



Phase 2 Intrusive Site Investigation Report

LOCATION	Proposed Dwellings, Land off Scott Lane, Cleckheaton BD19 3LX
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Table of Contents

Section	Content	Page
1	Introduction	3
2	Scope of Phase 2 Investigation	3
2.1	Scope of works	3
2.2	Sampling Rationale	4
3	Phase 2 Investigation Findings	4
3.1	Encountered ground conditions	4
3.1.1	Windowless Sampling Boreholes	4
3.1.2	Hand excavated Trial Pits	6
3.1.3	Rotary Open Hole Boreholes	7
3.1.3.1	Conclusions with respect to Coal Mining Risk	8
3.2	Soil Plasticity and Vegetation Influence	8
4	Contamination Testing	9
5	Risk Assessment	9
5.1	Method	9
5.2	Contamination Risk to Identified Receptors	10
5.2.1	Contamination Risk to Human Health	10
5.2.2	Contamination Risk to Controlled Waters	12
5.3	Review of Results	13
5.3.1	CGHM	14
6	Hazardous Gas	16
6.1	Gas Regime	16
6.2	Radon Gas	16
7	Conclusions	17
7.1	Contamination	17
7.2	Foundations & Floors	17
7.3	Hazardous Gas	17
7.4	Concrete Design	18
Appendix 1	Site Plan and Borehole & Trial Pit Logs Moisture & Plasticity Test Results & Moisture Profiles	
Appendix 2	Chemtech Analytical Test Report	



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1. Introduction

In accordance with your instruction and following the completion of a Phase 1 Desk Study Investigation (JPG Report Ref B22866 - November 2018), Geoinvestigate Ltd. has carried out a Phase 2 investigation on a plot of land to the south of Scott Lane, Cleckheaton. The site currently comprises two distinct areas, one to the north with several disused / dilapidated structures and areas of hardstanding and to other to the south with sparsely vegetated ground and areas of hardstanding and demolition material.

The Phase 1 Desk Study found that the site presented a Medium environmental risk, the most likely sources of potential contamination to comprise the site's previous industrial and domestic use and adjacent historic commercial activities. The most likely geological hazards were anticipated to be possible unrecorded shallow coal mine workings and a potentially poorly consolidated made ground.

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 and hazardous gas to occur, and to investigate the risk regarding the potentially presence of shallow coal mine workings and other geotechnical hazards and to provide advice regarding foundation design.

It is proposed to construct three detached blocks of apartments with associated car parking and limited landscaped areas. The boundary of the current study area 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 highlighted in the previous desk study:

- The sinking of nine (9) boreholes (BH1 to BH9) to depths of between 1.30m and 3.00m with associated soil sampling and supervision of the works by a suitably qualified geo-environmental engineer. The boreholes were sunk by windowless sampling techniques using a Dando Terrier 2002 mini drilling rig.
- The sinking of three (3) rotary open hole boreholes (RH1 to RH3) to a depth of 30.00m under licence from the Coal Authority to probe for shallow mine workings. The boreholes were sunk using Geoinvestigate's Microdrill® with water flush.
- Excavation of four (4) hand-dug trial pits (TPA, TPB, TPC and TPD) to further investigate the makeup of near surface soils and to recover additional samples for contamination analysis (mostly in areas of the site which were not accessible for the drilling rig).
- Geotechnical Testing comprising fifty (50) moisture determinations and four (4) Atterberg Limits to provide information on the general condition, plasticity and potential for vegetation influence on the soils
- The installation of three (3) gas monitoring wells in boreholes BH3, BH4 and BH5 with 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.

- Contamination analyses of ten (10) samples of both shallow and deeper made ground recovered at depths up to 1.50m to confirm that metals, Asbestos, polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons (including BTEX) are absent or within acceptable limits. A sample recovered from close to the substation was also analysed for PCB content (polychlorinated biphenyls). (Chemical analyses based on the attending engineer's assessment of soils and ground conditions at the site together with Phase 1 Desk Study findings). Leachate from two (2) samples was tested to check the mobility of the contaminants
- Provision of a factual and interpretative report including; site plan, trial pit and borehole logs and contamination analysis results, together with advice on the foundation, contamination, gas and coal mining situation at the site and, if required, remediation and validation.

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

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

The results of the contamination testing are included in Appendix 2.

2.2 Sampling Rationale

The borehole positions were chosen to give an indication of the ground conditions generally throughout the accessible parts of the site, which includes most or all of the proposed building footprint. Boreholes BH1 to BH5 were sunk to investigate the deeper ground conditions close to the proposed structure for foundation design purposes, whilst BH6 – BH9 and hand pits TPA to TPD were sunk to inspect the makeup of near-surface soils in areas of proposed soft landscaping / gardens, with the latter excavated in areas where access with the drill rig was not possible.

RH1 to RH3 were positioned throughout the accessible part of the site to explore for potential shallow historical mine workings below and close to the footprint of the proposed structure(s).

3. Phase 2 Investigation Findings

3.1 Encountered Ground Conditions

3.1.1 Windowless Sampling Boreholes

Save for BH7 the boreholes encountered made ground to depths of between 0.35m and 1.40m underlain by soft to firm and firm / loose very sandy gravelly clay / clayey gravelly sand natural strata with most of the boreholes finding rock at depths of between 1.10m and 2.20m. BH7, BH8 and BH9 encountered fill to the base of the borehole at 3.00m, 1.40m and 1.55m respectively.

3.1.1.1 BH1 – BH5 – Boreholes within Building Footprints

BH1 to BH5 encountered generally similar ground conditions comprising either tarmac hardstanding or a concrete floor slab (BH1 to BH3) or initial granular fill. Below the hardstanding or slab the made ground comprised mostly compact sandy gravel with brick, sandstone limestone and occasional ash and coal constituents. In BH4 the initial made ground from surface comprised loose sandy gravel of ash and coal, whilst BH5 found similar compact granular made ground to that found beneath the initial hard cover in BH1 to BH3. The made ground extended to depths of 0.55m in BH1, 0.70m in BH2, 1.20m in BH3, 0.35m in BH4 and 0.80m in BH5.

Below the fill BH1, BH3, BH4 and BH5 found stiff / compact natural very sandy gravelly clay / clayey gravelly sand in places, whilst in BH2 similar natural very sandy gravelly clay was noted to be in a soft to firm condition.

Weak to moderately strong or moderately strong weathered or completely weathered sandstone rock commenced below depths of 0.90m (BH1), 1.10m (BH2), 1.60m (BH3), 0.80m (BH4) and 1.90m (BH5). Where the rock was considered to be in a initially weak to moderately strong condition (BH1 and BH4) the rock was noted as becoming strong and un-weathered from depths of 1.20m and 1.40m.

Due to the highly granular nature of the natural clayey strata only a single vane shear strength value of 40kN/m^2 was returned at 0.80m in the weaker deposit in BH2.

In situ SPT testing (carried out with a solid cone sampler) returned testing results of between $N=8$ in the clayey strata in BH3, and between $N=20$ to $N=48$ within the weathered sandstone horizon. Testing within the sandstone rock at the base of the boreholes returned refusal N values of between $N=45/300\text{mm}$ and $N=50/5\text{mm}$ at depths of between 1.00m and 2.00m.

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

3.1.1.2 BH6 – Within hardstanding area

BH6 found similar strata to that of BH1 to BH5 with compact granular made ground with constituents including sandstone, brick, ash, concrete and coal to 0.85m underlain by stiff natural sandy gravelly clay, then very stiff silty sandy gravelly clay of possible weathered siltstone / sandstone origin, with weak highly weathered siltstone rock commencing below 2.20m to the base of the borehole at 2.80m.

Vane shear strength values of between 88kN/m^2 and 120kN/m^2 were recorded in the clay between depths of 1.00m and 2.00m. No SPT testing was carried out within the borehole.

The borehole remained open and dry on completion. No roots were recovered from the borehole.

3.1.1.3 BH7 to BH9

BH7, BH8 and BH9 were sunk within areas of proposed landscaping (BH7 and BH8), or potential hardstanding (BH9).

BH7 found turf and topsoil comprising soft to firm sandy gravelly clay to 0.20m then loose sandy gravel and cobbles of brick, concrete, sandstone and occasional coal to the base of the borehole at 3.00m.

BH8 found made ground comprising loose slightly silty sandy gravel and cobbles of brick, sandstone and coal with occasional ash and plastic. Below 1.40m further made ground was encountered comprising loose slightly silty sandy gravel and cobbles of sandstone, brick, concrete and coal.

In BH9, positioned close to the presumed location of a former above ground tank, the initial 170mm thick concrete hardstanding was underlain by loose sandy gravel and cobbles of sandstone, brick, concrete and occasional coal to the base of the borehole at 1.55m. No visual or olfactory evidence of any potential hydrocarbon leakage was observed within the borehole.

No SPT testing was carried out within the boreholes.

BH7 closed below 2.20m on completion, whilst BH8 and BH9 closed below 1.20m and 1.10m depth respectively. No standing water was recorded in any of the three boreholes and roots were only encountered in BH8 to a depth of 1.40m

3.1.1.5 Summary of ground conditions encountered in the boreholes.

Save for BH7 the boreholes encountered made ground to depths of between 0.35m and 1.40m underlain by soft to firm and firm / loose very sandy gravelly clay / clayey gravelly sand natural strata with most of the boreholes finding rock at depths of between 1.10m and 2.20m. BH7, BH8 and BH9 encountered fill to the base of the borehole at 3.00m, 1.40m and 1.55m respectively.

