(a,h)anthracene	<0.02	0.28	
PAH Benzo(ghi)perylene	<0.02	340	

*For residential use with allowance for cultivation of fruit/veg and at 2.5% 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 ref. 111351 (Appendix 3) the returned results are below the adopted target values without exception.

5.2.2 Contamination Risk to the Controlled Waters

Given the possible sources of historical contamination and nature of material, leachate was analysed from one (1) sample obtained from BH3 at 0.50m. 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 overleaf.

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)
Inorganic Chemicals		
Arsenic	0.9	**50** (DW, range: 50-100) (No Aq standard)
Boron	7	**1000** (DW & Aq)
Cadmium	0.3	**5** (DW & Aq)
Chromium	0.4	**50** (DW) / **5-250** (Aq, range: 5-250)
Copper	3.6	**50** (DW) / **5-112** (Aq, range: 5-112)
Lead	0.2	**50** (DW) / **4-250** (Aq, range: 4-250
Mercury (elemental Hg)	<0.008	**1** (DW & Aq)
Nickel	2.1	**20**** (DW) / **50-200** (Aq, range: 50-200)
Selenium	0.07	**10** (DW) (No Aq standard)
Zinc	23	**3000** (DW, range: 3000-5000) / **30-2000** (Aq, range: 30-2000)
pH	7.6	**Range 5.5 to 10** (UK drinking water standards)
Organic Chemicals		
Cyanide	<5	**50** (DW) / **5** (Aq)
Phenols	<10	**50****(DW) / **300** (Aq)
PAHs (total)	**<1.6**	0.2 (DW, range: 0.2-1.0) (No Aq standard)
Individual PAH species:		
Acenaphthene	<0.1	No applicable UK standard
Acenaphthylene	0.3	No applicable UK standard
Anthracene	0.4	**0.4** (surface water quality, max. allowable)
Chrysene	<0.1	No applicable UK standard
Dibenzo(a,h)anthracene		No applicable UK standard
Fluoranthene		**1** (surface water quality, max. allowable)
Fluorene	<0.1	No applicable UK standard
Naphthalene	<0.1	**10** (Aq, UK inland waters)
Phenanthrene	<0.1	No applicable UK standard
Pyrene	<0.1	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 111351 (Appendix 2), levels of potential contaminants in analysed leachates generally returned negligible concentrations, except for a minor exceedance of total PAHs. 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.

5.3 Review of Results

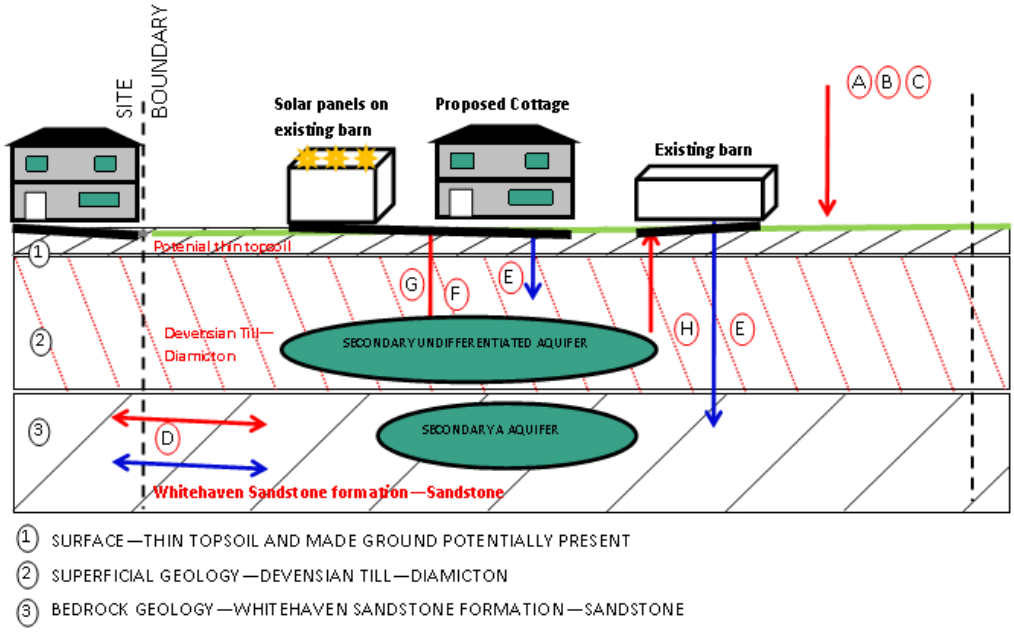
The data presented in Tables 1 and 2 and the associated discussion show that returned concentrations of potential contaminants in the soils and leachates analysed generally fall below the adopted assessment criteria in Table 2 and always fall below adopted assessment criteria in table 1. Due to the minor 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