The granular constituents within the latter strata comprise almost exclusively sandstone, concrete, brick and coal, with occasional ash noted.

3.1.2 Hand excavated Trial Pits – TPA, TPB, TPC and TPD

Trial Pits TPA, TPB, TPC and TPD were sunk in proposed landscaping areas provide further information on the soil conditions at the site and recover representative samples for subsequent testing.

Although TPA was excavated on sloping ground it and TPB encountered similar ground conditions comprising made ground of loose clayey sandy gravel, or slightly silty clayey sandy gravel, with gravel constituents including sandstone, brick, concrete and occasional ash to a depth of circa 0.50m then firm natural very sandy gravelly clay.

TPC found topsoil comprising loose slightly silty clayey gravelly sand with brick and coal constituents to 0.25m underlain by made ground of loose clayey sandy gravel with sandstone, brick, and occasional coal and ash constituents to the base of the pit at 0.70m.

TPD found made ground similar to that encountered in TPC of loose slightly silty gravelly sand / sandy gravel with sandstone brick and occasional coal constituents. A single glass fragment was also noted. The trial pit was terminated at 0.60m on large sandstone cobbles.

Each trial pit remained stable and dry on completion and no significant roots were encountered.

Samples for contamination testing were taken from depths of 0.50m in TPA, 0.20m in TPB and TPC and 0.30m in TPD.

3.1.3 Rotary Open Hole Boreholes

As a possible risk to the new development from possible unrecorded shallow coal mine workings had been highlighted by the Phase 1 report. The report suggests that the Wheatley Lime Coal seam outcrops some 70m to the north of the site extending beneath the site. With a thickness of between 0.40m to 1.20m the seam is inferred to underlie the site at between 10m and 20m depth. Therefore, three rotary open hole boreholes were sunk to establish the nature of the underlying rock strata and whether coal seams and/or mine workings or collapsed/broken ground were present at the site, and if these seams or workings present a hazard to the surface.

The rotary open-hole boreholes were undertaken using Geoinvestigate's Microdrill®, a custom built tracked mini rotary drill designed specifically for probing for shallow mine workings using water flush. The holes were located close to or below the proposed building footprints. The rock descriptions are tentative and generally based on the contents of returned water flush, drilling progress (speed of advance) and water pressures observed during drilling; no cores were recovered from the boreholes to verify these though at several times during excavation the drill-string is withdrawn from the ground to inspect the composition of the build-up on the drill bit.

Gas readings were taken in the boreholes during and following drilling. These are shown on the logs in Appendix 1 (no hazardous gas concentrations were detected).

All three boreholes (RH1 to RH3) encountered similar ground conditions comprising what was inferred to be drift (a generalised description likely to be made ground in this case) to between 1.20m to 1.80m roughly corresponding with depths encountered in the shallower windowless sampling boreholes, though this probably includes weathered and highly weathered bedrock as well as this would allow similarly easy progress with the Microdrill. Therefore, the actual commencement of weathered bedrock is likely to be shallower than these depths.

Below the superficial deposits RH1 encountered sandstone to a depth of 9.10m underlain by sandstone with mudstone inclusions with some small fractures. An intact possible coal seam of 100mm in thickness was found below 21.4m underlain by mudstone with sandstone inclusions to 30.0m

In RH2 sandstone with some small fractures commenced below 1.60m extending to 10.4m where sandstone with mudstone inclusions commenced, then mudstone with sandstone inclusions to the base of the borehole at 30.0m. No coal seams were evident.

In RH3, similar to RH2 sandstone with some small fractures commenced below 1.20m extending to 14.4m followed by mudstone with sandstone from 24.3m to 30.0m. No coal seams were evident.

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None of the boreholes encountered voids or broken ground indicative of shallow mine workings, however intact coal seam of 100mm thick, was present at depth of 21.4m in RH1. Water flush was lost below 12.5m in RH1 and 5.2m in RH2 whilst full water flush was returned in RH3.

3.1.3.1 Conclusions with respect to Coal Mining Risk

Although of the rotary boreholes sunk at the site only RH1 site encountered an intact possible thin seam of coal below 21.4m, no evidence of voided or broken ground, indicative of the working of this seam was encountered and given the thin nature and sporadic presence at the site none would be expected.

The general rule of thumb for overlying solid rock cover of ten times the thickness of any coal seam is often adopted as a generally applicable safety factor; based on the actual ground conditions encountered by the drilling exercise undertaken at the site then there is considered to be sufficient competent rock cover even if this were to have been mined.

Therefore, given the above and lack of voiding or broken ground, indicative of any workings it is considered that no mitigation measures are required at the site with regard to the site's past coal mining legacy.

3.2 Soil Plasticity and Vegetation Influence

Plasticity testing on the clay strata at the site recovered from pertinent boreholes returned Plasticity Indices (PIs) between 19.6% to 23.0% classifying the soils as Clay of Intermediate Plasticity (CI) according to BS5930. The clay strata classify as NHBC Low and Medium Shrinkage soils.

No roots were recovered from the boreholes at the site.

Although, generally vegetation at the site is largely absent, however a large hedge and immature trees is present along the western boundary of the site. Although no roots and no obvious moisture depletion is evident on the moisture profiles given the proximity of the proposed building to the boundary and vegetation, some depletion might be expected.

Given the above, although it is considered that, generally the risk to the site from seasonal shrinkage and swelling attributable to vegetation may be very low, precautions should be taken with regard the western elevation of the building, adjacent to the vegetated area.

4. Contamination Testing

Prior to the site works, the site's previous development and industrial and domestic use and adjacent historic commercial activities considered to comprise the most credible source of made ground and possible contamination within the site. It was considered prior to the site works that if former land uses within and near to the site had caused contamination the contaminants could potentially occur throughout the full thickness of the made ground or possible topsoil horizons. 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.

Based on the findings of the site works ten (10) samples of both near-surface ($\leq 0.50\text{m}$) topsoil and made ground and deeper made ground (up to 1.50m deep) 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 and Asbestos. In addition, analysis was included in the testing for petroleum hydrocarbons and BTEX (benzene, toluene, ethyl benzene and xylene) where appropriate. Leachate from two (2) of the samples was analysed also.

The results of the contamination testing are included in Appendix 2 of this report (Chemtech Environmental Ltd. report 77765) 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; Environment Agency Environmental Quality Standards (EQSs) Soil Guideline Values (SGVs), Site Specific Assessment Criteria (SSAC) generated using CLEA software version 1.06 site specific risk assessment modelling, DEFRA Category 4 Screening Levels (C4SLs), and Land Quality Management / Chartered Institute of Environmental Health (LQM/CIEH) Safe for Use Levels (S4ULs) in order to assess the presence of potentially harmful chemicals within soils and water.

As the site is to be developed as a residential development, it falls within the residential end-use category. However, given that the landscaped areas at the site are likely to be communal areas for the apartments, it is highly unlikely that persons living on the site will cultivate vegetables / fruit for consumption, consideration to this end is considered un-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.

Where results are above the intervention values, an assessment of the available pathways and receptors has been carried out to determine whether further investigation or remediation is 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 found to extend to depths of generally ($\leq 1.50\text{m}$) in the majority of the boreholes however fill in excess of 3.00m was found in BH7.

As discussed previously, the majority of the made ground extending to between 0.35m and 1.40m , and occasionally 3.00m was found to comprise sandy gravel and cobbles of brick, sandstone, concrete with occasional coal and ash. Representative samples of this material were tested from the boreholes and trial pits.

The ash and coal content of the fill comprised the only visual evidence of possible contamination while no other soils encountered at the site exhibited any noteworthy visual or olfactory evidence of possible contamination. Further to this, no visible evidence of Asbestos contamination such as roofing board was noted in any of the soils encountered in the boreholes and trial pits.

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 ten (10) samples of soil recovered from the site from depths up to 1.50m returned concentrations of a range of substances falling for the most part below respective assessment criteria adopted from the sources named above with some exceptions discussed later. 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 7.2% and mean Soil Organic Matter Content (SOM) of 12.4% (estimated from the TOC) were returned from the soil analyses. Therefore, the LQM/CIEH GAC for PAHs and Hydrocarbons were chosen using the highest Soil Organic Matter (SOM) option of 6.0% .