-Historic and current agricultural use of site meaning potential exposure to fuels
-Over ground tank noted previously on site
-Nearby residential developments
-Contamination risk and Ground surface instability risk from mine shaft collapse
-Potential hazardous gases sourced from made ground near to or within 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, Possible or unlikely given the intended end use of the site.

C— End Users through cultivation and consumption of vegetables / fruit. Possible given the intended end use of the site

D— Neighbouring Sites through lateral migration (in soil and water, including surface water run off)

E— Ground water 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—F considered broken as no elevated determinands recorded in soils or leachates.

G— End users and buildings through ground gas migration.

Characteristic Situation 2/Amber 1 gas protection measures required.

H— Running sands, compressible deposits etc

Linkage H considered broken as sandy clay encountered, no groundwater encountered.

6 Hazardous Gas

6.1 Gas Regime

Given the proximity of the proposed development to a known capped mine shaft, 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	5.4 – 5.36	12.6 – 13.4	<0.1	1011 - 1025 (rising)
BH2		<0.1	4.7 – 5.1	12.0 – 14.7		
BH3		<0.1	2.6 – 3.0	17.5 – 17.6		

The gas monitoring visit carried out to date at atmospheric pressures of 1011mb to 1025mb returned:

- Slightly elevated and elevated levels of CO_2.
- Negligible levels of CH_4.
- Slightly depleted and near-normal oxygen levels.
- Consistently negligible H_2S and CO below detectable limits (<1ppm).
- Negligible flow rates, below detectable limits (<0.1 l/hr) were recorded on each monitoring occasion.

6.1 Radon Gas

With regard to Radon Gas risk, 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 for the proposed residential 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

Gas monitoring is ongoing at the site with one of a potential six monitoring visits having been undertaken to date. The monitoring undertaken to date has returned elevated carbon dioxide (above 5%) and slightly depleted oxygen levels. Negligible levels of methane have been recorded.

Based the data to date, the property is likely to fall into “Amber 1” of the NHBC Traffic Light System for low rise housing or Characteristic Situation 2 on the Wilson and Card Classification Scheme of CIRIA C665.

Therefore, gas protection measures are likely to be required commensurate to this level for proposed building. Given the presence of the historically capped mine-shaft at the site, this level of protective measures had been considered necessary as a minimum, despite the gas monitoring data.

Note that these conclusions are provisional and that the gas monitoring exercise is not yet completed, with only two of a possible six sets of readings gathered to date. Final recommendations regarding gas protection will be issued in due course in a Gas Monitoring Addendum Report following completion of the gas monitoring exercise and this will also include details of some possible gas protection options an may require validation of measures, during installation.

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 made ground (topsoil) underlain by firm to stiff cohesive deposits with mudstone bedrock below. It is understood that the building levels will be lowered by some margin, from those at the time of the investigation, potentially requiring appropriately designed retaining structures. The CMRA report discounts the geotechnical risk to the site from the nearby capped mineshaft.

It is proposed to construct a residential dwelling. The cottage will have a rainwater storage tank and ground source heating.