Table 1: Chemical Determinands in Soils

	Range of Returned concentrations (mg/kg)	Residential EA SGV or DEFRA C4SL (mg/kg)	LQM/CIEH S4UL* (mg/kg)
Asbestos	None detected (5 samples)	Any presence unacceptable	
Arsenic	12-55	32/40***	40
Boron	0.8-1.4		11,000
Cadmium	<0.2-4.5	10/149***	85
Chromium VI	<1 (all 9)	21***	6
Chromium III	26-73		910
Copper	31-342		7,100
Lead	43-1084	310***	
Mercury (elemental)	<0.5 (all 9)	1	1.2
Nickel	13-56		180
Selenium	0.6-1.8	350	430
Zinc	63-536		40,000
pH	7.7-8.0	See Report Section 7.4 "Concrete Design"	
Water Soluble SO ₄	<10-187		
Phenol	<0.5 (all 9)	420	2,300
Total PAH	1.37-1059		
PAH Naphthalene	0.08-12.43		13
PAH Acenaphthylene	<0.02-0.26		6,000 (506)**
PAH Acenaphthene	<0.02-24.23		6,000 (336)**
PAH Fluorene	<0.02-22.04		4,500 (183)**
PAH Phenanthrene	0.31-207.63		1,500
PAH Anthracene	0.14-55.69		37,000
PAH Fluoranthene	0.27-184.71		1,600
PAH Pyrene	0.28-161.68		3,800
PAH Benzo[a]anthracene	0.15-66.59		15
PAH Chrysene	0.15-60.56		32
PAH Benzo(b)fluoranthene	0.05-77.75		4.0
PAH Benzo(k)fluoranthene	<0.03-25.28		110
PAH Benzo(a)pyrene	0.08-66.59	5.3***	3.2
PAH Indeno(123-cd)pyrene	<0.02-47.50		46
PAH Dibenzo(a,h)anthracene	<0.02-7.32		0.32
PAH Benzo(ghi)perylene	0.02-47.34		360
TPH Aromatic C5-C7	<0.01 (all 4)		1,400
TPH Aromatic C7-C8	<0.01 (all 4)		3,900
TPH Aromatic C8-C10	<0.01 (all 4)		270
TPH Aromatic C10-C12	<1 (all 4)		1,200
TPH Aromatic C12-C16	<1-2		2,500
TPH Aromatic C16-C21	1-75		1,900
TPH Aromatic C21-C35	<1-71		1,900
TPH Aromatic C35-C44	<1-15		1,900
TPH Aliphatic C5-C6	<0.1 (all 4)		160
TPH Aliphatic C6-C8	<0.1 (all 4)		530
TPH Aliphatic C8-C10	<0.1 (all 4)		150
TPH Aliphatic C10-C12	<4-6		770 (283)**
TPH Aliphatic C12-C16	<4-56		4,400 (142)**
TPH Aliphatic C16-C35	13-1033		110,000
TPH Aliphatic C35-C44	<10-265		110,000

*For residential use without allowance for plant uptake / consumption of homegrown produce and SOM of 6% where relevant.

**Value in parentheses denotes estimated soil saturation limit above which a possibility of free-phase contamination might exist in soil.

***DEFRA C4SL for residential use with allowance for plant uptake / consumption of homegrown produce

As can be seen from the results in Table 1 and the detailed results presented in Chemtech Environmental Ltd. report 77765 (Appendix 2) the majority of the returned results are less than the adopted assessment criteria. However, a single exception was noted for Metals and several for individual species of PAH.

The lead (Pb) concentration in the two samples of made ground recovered from BH4 at 0.20m and BH8 at 0.50m were 1084mgkg⁻¹ and 442mgkg⁻¹ which are in excess of the adopted assessment criterion of 310mgkg⁻¹ (C4SL for residential use with no allowance for homegrown produce).

Most of the exceedances for PAHs were returned for the sample from a depth of 0.20m in BH4. These species included PAH Benzo[a]anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(a)pyrene, Indeno(123-cd)pyrene and Dibenzo(a,h)anthracene. A single marginal exceedance of 0.56mgkg⁻¹ was noted for PAH Dibenzo(a,h)anthracene within a sample from TPD at 0.30m.

No asbestos was detected in any of the samples analysed and no results of any significant concern were returned for petroleum hydrocarbons. In addition, BTEX compounds and PCBs returned concentrations below levels of detection.

5.2.2 Contamination Risk to Controlled Waters

Given the possible sources of historical contamination and potential surface water receptors present directly adjacent to the site leachate was analysed from two (2) samples obtained from BH4 and TPB. 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)
<u>Inorganic Chemicals</u>		
Arsenic	8.83-8.99	50 (DW, range: 50-100) / 50 (Aq)
Boron	9-16	1000 (DW & Aq)
Cadmium	<0.07 (both)	5 (DW & Aq)
Chromium	0.3-9.2	50 (DW) / 5 (Aq, range: 5-250)
Copper	6.2-7.0	50 (DW) / 5 (Aq, range: 5-112)
Lead	2.8-16.2	50 (DW) / 4 (Aq, range: 4-250)
Mercury (elemental Hg)	0.010-0.019	1 (DW & Aq)
Nickel	1.1-3.4	20** (DW) / 50 (Aq, range: 50-200)
Selenium	0.38-0.49	10 (DW) (No Aq standard)
Zinc	3-5	3000 (DW, range: 3000-5000) / 30 (Aq, range: 30-2000)
pH	7.2-7.5	Range 5.5 to 10 (UK drinking water standards)
<u>Organic Chemicals</u>		
Cyanide	<20 (all 4)	50 (DW) / 5 (Aq)
Phenols	<10 (all 4)	50**(DW) / 300 (Aq)
PAHs (total)	5.6-16.0***	0.2 (DW, range: 0.2-1.0) (No Aq standard)
See Table 2a for PAH Species at detectable concentrations:		

*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) the lowest value has been adopted.

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

***Sum of USEPA 16, each at Lower Limit of Detection of <0.1

Table 2A Chemical Determinands in Leachate – Leachates above detectable concentrations

	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)
Acenaphthene	0.4-3.2	No applicable UK standard
Anthracene	0.3-0.4	0.4 (inland surface waters – max. allowable concentration)
Benzo(ghi)perylene	<0.1-0.2	No applicable UK standard
Fluoranthene	0.5-0.9	1 (inland surface waters – max. allowable concentration)
Fluorene	0.7-3.1	No applicable UK standard
Naphthalene	0.3-5.2	10 (Aq) / 2.4 (inland surface waters)
Phenanthrene	2.4-3.2	No applicable UK standard
Pyrene	0..3-0.5	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) the lowest value has been adopted.

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

***Sum of USEPA 16, each at Lower Limit of Detection of <0.1

As can be seen from Table 2 and 2A and the detailed results presented in Chemtech Environmental Ltd report 77765 (Appendix 3), soils at the site have been shown not to be leaching any potential contaminants at elevated levels and as such would not be considered to pose a potential risk to the local ground or surface water features through leaching.

The leachates returned slightly or very slightly elevated, chromium, copper and lead concentrations which marginally exceed the lowest assessment criteria options (of several possible choices). These options are chosen according to the calcium carbonate content of the water with the lowest options relating to water of low calcium carbonate content; this would only be expected in more acidic waters and so, given that the pH of these leachates is slightly alkaline (with slightly alkaline soil pHs also returned), the lowest assessment criteria options are not applicable, and the slightly elevated levels are inferred to represent no significant risk

Concentrations of the individual PAHs have been compared to surface water quality standards in the absence of any viable alternative standards. These standards are however not strictly applicable to leachates however, and where a 'protection of Aquatic Life' standard exists (which have been used for other potential contaminants) for naphthalene and Anthracene levels in these leachates are below that target level. As such soils at the site are concluded to pose no risk to controlled waters, especially with respect to the presence of the site at least 500m from the nearest surface water feature* and the very low analysis results. *According to information from available mapping, not appended.

Each borehole sunk at the site was recorded as stable and dry, suggesting no perched groundwater exists beneath the site.

5.3 Review of Results

Soils

In general, the majority of samples returned concentrations of all (tested) potential contaminants within acceptable limits save for the sample recovered from 0.20m in BH4 and that from BH8 at 0.40m. These returned elevated lead (Pb) concentrations at 1084mgkg⁻¹ and 442mgkg⁻¹. The adopted assessment criterion for Pb is the C4SL at 310mgkg⁻¹.

The normal background soil concentration of Lead (according to C4SL Literature) in urban environments is 820mgkg^{-1} for the urban domain. Only one of the analysed samples returned a level in excess of this background concentration. Therefore, the other returned values which exceed the 310mgkg^{-1} DEFRA C4SL might not be unexpected in this urban context. Furthermore, the mean lead concentration is just 267mgkg^{-1} , significantly lower than the normal background concentration.

The sample from 0.20m in BH4 also returned elevated levels of several species of PAH, with the sample from TPC at 0.30m returning a marginal exceedance of PAH Dibenzo(a,h)anthracene at 0.56mgkg^{-1} .

It was noted that BH4 lies within the footprint of one of the proposed buildings at the site and would therefore not be of significant concern, due to the lack of potential linkage to the site's end user. In addition, no exceedances were noted in the sample from the nearby TPD. Furthermore, leachate testing on the sample from BH4 at 0.20m returned very low concentrations of lead or PAHs, indicating that the compounds are of very low mobility.

With regard to exceedance of PAH Dibenzo(a,h)anthracene at 0.56mgkg^{-1} within TPD at 0.30m, this minor exceedance of the C4SL is not considered representative of any noteworthy risk at the site, nor would any remedial works be justified given the extremely minor potential gains when weighed against the likely costs* associated with such an exercise.

*Beyond the financial consideration, unjustifiable costs associated with remedial works would include unnecessary stress to all stakeholders, time lost, additional vehicle movements affecting local traffic, vehicle emissions, noise pollution, and potentially avoidable volumes of soil going to landfill.