Given the competent ground conditions present the firm to stiff very sandy gravelly clay would provide a suitable base for construction of the foundations. Seated below 1.00m, foundations may be designed to a net bearing pressure of 120kN/m based on the lowest SPT 'N' value of N=12. Providing the safe bearing capacity is not exceed settlements have been calculated to be less than 25mm.

Competent natural strata would provide a suitable base to commence construction of a lightly loaded ground bearing floor slab.

Although groundwater was not encountered within the boreholes and therefore groundwater sumps and pumps are not anticipated to be required when forming foundation excavations, suitable design should be made of any temporary works required for support of the ground, given the anticipated excavation into the slope during construction. However, all open excavations should be monitored during construction for water ingress.

7.4 Concrete Design

The results of chemical analyses of the fill returned Water Soluble Sulphate levels of between <10mgl^{-1} and 17mgl^{-1} and pH levels of between 5.5 and 5.8. 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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APPENDIX 1

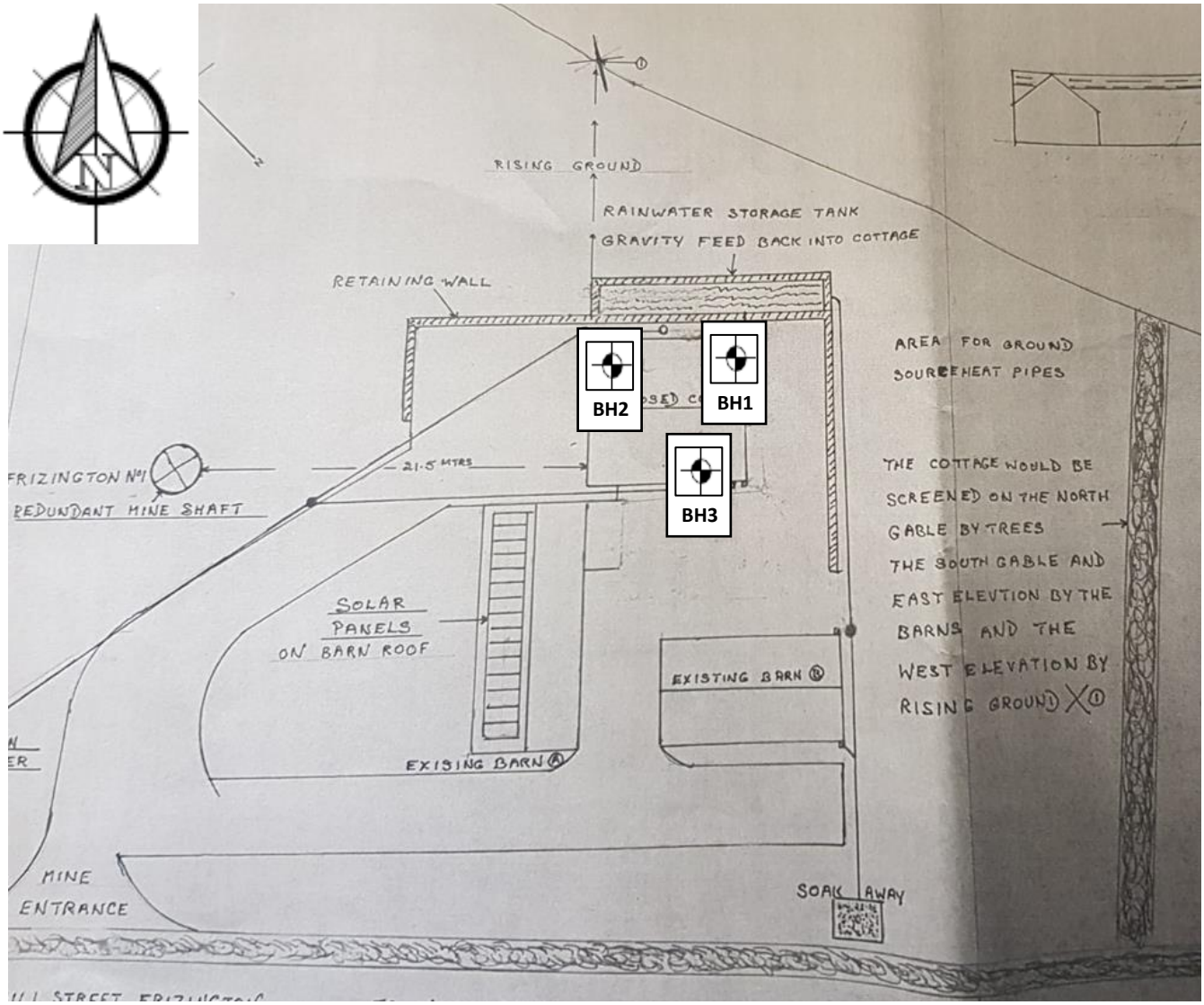
Site Plan

and

Borehole Logs

GEOINVESTIGATE Ltd.

OUR REF: G22250	YOUR REF:	SITE PLAN (NOT TO SCALE)
DATE: 25/07/2022	LOCATION: Land at Mill Street, Frizington CA26 3SL	



Key

BH1

Window Sample
Borehole Location

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref**. G22250(b) **BH No.1** **Sheet No. 1 of 1**

Location: Land at Mill Street, Frizington, CA26 3SL **DATE**: 30/06/22

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.40	TURF onto MADE GROUND. Soft dark brown mottled black and orange very sandy gravelly clay. Gravel is fine to coarse of sandstone and coal.	400			O	Cv kN/m^2			0.25
1.90	Firm to stiff red and grey very sandy very gravelly CLAY. Gravel is fine to coarse of sandstone and mudstone.	1500			O O O		1.00m - 1.45m 3/3/3/3/3/3 N = 12 2.00m - 2.45m 2/2/4/4/5/5 N = 18		0.50 0.75 1.00 1.25 1.50 1.75
3.30	Very weak and very weathered reddish brown MUDSTONE.	1400			O O O		3.00m - 3.45m 5/5/6/8/10/15 N = 39		2.00 2.25 2.50 2.75 3.00 3.25
3.50	Weak reddish brown MUDSTONE.	200			O				3.50
	Borehole terminated at 3.50m due to refusal.								

Remarks:

Casing to 1.00m

Dynamic windowless sampling by Terrier Rig to 3.50m

Borehole remained dry on completion

Key:

Slotted Pipe

Plain Pipe

Bentonite

Gravel Filter

O Disturbed sample

Cv Shear vane

W Water sample

S Standard Penetration Test

BH1

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref**. G22250(b) **BH No.2** **Sheet No. 1 of 1**

Location: Land at Mill Street, Frizington, CA26 3SL **DATE**: 30/06/22

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.10	TURF and TOPSOIL. Soft dark brown very sandy gravelly clay. Gravel is fine to coarse of sandstone and coal.	100				Cv kN/m^2			
	Firm to stiff red and grey very sandy very gravelly CLAY. Gravel is fine to coarse of sandstone and mudstone.				O				0.25
					O				0.50
									0.75
							1.00m - 1.45m 2/2/2/3/3/4 N = 12		
					O				1.00
		2000							1.25
					O				1.50
									1.75
							2.00m - 2.45m 3/3/4/4/4/5 N = 17		
2.10					O				2.00
	Very weak and very weathered reddish brown MUDSTONE.								2.25
		800			O				2.50
									2.75
2.90							3.00m - 3.21m 20/20/20 N = 60		
3.00	Weak to moderately strong reddish brown MUDSTONE.	100			O				3.00
	Borehole terminated at 3.00m due to refusal.								

Remarks:

Casing to 1.00m

Dynamic windowless sampling by Terrier Rig to 3.00m

Borehole remained dry on completion

Key:

Slotted Pipe

Plain Pipe

Bentonite

Gravel Filter

O Disturbed sample

Cv Shear vane

W Water sample

S Standard Penetration Test

BH2

GEOINVESTIGATE Ltd.