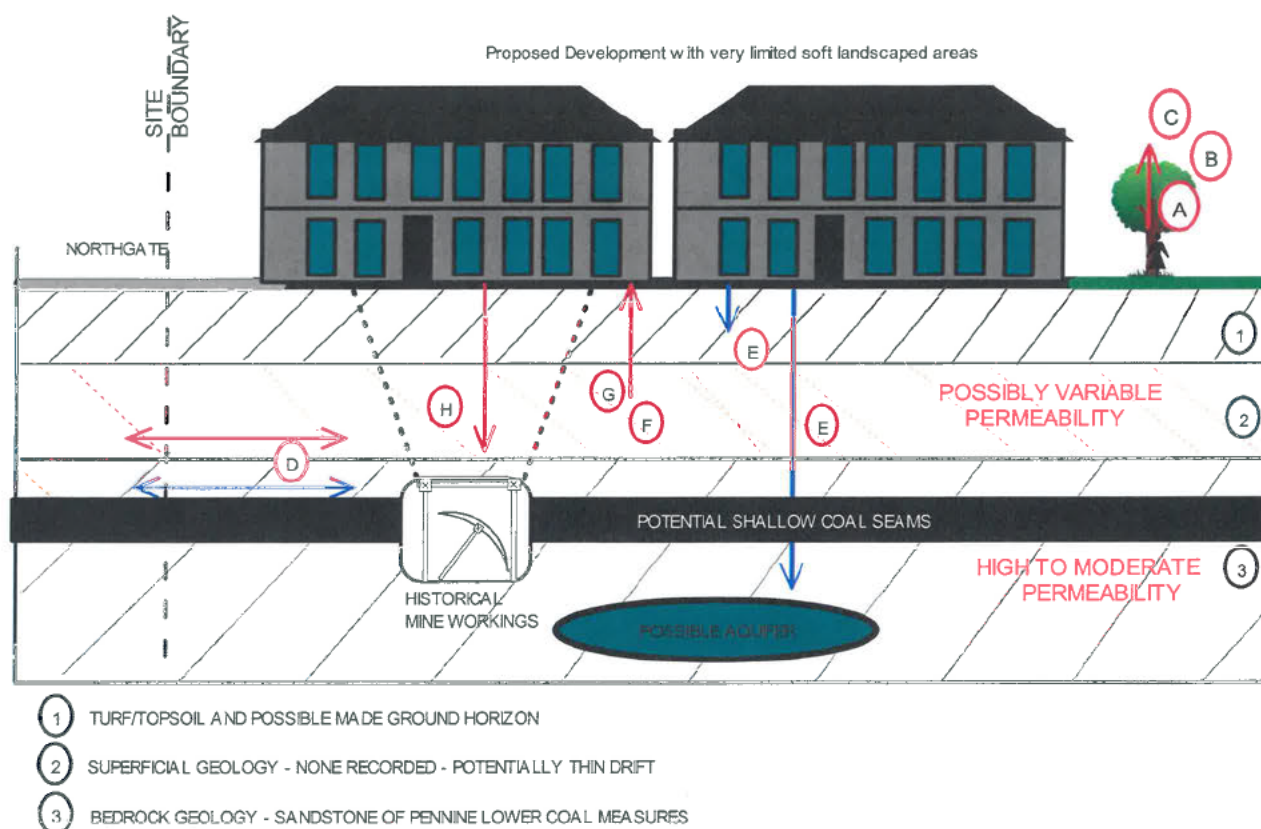
Waters

Leachates from topsoil and made ground have been analysed and these contained no levels of potential contaminants that would be expected to pose any significant risk to ground and surface waters.

This would suggest that any contamination which is present in these soils has low mobility and at present does not pose any noteworthy risk to controlled waters.

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**

- Nearby and on site historic potentially polluting land uses (mills / works etc).
- Made ground from adjacent and on site development.
- Potential hazardous gas sourced from made ground and potential shallow mining activity

IDENTIFIED RECEPTORS and ASSOCIATED PATHWAY

- A - End Users through Direct Contact / Inhalation / Ingestion. Buildings and hardstanding will encompass some of the site, removing any pathway to end users through direct contact in these areas.
- B - Plants and Trees through uptake.
- 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). Linkages A to D not present due to low levels of contaminants returned.
- E - Ground water through leaching of sub-soil. No risk identified. No mobile contaminants identified.
- F - Building and services through direct contact. No risk identified, ground not aggressive with regard to concrete design.
- G - End users and buildings through ground gas migration. Gas monitoring exercise ongoing but Low gasing regime identified to date hence low risk inferred.
- H - Ground instability via potential shallow and very shallow mine collapse. Although thin coal seam encountered, no voids or broken ground identified suggestive of shallow mine-workings. No mitigation measures required at the site with regard to coal mining legacy.

6 Hazardous Gas

6.1 Gas Regime

Based on the conclusions of the Phase 1 Desk Study Report (JPG Report Ref B22866) it was concluded that a ground gas monitoring would be likely to be required at the site prior to development for residential use. The presence of made ground on some of the site and the sites location within a coal mining area gave further credence that a ground gas monitoring exercise would be necessary to properly quantify this risk.

Gas monitoring wells were therefore installed in boreholes BH3, BH4 and BH5. The results of two (2) initial gas monitoring visits at the site are presented in Table 3 below.

A further set of up to four additional measurements may be required to complete the gas risk assessment at the site but no elevated results have been returned to date (see below).

Table 3 Summary of Gas Monitoring Data

Borehole	Number of Visits	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Flow Rate (l/hr)	Atmospheric Pressure (mb)
BH3	2	0.1-0.2	1.5-1.7	19.0-19.9	<0.1	981-1000
BH4		<0.1-0.1	2.3-2.4	16.4-16.8	<0.1	
BH5		<0.1 (all)	0.6 (both)	20.1-20.6	<0.1	

The two gas monitoring visits carried out to date at atmospheric pressures of between 981mb and 1000mb returned:

- Near normal or slightly depleted levels of O₂ of between 16.4% and 20.6%.
- Levels of CH₄ mostly below detectable limits (<0.1%) or retuning negligible concentrations.
- Low levels of CO₂ of between 0.6% and 2.4%.
- Negligible H₂S and CO below detectable limits (<1ppm) on all monitoring occasions.
- Consistently negligible flow rates below detectable limits (<0.1 l/hr) on all monitoring occasions.

6.2 Radon Gas

The desk study findings confirmed that Radon protection is not necessary for new buildings at the site.

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 residential end use of the site.

Additionally, 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 Foundations & Floors

As summarised in section 3.1.4 BH1 to BH5 sunk within the footprints of the proposed buildings at the site revealed made ground to depths of between 0.35m and 1.40m underlain by soft to firm and firm / loose very sandy gravelly clay / clayey gravelly sand natural strata with most of the boreholes finding rock at depths of between 1.10m and 2.20m.

Given the above, although the natural strata beneath the made ground at the site were in a mostly competent condition, the weak strata encountered in BH2 to a depth of 1.10m, it would be prudent to extend the foundations well into the un-weathered sandstone rock below depths of 1.20m in BH1, 1.60m in BH2 and BH3, 1.40m in BH4 and 2.00m in BH5.

Trench-fill or pad foundations seated within competent sandstone rock may be designed to a net bearing pressure of 150kN/m² and 170kN/m² respectively.

Although the made ground at the site is mostly in a compact condition, the presence of weaker horizons were noted in places and within the underlying natural soils in places (ie BH2) together with the variable thickness of the fill may lead to damaging settlement of even a lightly loaded ground bearing floor slab, therefore a suspended block and beam floors should be adopted, for the new development.

7.3 Hazardous Gas

Gas monitoring is ongoing at the site with two of a potential six monitoring visits having been undertaken to date. However, the monitoring undertaken to date has returned no cause for concern in this regard.

If the continued monitoring returns comparable data the site is expected fall into Characteristic situation 1 (CS1) of the Modified Wilson and Card classification or "Green" of the NHBC Traffic Light System for low rise housing with a ventilated under-floor void (min 150mm) (CIRIA C665).

No radon protection measures are required for the new development.

7.4 Concrete Design

The results of chemical analyses of the fill returned Water Soluble Sulphate levels of between 22mg l^{-1} and 187mg l^{-1} and pH levels of between 7.6 and 8.1. Additionally, the site is inferred to classify as brownfield with no mobile water.

On this basis concrete in contact with the ground may be designed to ACEC Class DS-1 AC-1s (DC1) 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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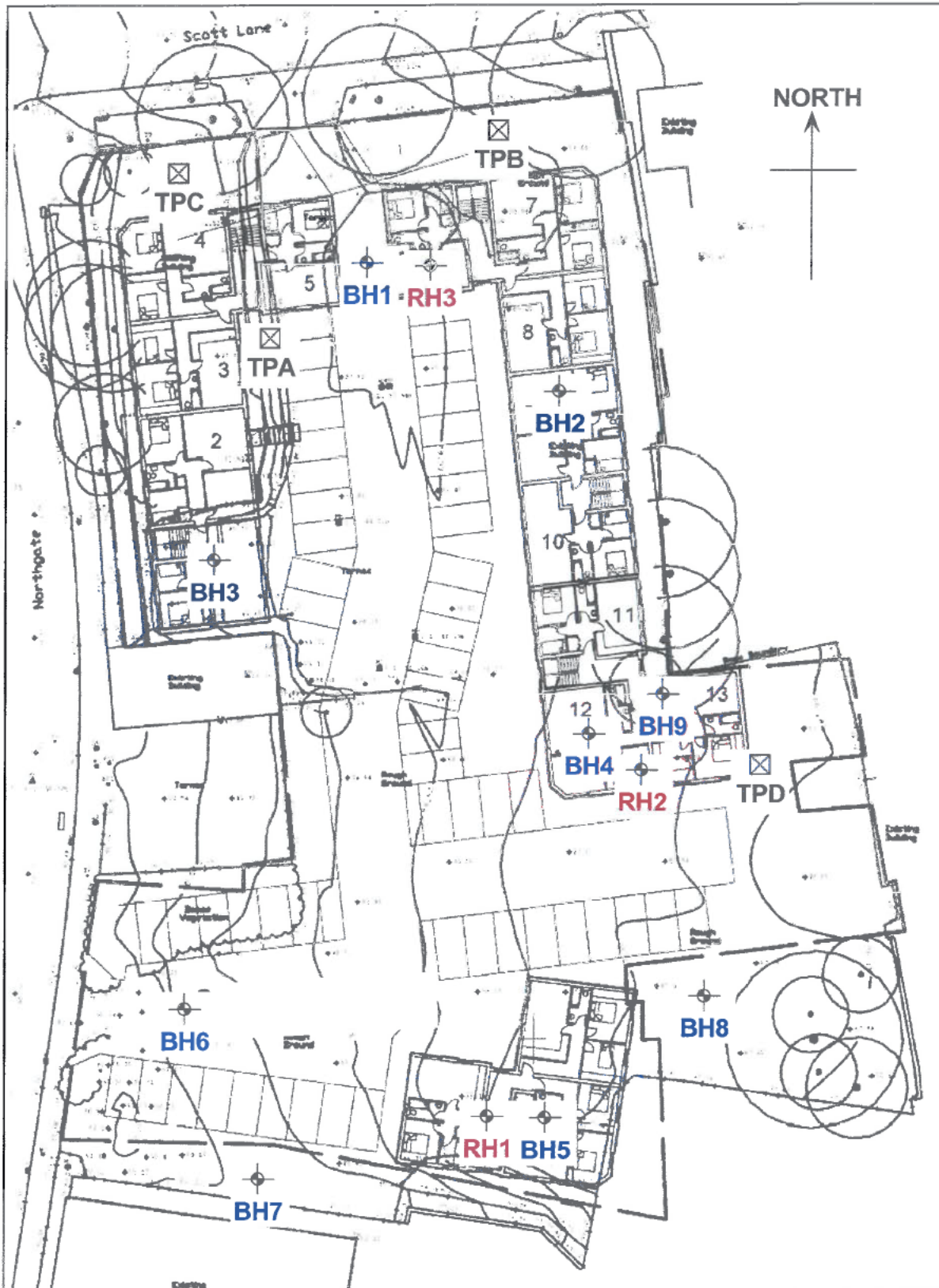
Fax 01642713923