Your Ref. **Our Ref**. G22250(b) **BH No.3** **Sheet No. 1 of 1**

Location: Land at Mill Street, Frizington, CA26 3SL **DATE**: 30/06/22

Depth (m)	Description of Strata	Thick -ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.20	TURF onto MADE GROUND. Soft dark brown mottled black and orange very sandy gravelly clay. Gravel is fine to coarse of sandstone and coal.	200			O	Cv kN/m^2			0.25
	Firm to stiff red and grey very sandy very gravelly CLAY. Gravel is fine to coarse of sandstone and mudstone.				O				0.50
							1.00m - 1.45m 2/2/3/3/3/3 N = 12		0.75
					O				1.00
		2300							1.25
					O				1.50
							2.00m - 2.45m 3/4/4/4/5/5 N = 18		1.75
					O				2.00
2.50					O				2.25
	Very weak and very weathered reddish brown MUDSTONE.	500							2.50
							3.00m - 3.45m 5/6/8/10/12/15 N = 45		2.75
3.00					O				3.00
	Borehole terminated at 3.00m due to refusal.								

Remarks:

Casing to 1.00m

Dynamic windowless sampling by Terrier Rig to 3.00m

Borehole remained dry on completion

Key:

Slotted Pipe

Plain Pipe

Bentonite

Gravel Filter

O Disturbed sample

Cv Shear vane

W Water sample

S Standard Penetration Test

BH3

APPENDIX 2

Geotechnical Testing

GEOINVESTIGATE Ltd.

Atterberg Limit Test Results

Our ref. G22250(b) **Table 1**

Your ref. **Location**: Land at Mill Street, Frizington, CA26 3SL

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	16.7						
	1.00	13.6						Too sandy
	1.50	11.0						
	2.00	10.8						
	2.50	10.1						
	3.00	8.0						
	3.50	4.9						
2	0.50	20.7						
	1.00	14.2						Too sandy
	1.50	15.8						
	2.00	15.0						
	2.50	7.5						
	3.00	5.1						