Email enquiries@geoinvestigate.co.uk

APPENDIX 1
Site Plan and
Borehole & Trial Pit Logs.
Moisture & Plasticity Test Results &
Moisture Profiles

GEOINVESTIGATE Ltd.

OUR REF:G19086	YOUR REF:	SITE PLAN (NOT TO SCALE)
DATE:18/03/19	LOCATION: Land to the south of Scott Lane, Cleckheaton BD19 3LX	



-  WINDOWLESS SAMPLING BOREHOLE LOCATION
 ROTARY OPEN-HOLE BOREHOLE LOCATION
 TRIAL PIT LOCATION

GEOINVESTIGATE Ltd.

Your Ref.

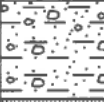
Our Ref.

G19086

BH No.1 Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.15	ASPHALT HARDSTANDING	150				Cv kN/m ²			
0.25	MADE GROUND Compact red sandy gravel of brick. Cobbles noted	200			O				0.20
0.55	MADE GROUND Compact grey and orangish brown sandy gravel. Gravel is fine to coarse sandstone. Cobbles noted	300			O				0.50
0.90	Stiff light greyish brown and brown sandy gravelly CLAY. Gravel is fine to coarse of sandstone and occasional coal. Cobbles noted	250			O S				0.75
1.30	Weak to moderately strong completely weathered SANDSTONE recovered as very sandy gravelly clay / clayey gravelly sand. Becomes strong and un-weathered from 1.20m	400			O		N=45/300mm 1.00-1.30m		1.00
	Borehole terminated at 1.30m due to refusal								1.30

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.30m
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
C Cone Penetration Test

BH1

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref.

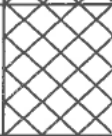
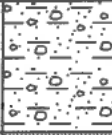
G19086

BH No.2

Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.10	ASPHALT HARDSTANDING	100				Cv kN/m ²			
0.30	MADE GROUND Compact grey sandy gravel of sandstone and limestone	200			O				0.20
0.70	MADE GROUND Firm / compact dark brown and brown very sandy gravelly clay/ clayey sandy gravel. Gravel is fine to coarse of brick. Cobbles noted	400			O				0.50
1.10	Soft to firm dark orangish brown and grey very sandy gravelly CLAY. Gravel is fine to coarse of sandstone and occasional coal Cobbles noted	400			O S	40	1,3,5,5,5,5 N=20 1.00-1.45m		0.75 1.00
1.60	Moderately strong completely weathered SANDSTONE recovered as very sandy gravelly clay / clayey gravelly sand. Becomes strong and un-weathered from 1.55m	500			O O S		14,27,17,12 N=82/300mm 1.60-1.90m		1.25 1.50 1.60
	Borehole terminated at 1.60m due to refusal								

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.60m
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
C Cone Penetration Test

BH2

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref.

G19086

BH No.3

Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.40	CONCRETE FLOOR SLAB Polystyrene insulation 0.20m to 0.30m	400				Cv kN/m ²			0.20
0.60	DPM Present below								
0.60	MADE GROUND Compact dark brown and reddish brown sandy gravel. Gravel is fine to coarse of brick and sandstone	200			O				0.50
1.20	MADE GROUND Firm dark brown very sandy gravelly clay. Gravel is fine to coarse of sandstone, brick and coal	600			O S		1,1,2,2,2,2 N=8 1.00-1.45m		0.75 1.00
1.60	Firm dark brown very sandy gravelly CLAY Gravel is fine to coarse of sandstone and coal	400			O				1.25 1.50
1.85	Moderately strong completely weathered SANDSTONE recovered as very sandy gravelly clay / clayey gravelly sand. Becomes strong and un-weathered from 1.75m	250			O S		10,14,12,12, 12,12 N=48 1.80-2.25m		1.75 1.85
	Borehole terminated at 1.85m due to refusal								

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 4.00m
Borehole remained dry on completion
Gas well installed to 1.60m with bung and cover

Key:

Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

BH3

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Your Ref.

Our Ref.

G19086

BH No.4 Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.35	MADE GROUND Loose black and brown sandy gravel of ash and coal	350			O	Cv kN/m ²			0.20
0.80	Stiff / compact light greyish brown very sandy gravelly CLAY/clayey gravelly SAND Gravel is fine to coarse of sandstone	250			O				0.50
									0.75
	Weak to moderately strong completely weathered SANDSTONE recovered as very sandy gravelly clay / clayey gravelly sand. Becomes strong and un-weathered from 1.40m	700			O S		3,3,4,6,6,6 N=22 1.00-1.45m		1.00
1.50					O S				1.25
							N=50/5mm 1.50-1.505m		1.50
	Borehole terminated at 1.50m due to refusal								

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.50m
Borehole remained dry on completion
Gas well installed to 1.50m with bung and cover

Key:

Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

BH4

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Your Ref.

Our Ref.

G19086

BH No.5 Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.80	MADE GROUND Compact dark brown and black clayey sandy gravel. Gravel is fine to coarse of sandstone, brick and concrete Occasional ash and coal noted	800			O	Cv kN/m ²			0.25 0.50 0.75
1.90	Stiff / compact sark orangish brown very sandy gravelly CLAY/clayey sandy GRAVEL. Gravel is fine to coarse of sandstone. Probable completely weathered sandstone rock	1100			O O S		5,5,4,4,5,5 N=18 1.00-1.45m		1.00 1.25 1.50 1.75
2.20	Moderately strong completely weathered SANDSTONE recovered as very sandy gravelly clay / clayey gravelly sand. Becomes strong and un-weathered from 1.15m	300			O O S		N=81/225mm 2.20-2.225m		2.00 2.25
	Borehole terminated at 2.20m due to refusal								

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 2.20m
Borehole remained dry on completion
Gas well installed to 2.00m with gas bung and cover

Key:

Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

Disturbed sample
 Cv Shear vane
 W Water sample
 S Standard Penetration Test
 C Cone Penetration Test

BH5

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Your Ref.

Our Ref.

G19086

BH No.6 Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.85	MADE GROUND Compact dark brown sandy gravel and cobbles. Gravel and cobbles are fine to coarse of sandstone, brick, ash, concrete and coal Becomes stiff and clayey below 0.50m	850			O	Cv kN/m ²			0.20
1.20	Still pale orangish mottled grey sandy gravelly CLAY. Gravel is fine to coarse of sandstone and occasional coal	350			O	88 108			0.50
2.20	Very stiff pale greyish brown mottled orange and grey silty sandy gravelly CLAY. Gravel is fine to coarse of sandstone Probable completely weathered sandstone/siltstone rock	1000			O	100			0.75
2.75	Weak pale brown mottled orange highly weathered SILTSTONE	550			O				1.00
2.80	Weak to moderately strong pale brown mottled orange sandy SILTSTONE	50							1.25
									1.50
									1.75
									2.00
									2.25
									2.50
									2.75

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 2.80m
Borehole remained dry on completion

Key:

Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

Disturbed sample
 Cv Shear vane
 W Water sample
 S Standard Penetration Test
 C Cone Penetration Test

BH6

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref.

G19086

BH No.7

Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.20	TURF / TOPSOIL Soft to firm brown sandy gravelly clay. Gravel is fine to coarse of sandstone	200			O	Cv kN/m ²			0.20
	MADE GROUND Loose grey and red sandy gravel and cobbles of brick, concrete sandstone and occasional coal				O				0.50
					O				0.75
					O				1.00
					O				1.25
	Poor sample recovery below 1.50m	2800			O				1.50
					O				1.75
					O				2.00
					O				2.25
					O				2.50
					O				2.75
3.00	Borehole terminated at 3.00m				O				3.00

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
C Cone Penetration Test

BH7

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref.