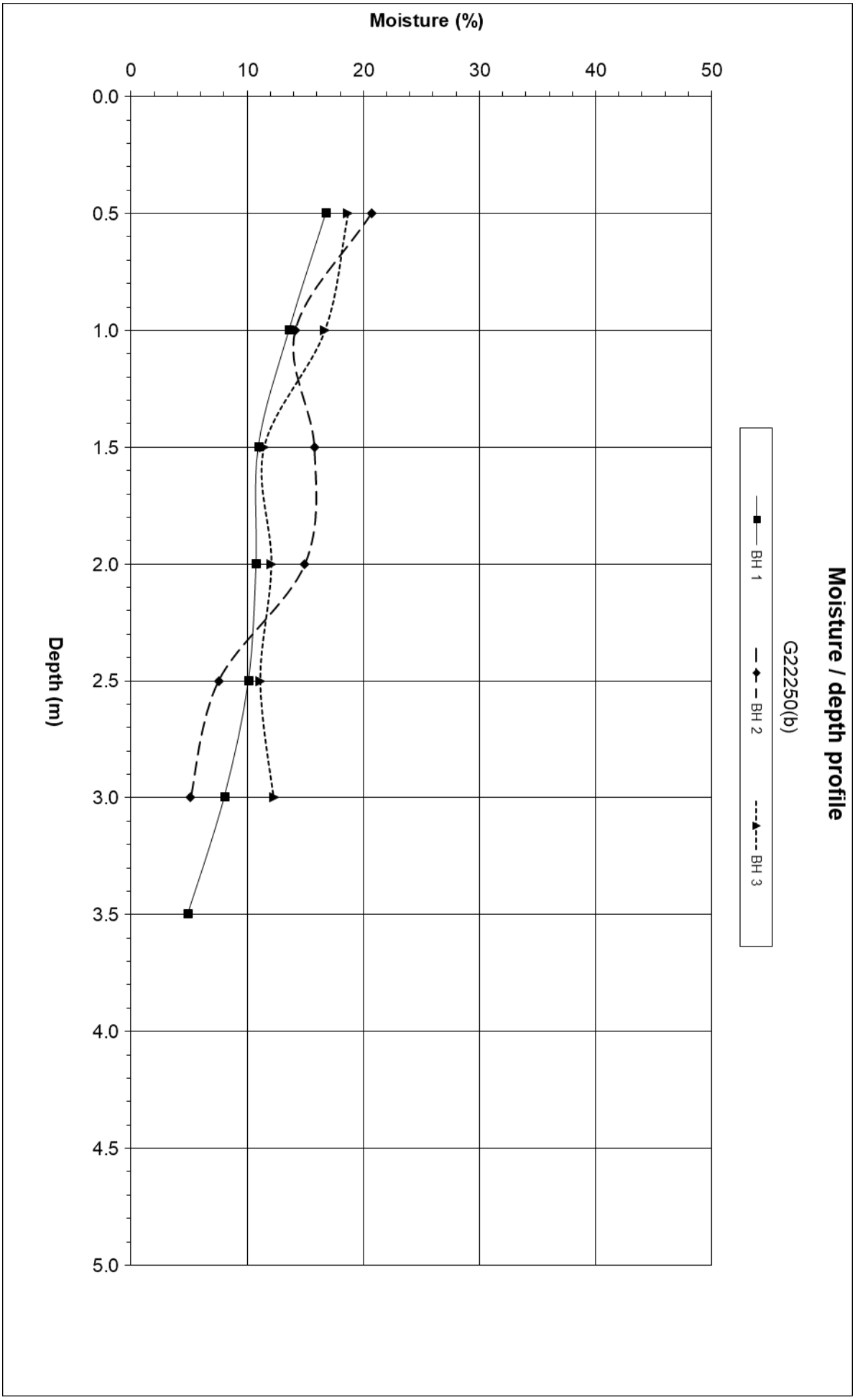
GEOINVESTIGATE Ltd.

Atterberg Limit Test Results

Our ref. G22250(b) **Table 1**

Your ref. **Location**: Land at Mill Street, Frizington, CA26 3SL

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]
3	0.50	18.7						
	1.00	16.7						
	1.50	11.5						
	2.00	12.1						
	2.50	11.2						
	3.00	12.3						


Moisture (%)
0
10
20
30
40
50
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Depth (m)
BH 1
BH 2
BH 3
G22250(b)
Moisture / depth profile

APPENDIX 3

Chemtech Analytical Test Report

ANALYTICAL TEST REPORT

Contract no: 111351

Contract name: Mill Street, Frizington

Client reference: G22250

Clients name: Geo Investigate

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

Samples received: 11 July 2022

Analysis started: 11 July 2022

Analysis completed: 22 July 2022

Report issued: 22 July 2022

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:

Megan Harris

Senior Reporting Administrator

Unit 6 Parkhead, Greencroft Industrial Park, Stanley, County Durham, DH9 7YB
Tel 01207 528578 Email customerservices@chemtech-env.co.uk
Vat Reg No. 772 5703 18 Registered in England number 4284013

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
111351-1	BH3	0.50	Sandy Clay with Gravel & Roots	-	-	13.0
111351-3	TPB	0.20	Sandy Clayey Loam with Roots	-	-	26.4
111351-4	TPC	0.20	Sandy Clayey Loam with Roots	-	-	15.1

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SOILS

Lab number			111351-1	111351-2	111351-3	111351-4
Sample id			BH3	TPA	TPB	TPC
Depth (m)			0.50	0.20	0.20	0.20
Date sampled			06/07/2022	06/07/2022	06/07/2022	06/07/2022
Test	**Method**	**Units**				
Arsenic (total)	CE127 M	mg/kg As	18	-	4.4	10
Boron (water soluble)	CE063	mg/kg B	0.6	-	0.6	<0.5
Cadmium (total)	CE127 M	mg/kg Cd	<0.2	-	<0.2	< 0.2
Chromium (total)	CE127 M	mg/kg Cr	68	-	53	51
Chromium (III)	CE208	mg/kg CrIII	68	-	53	51
Chromium (VI)	CE146	mg/kg CrVI	<1	-	<1	<1
Copper (total)	CE127 M	mg/kg Cu	3.3	-	6.7	6.1
Lead (total)	CE127 M	mg/kg Pb	16	-	8.0	7.0
Mercury (total)	CE127 M	mg/kg Hg	<0.5	-	<0.5	< 0.1
Nickel (total)	CE127 M	mg/kg Ni	30	-	8.2	11
Selenium (total)	CE127 M	mg/kg Se	0.6	-	0.5	< 1.0
Zinc (total)	CE127 M	mg/kg Zn	23	-	6.0	12
pH	CE004 M	units	5.8	-	5.5	5.5
Sulphate (2:1 water soluble)	CE061 U	mg/l SO_4	<10	-	17	17
Sulphide	CE016	mg/kg S^{2-}	16	-	37	41
Cyanide (free)	CE077	mg/kg CN	<1	-	<1	<1
Cyanide (total)	CE077	mg/kg CN	<1	-	<1	<1
Thiocyanate	CE145 M	mg/kg SCN	1.2	-	3.5	1.8
Phenols (total)	CE078	mg/kg PhOH	<0.5	-	<0.5	<0.5
Total Organic Carbon (TOC)	CE197	% w/w C	0.3	-	7.2	1.8
Estimate of OMC (calculated from TOC)	CE197	% w/w	0.4	-	12.3	3.1
PAH						
Acenaphthene	CE087 M	mg/kg	<0.02	-	-	-
Acenaphthylene	CE087 M	mg/kg	<0.02	-	-	-
Anthracene	CE087 U	mg/kg	<0.02	-	-	-
Benzo(a)anthracene	CE087 U	mg/kg	<0.02	-	-	-
Benzo(a)pyrene	CE087 U	mg/kg	<0.02	-	-	-
Benzo(b)fluoranthene	CE087 M	mg/kg	<0.02	-	-	-
Benzo(ghi)perylene	CE087 M	mg/kg	<0.02	-	-	-
Benzo(k)fluoranthene	CE087 M	mg/kg	<0.03	-	-	-
Chrysene	CE087 M	mg/kg	<0.03	-	-	-
Dibenz(ah)anthracene	CE087 M	mg/kg	<0.02	-	-	-
Fluoranthene	CE087 M	mg/kg	<0.02	-	-	-
Fluorene	CE087 U	mg/kg	<0.02	-	-	-
Indeno(123cd)pyrene	CE087 M	mg/kg	<0.02	-	-	-
Naphthalene	CE087 M	mg/kg	<0.02	-	-	-
Phenanthrene	CE087 M	mg/kg	<0.02	-	-	-
Pyrene	CE087 M	mg/kg	<0.02	-	-	-
PAH (total of USEPA 16)	CE087	mg/kg	<0.34	-	-	-
Subcontracted analysis						
Asbestos (qualitative)	$	-	-	NAD	NAD	NAD