G19086

BH No.8

Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.70	MADE GROUND Loose dark brown slightly claye silty sandy gravel. Gravel is fine to coarse of sandstone, brick, concrete and coal. Occasional ash and plastic noted	700			O	Cv kN/m ²			0.20
					O				0.50
									0.75
1.40	MADE GROUND Loose grey and dark grey slightly silty sandy gravel. Gravel is fine to coarse of sandstone, brick, concrete and coal Becoming mostly cobbles with some black sandy gravel inclusions below 1.20m Roots noted to 1.40m	700			O				1.00
					O				1.25
									1.40
	Borehole terminated at 1.20m due to refusal								

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.40m
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
C Cone Penetration Test

BH8

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref.

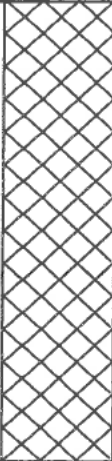
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BH No.9

Sheet No. 1 of 1

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.17	CONCRETE. No rebar or DPM	170				Cv kN/m ²			0.25
1.55	MADE GROUND Loose grey, red and greyish brown sandy gravel and cobbles. Gravel and cobbles are fine to coarse of brick, concrete and occasional coal No signs of staining or odours suggestive of adjacent tank leakage	1330			O				0.50
					O				0.75
					O				1.00
					O				1.25
					O				1.50
									1.55
	Borehole terminated at 1.55m due to refusal								

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.55m
Borehole closed below 1.10m
Borehole remained dry on completion

Key:

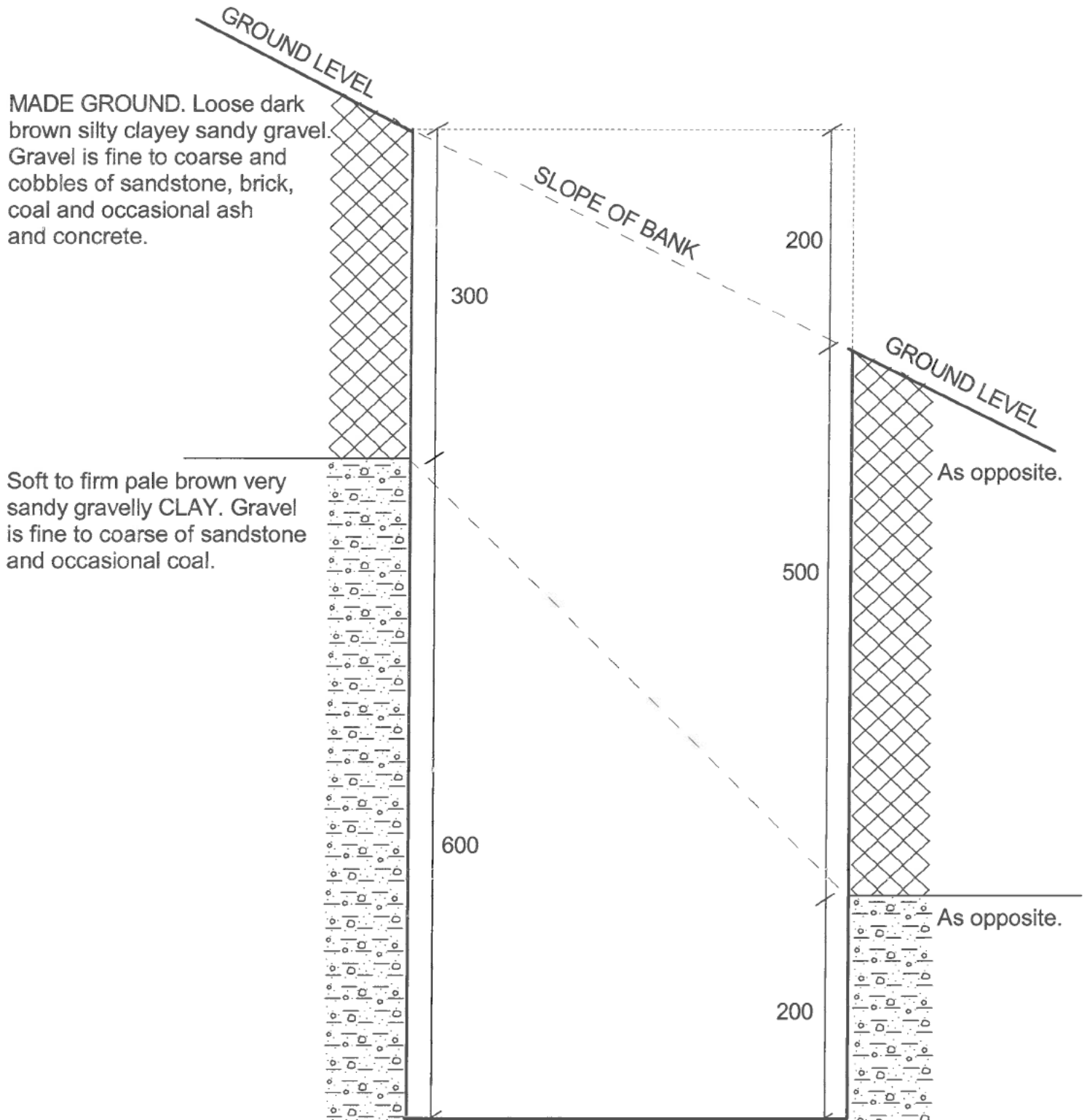
 Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

BH9

GEOINVESTIGATE Ltd.

OUR REF: G19086	YOUR REF:	TRIAL PIT: TPA
DATE: 18/03/19	LOCATION: Land to the south of Scott Lane, Cleckheaton, BD19 3LX	



Trial pit Terminated at 0.90m/0.70m (upslope/downslope).

Trial pit remained stable and dry on completion.

Soil samples recovered from depths of 0.20m, 0.50m (made ground), and 0.80m

GEOINVESTIGATE Ltd.

Your Ref.

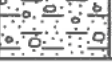
Our Ref. G19086

TP B

Sheet No. 1 of 1

Location: Land to the South of Scott Lane, Cleckheaton, BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thick-ness	Legend	Sample	Test Type Result	Root Information	Depth to Water	Depth (m)
0.50	MADE GROUND (disturbed topsoil). Loose dark brown slightly silty clayey gravelly sand. Gravel is fine to coarse and cobbles of sandstone, brick, coal and occasional ash.	500		O	Cv kN/m ²			0.25
0.70	Firm brown very sandy gravelly CLAY. Gravel is fine to coarse and cobbles of sandstone and coal.	200		O				0.50
	Trial pit Terminated at 0.70m Trial pit Location:  Close up of trial pit: 							0.70

Remarks: Hand excavated to 0.70m
Trial pit remained stable and dry on completion

Key: O Disturbed sample
Cv Shear vane
W Water sample

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref. G19086

TP C

Sheet No. 1 of 1

Location: Land to the South of Scott Lane, Cleckheaton, BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thick-ness	Legend	Sample	Test Type Result	Root Information	Depth to Water	Depth (m)
0.25	TOPSOIL. Loose dark brown slightly silty clayey gravelly sand. Gravel is fine to coarse of sandstone and occasional brick and coal.	250		O	Cv kN/m ²			0.25
0.70	MADE GROUND. Loose brown and pale brown clayey sandy gravel. Gravel is fine to coarse and cobbles of sandstone, brick and occasional coal and ash.	450		O				0.50 0.70
Trial pit Terminated at 0.70m due to refusal on large cobble Trial pit Location:  Close up of trial pit: 								
Soils excavated from trial pit: 								

Remarks: Hand excavated to 0.70m
Trial pit remained stable and dry on completion

Key: O Disturbed sample
Cv Shear vane
W Water sample

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref. G19086

TP D

Sheet No. 1 of 1

Location: Land to the South of Scott Lane, Cleckheaton, BD19 3LX

DATE: 18/03/19

Depth (m)	Description of Strata	Thick-ness	Legend	Sample	Test Type Result	Root Information	Depth to Water	Depth (m)	
0.60	MADE GROUND. Loose dark brown slightly silty gravelly sand / sandy gravel. Gravel is fine to coarse and cobbles of sandstone, brick and occasional coal. Single fragment of glass also noted.	600		O	Cv kN/m ²			0.25 0.50 0.60	
Trial pit Terminated at 0.60m due to refusal on large cobbles. Trial pit excavated from top of soil heap as shown: Trial pit Location:  Trial pit Location (additional): 									Close up of trial pit:  Soils excavated from trial pit: 