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PREPARED LEACHATES

Lab number			111351-1L
Sample id			BH3
Depth (m)			0.50
Test	**Method**	**Units**	
Arsenic (dissolved)	CE128 U	µg/l As	0.90
Boron (dissolved)	CE128 U	µg/l B	7
Cadmium (dissolved)	CE128 U	µg/l Cd	0.30
Chromium (dissolved)	CE128 U	µg/l Cr	0.4
Copper (dissolved)	CE128 U	µg/l Cu	3.6
Lead (dissolved)	CE128 U	µg/l Pb	0.2
Mercury (dissolved)	CE128 U	µg/l Hg	<0.008
Nickel (dissolved)	CE128 U	µg/l Ni	2.1
Selenium (dissolved)	CE128 U	µg/l Se	0.07
Zinc (dissolved)	CE128 U	µg/l Zn	23
pH	CE213 U	units	7.6
Sulphate	CE049 U	mg/l SO_4	<1.7
Sulphur (dissolved)	CE128 U	mg/l S	1.0
Sulphide	CE249	µg/l S^{2-}	400
Cyanide (free)	CE147	µg/l CN	<5
Cyanide (total)	CE147	µg/l CN	<5
Thiocyanate	CE014	µg/l SCN	401
Phenols (total)	CE148	µg/l PhOH	<10
PAH			
Naphthalene	CE051	µg/l	<0.1
Acenaphthene	CE051	µg/l	<0.1
Acenaphthylene	CE051	µg/l	0.3
Anthracene	CE051	µg/l	0.4
Benzo(a)anthracene	CE051	µg/l	<0.1
Benzo(a)pyrene	CE051	µg/l	<0.1
Benzo(b)fluoranthene	CE051	µg/l	<0.1
Benzo(ghi)perylene	CE051	µg/l	<0.1
Benzo(k)fluoranthene	CE051	µg/l	<0.1
Chrysene	CE051	µg/l	<0.1
Dibenz(ah)anthracene	CE051	µg/l	<0.1
Fluoranthene	CE051	µg/l	<0.1
Fluorene	CE051	µg/l	<0.1
Indeno(123cd)pyrene	CE051	µg/l	<0.1
Phenanthrene	CE051	µg/l	<0.1
Pyrene	CE051	µg/l	<0.1
PAH (total of USEPA 16)	CE051	µg/l	<1.6

111351
Mill Street, Frizington
G22250

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CE709 Test Report Issue 19, issued 20 May 2022

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE127	Arsenic (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg As
CE063	Boron (water soluble)	Hot water extract, ICP-OES	Dry		0.5	mg/kg B
CE127	Cadmium (total)	Aqua regia digest, ICP-MS	Dry	M	0.2	mg/kg Cd
CE127	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
CE127	Copper (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cu
CE127	Lead (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Pb
CE127	Mercury (total)	Aqua regia digest, ICP-MS	Dry	M	0.5	mg/kg Hg
CE127	Nickel (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Ni
CE127	Selenium (total)	Aqua regia digest, ICP-MS	Dry	M	0.3	mg/kg Se
CE127	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
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

Chemtech Environmental Limited

METHOD DETAILS

METHOD	PREPARED LEACHATES	METHOD SUMMARY	STATUS	LOD	UNITS
CE002	Leachate preparation (EA)	L:S 10:1		-	-
CE128	Arsenic (dissolved)	ICP-MS	U	0.06	µg/l As
CE128	Boron (dissolved)	ICP-MS	U	8	µg/l B
CE128	Cadmium (dissolved)	ICP-MS	U	0.07	µg/l Cd
CE128	Chromium (dissolved)	ICP-MS	U	0.2	µg/l Cr
CE128	Copper (dissolved)	ICP-MS	U	0.4	µg/l Cu
CE128	Lead (dissolved)	ICP-MS	U	0.2	µg/l Pb
CE128	Mercury (dissolved)	ICP-MS	U	0.008	µg/l Hg
CE128	Nickel (dissolved)	ICP-MS	U	0.5	µg/l Ni
CE128	Selenium (dissolved)	ICP-MS	U	0.07	µg/l Se
CE128	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
CE128	Sulphur (dissolved)	ICP-MS	U	0.2	mg/l S
CE249	Sulphide	Distillation, Titration		100	µg/l S2-
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

Chemtech Environmental Limited

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)
111351-1	BH3	0.50	N	
111351-3	TPB	0.20	N	
111351-4	TPC	0.20	N	

Chemtech Environmental Limited

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.