Remarks: Hand excavated to 0.60m

Trial pit remained stable and dry on completion

Key: O Disturbed sample

Cv Shear vane

W Water sample

Atterberg Limit Test Results

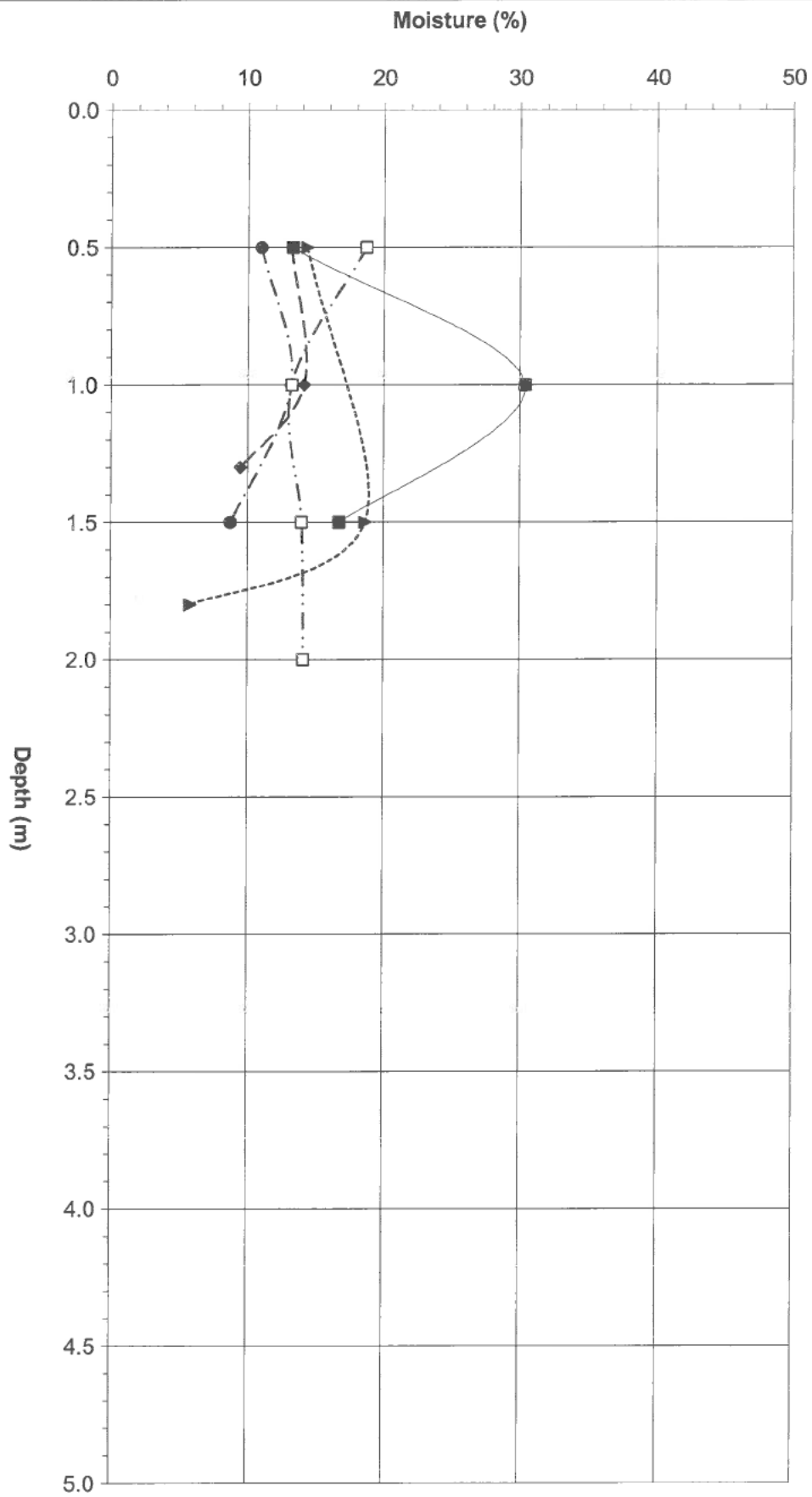
Your ref.

Location: Land to the south of Scott Lane, Cleckheaton BD19 3LX

TP / BH No.	Sample Depth (m)	In situ Moisture Content (%)	% Passing BS 425 Micron Sieve	Corrected Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Soil Classification										
1	0.50	13.3	>95	14.2	25.6	44.3	18.7	CI/MI										
	1.00	30.4																
	1.50	16.7																
2	0.50	13.2							14.2	25.6	44.3	18.7	CI/MI					
	1.00	14.2																
	1.30	9.5																
3	0.50	14.3												14.2	25.6	44.3	18.7	CI/MI
	1.50	18.6																
	1.80	5.8																
4	0.50	11.0	14.2	25.6	44.3	18.7	CI/MI											
	1.00	13.2																
	1.50	8.7																
5	0.50	18.7						82.0	16.1	19.3	32.6	13.3	CL					
	1.00	13.2																
	1.50	14.0																
	2.00	14.1																

Moisture / depth profile

G19086



GEOINVESTIGATE Ltd.

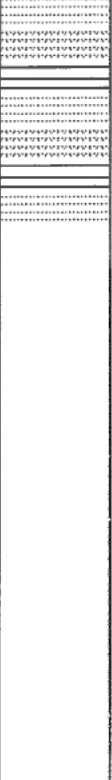
Your Ref.

Our Ref. G19086

RH No.1 Sheet No. 1 of 2

Location: Land Off Scott Lane, Cleckheaton, BD19 3LX

DATE: 03-04-19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
1.80	Dark brown DRIFT.	1800							
9.10	Orange SANDSTONE.	7300							2.50 5.00 7.50
21.4	Light brown SANDSTONE with MUDSTONE inclusions. Sandstone contains some slight fractures.	12300					Flush lost at 12.50m		10.00 12.50 15.00 17.50 20.00
21.5	Possible COAL, intact.	100							
30.0	MUDSTONE with SANDSTONE inclusions.	8500							22.50 25.00

Remarks: Casing to 1.00m

Microdrill rotary open hole borehole to 30.00m

No cores recovered from borehole

No gas detected from borehole on completion

Lost flush at 12.50m. No voids encountered.

Key:

 Slotted Pipe

 Plain Pipe

 Bentonite

 Gravel Filter

O Disturbed sample

Cv Shear vane

W Water sample

S Standard Penetration Test

C Cone Penetration Test

RH1

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref. G19086

RH No.1 Sheet No. 2 of 2

Location: Land Off Scott Lane, Cleckheaton, BD19 3LX

DATE: 03-04-19

Depth (m)	Description of Strata	Thick- ness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
	MUDSTONE with SANDSTONE inclusions.	8500							27.50
30.0									30.00
	Rotary hole terminated at 30.00m								

Remarks: Casing to 1.00m

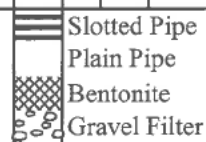
Microdrill rotary open hole borehole to 30.00m

No cores recovered from borehole

No gas detected from borehole on completion

Flush lost at 12.50m. No voids encountered.

Key:



- O** Disturbed sample
- Cv** Shear vane
- W** Water sample
- S** Standard Penetration Test
- C** Cone Penetration Test

RH1

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref. G19086

RH No.2 Sheet No. 1 of 2

Location: Land Off Scott Lane, Cleckheaton, BD19 3LX

DATE: 03-04-19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
1.60	Dark brown DRIFT	1600							
10.4	Orange SANDSTONE containing some small fractures	8800					Lost flush at 5.20m		2.50 5.00 7.50 10.00
17.7	SANDSTONE with MUDSTONE inclusions. Sandstone contains some slight fractures	7300							12.50 15.00 17.50
30.0	MUDSTONE with SANDSTONE inclusions	12300							20.00 22.50 25.00

Remarks: Casing to 1.00m

Microdrill rotary open hole borehole to 30.00m

No cores recovered from borehole

No gas detected from borehole on completion

Lost flush at 5.20m. No voids encountered.

Key:



Slotted Pipe

Plain Pipe

Bentonite

Gravel Filter

O Disturbed sample

Cv Shear vane

W Water sample

S Standard Penetration Test

C Cone Penetration Test

RH2

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref. G19086

RH No.2 Sheet No. 2 of 2

Location: Land Off Scott Lane, Cleckheaton, BD19 3LX

DATE: 03-04-19

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
30.0	MUDSTONE with SANDSTONE inclusions	12300							27.50
	Rotary hole terminated at 30.00m								30.00

Remarks: Casing to 1.00m
Microdrill rotary open hole borehole to 30.00m
No cores recovered from borehole
No gas detected from borehole on completion
Flush lost at 5.20m. No voids encountered.

Key:

 Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

RH2

GEOINVESTIGATE Ltd.

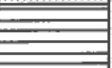
Your Ref.

Our Ref. G19086

RH No.3 Sheet No. 1 of 2

Location: Land Off Scott Lane, Cleckheaton, BD19 3LX

DATE: 03-04-19

Depth (m)	Description of Strata	Thick- ness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
1.20	Dark brown DRIFT	1200							
14.4	Orange SANDSTONE containing some slight fractures	13200							2.50 5.00 7.50 10.00 12.50
24.3	Light brown SANDSTONE with MUDSTONE inclusions	9900							15.00 17.50 20.00 22.50
30.0	Light grey MUDSTONE with SANDSTONE inclusions	5700							25.00

Remarks: Casing to 1.00m

Microdrill rotary open hole borehole to 30.00m

No cores recovered from borehole

No gas detected from borehole on completion

Full flush returned. No voids encountered.

Key:

 Slotted Pipe

 Plain Pipe

 Bentonite

 Gravel Filter

O Disturbed sample

Cv Shear vane

W Water sample

S Standard Penetration Test

C Cone Penetration Test

RH3

GEOINVESTIGATE Ltd.

Your Ref.

Our Ref. G19086

RH No.3 Sheet No. 2 of 2

Location: Land Off Scott Lane, Cleckheaton, BD19 3LX

DATE: 03-04-19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
30.0	Light grey MUDSTONE with SANDSTONE inclusions	5700							27.50 30.00
	Rotary hole terminated at 30.00m								

Remarks: Casing to 1.00m

Microdrill rotary open hole borehole to 30.00m

No cores recovered from borehole

No gas detected from borehole on completion

Full flush returned. No voids encountered.

Key:

 Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test
C Cone Penetration Test

RH3



The Coal
Authority

Permit to Enter or Disturb Coal Authority Mining Interests

Permit Reference Number 17721

Name and Address of Permit Holder:

*Geoinvestigate Ltd
Unit 3A Ellerbeck Way
Stokesley
Middlesbrough
TS9 7AE*

Site Location:

*Land off
Scott Lane
Cleckheaton
BD19 3LX*

This certificate hereby grants the above named Permit Holder a Permit to carry out:-

Investigation of shallow mine workings by three boreholes to 30m bgl

within the Authority's mining interests at the identified site location for the period of 12 months from the granted date shown below. The granting of this Permit does not constitute advice given by the Authority in relation to the proposed operations. It is the Applicant's responsibility to obtain appropriate health, safety, environmental, technical and legal advice.

Signed: Paul Heap Granted Date: 20/03/2019

For and on behalf of The Coal Authority

Nominated Representative: Paul Heap, Permitting Manager;

The Coal Authority, Permitting Office, 200 Lichfield Lane, Mansfield, Notts, NG18 4RG

Tel: 01623 637339; E-Mail: permissions@coal.gov.uk



Permit Ref.	17721	Project / Site Location	Land off, Scott Lane, Cleckheaton, BD19 3LX
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Please complete and return this e-form within **3 months** of the permitted works being completed. It is supplementary to, and should form part of, the full completion/validation reporting.

Where relevant the report should include; borehole logs and details of mine or mine entry treatment works carried out (incl. engineering drawings, grout takes etc.) and a scaled site layout plan (correlated to O.S N' Grid) showing all relevant mine entry positions, coal seams, voids and broken ground proved by the works.

Summary of works

Start date

Finish date

Have variations occurred to the scope / design of the works since the Permit was granted? ☐ No, ☐ Yes.

If yes, please describe;

Did if any of the following incidents occur?

- ☐ Spontaneous combustion, ☐ Water emission, ☐ Gas emission (elevated or above action levels)
☐ Geotechnical instability, ☐ Legal issues incl. damage or potential claims, ☐ None

If yes, please detail each item;

If shallow coal or coal workings were encountered please describe the conditions.

- ☐ Intact coal only, ☐ Broken ground, ☐ Backfilled ground, ☐ Voids

Please provide a general description;

Will further works be necessary that require a Permit? ☐ No ☐ Yes

If yes, please describe, including any recommendations;

Will the closure information be submitted to the LPA for discharge of a Planning Condition? ☐ No ☐ Yes

Relevant Planning Application Reference No.

Please provide the details;

Name:	Email:
Company:	Tel:

APPENDIX 2
Chemtech Analytical Test Reports



ANALYTICAL TEST REPORT

Contract no: 77765
Contract name: Land off Scott Lane, Cleckheaton, BD19 3LX
Client reference: G19086
Clients name: Geo Investigate
Clients address: Units 3a & 4 Terry Dicken Industrial Estate
Ellerbeck Way, Stokesley
North Yorkshire
TS9 7AE
Samples received: 26 March 2019
Analysis started: 26 March 2019
Analysis completed: 02 April 2019
Report issued: 02 April 2019

Notes: Opinions and interpretations expressed herein are outside the UKAS accreditation scope. Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling. 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. BTEX compounds are identified by retention time only and may include interference from co-eluting compounds.

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:

K Campbell

Karan Campbell
Director

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.

All results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.

Analytical results are inclusive of stones.

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
77765-1	BH3	1.00	Sandy Clay with Gravel	-	-	14.9
77765-2	BH4	0.20	Sandy Clay with Gravel	-	-	22.6
77765-3	BH6	0.50	Sandy Clay with Gravel	-	-	19.5
77765-4	BH7	0.10	Sandy Clay with Gravel	-	-	29.3
77765-5	BH8	0.50	Sandy Clay with Gravel	-	-	20.7
77765-6	BH9	1.50	Sandy Clay with Gravel	-	-	7.6
77765-7	TPA	0.50	Sandy Clay with Gravel	-	-	27.9
77765-8	TPB	0.20	Sandy Clay with Gravel	-	-	23.2
77765-9	TPC	0.20	Sandy Clay with Gravel	-	-	20.2
77765-10	TPD	0.30	Sandy Clay with Gravel	-	-	14.9

Chemtech Environmental Limited

SOILS

Lab number			77765-1	77765-2	77765-3	77765-4	77765-5	77765-6
Sample id			BH3	BH4	BH6	BH7	BH8	BH9
Depth (m)			1.00	0.20	0.50	0.10	0.50	1.50
Date sampled			18/03/2019	18/03/2019	18/03/2019	18/03/2019	18/03/2019	18/03/2019
Test	Method	Units						
Arsenic (total)	CE127 ^M	mg/kg As	15	55	24	16	29	-
Boron (water soluble)	CE063 ^M	mg/kg B	0.8	1.1	1.2	1.2	1.4	-
Cadmium (total)	CE127 ^M	mg/kg Cd	<0.2	0.5	<0.2	<0.2	4.5	-
Chromium (total)	CE127 ^M	mg/kg Cr	31	47	33	26	73	-
Chromium (III)	-	mg/kg CrIII	31	47	33	26	73	-
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1	<1	-
Copper (total)	CE127 ^M	mg/kg Cu	34	226	50	31	342	-
Lead (total)	CE127 ^M	mg/kg Pb	80	1084	77	43	442	-
Mercury (total)	CE127 ^M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	<0.5	-
Nickel (total)	CE127 ^M	mg/kg Ni	26	56	24	13	46	-
Selenium (total)	CE127 ^M	mg/kg Se	1.0	1.6	1.8	0.6	1.1	-
Zinc (total)	CE127 ^M	mg/kg Zn	91	161	56	63	390	-
pH	CE004 ^M	units	8.1	8.0	7.9	7.7	7.8	-
Sulphate (2:1 water soluble)	CE061 ^M	mg/l SO ₄	36	70	22	31	113	-
Sulphide	CE079	mg/kg S ²⁻	<10	<10	<10	<10	<10	-
Cyanide (free)	CE077	mg/kg CN	<1	<1	<1	<1	<1	-
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1	<1	-
Thiocyanate	CE145 ^M	mg/kg SCN	<1	<1	<1	1.0	<1	-
Phenols (total)	CE078	mg/kg PhOH	<0.5	<0.5	<0.5	0.8	<0.5	-
Total Organic Carbon (TOC)	CE072 ^M	% w/w C	3.0	21.3	7.7	5.3	7.0	-
Estimate of OMC (calculated from TOC)	CE072 ^M	% w/w	5.2	36.8	13.3	9.1	12.0	-
PAH								
Acenaphthene	CE087 ^M	mg/kg	0.08	24.23	0.02	0.13	0.13	-
Acenaphthylene	CE087 ^M	mg/kg	<0.02	0.18	<0.02	<0.02	<0.02	-
Anthracene	CE087 ^U	mg/kg	0.49	55.69	0.14	0.32	0.59	-
Benzo(a)anthracene	CE087 ^U	mg/kg	0.92	66.59	0.08	0.71	1.33	-
Benzo(a)pyrene	CE087 ^U	mg/kg	0.68	61.80	0.07	0.64	1.32	-
Benzo(b)fluoranthene	CE087 ^M	mg/kg	0.88	77.75	0.05	0.75	1.81	-
Benzo(ghi)perylene	CE087 ^M	mg/kg	0.31	43.74	<0.02	0.33	0.86	-
Benzo(k)fluoranthene	CE087 ^M	mg/kg	0.35	25.28	<0.03	0.41	0.80	-
Chrysene	CE087 ^M	mg/kg	0.80	60.56	0.07	0.71	1.28	-
Dibenz(ah)anthracene	CE087 ^M	mg/kg	0.06	7.32	<0.02	<0.02	0.16	-
Fluoranthene	CE087 ^M	mg/kg	1.78	184.71	0.27	1.66	2.66	-
Fluorene	CE087 ^U	mg/kg	0.05	22.04	<0.02	0.08	0.09	-
Indeno(123cd)pyrene	CE087 ^M	mg/kg	0.35	47.50	<0.02	0.35	0.94	-
Naphthalene	CE087 ^M	mg/kg	0.21	12.43	0.08	0.08	0.15	-
Phenanthrene	CE087 ^M	mg/kg	1.31	207.63	0.40	1.24	1.82	-
Pyrene	CE087 ^M	mg/kg	1.52	161.68	0.19	1.35	2.45	-
PAH (total of USEPA 16)	CE087	mg/kg	9.81	1059	1.37	8.75	16.4	-

Chemtech Environmental Limited

SOILS

Lab number			77765-1	77765-2	77765-3	77765-4	77765-5	77765-6
Sample id			BH3	BH4	BH6	BH7	BH8	BH9
Depth (m)			1.00	0.20	0.50	0.10	0.50	1.50
Date sampled			18/03/2019	18/03/2019	18/03/2019	18/03/2019	18/03/2019	18/03/2019
Test	Method	Units						
BTEX & TPH								
Benzene	CE057 ^U	mg/kg	-	-	<0.01	-	<0.01	<0.01
Toluene	CE057 ^U	mg/kg	-	-	<0.01	-	<0.01	<0.01
Ethylbenzene	CE057 ^U	mg/kg	-	-	<0.01	-	<0.01	<0.01
m & p-Xylene	CE057 ^U	mg/kg	-	-	<0.01	-	<0.01	<0.01
o-Xylene	CE057 ^U	mg/kg	-	-	<0.02	-	<0.02	<0.02
VPH Aromatic (>EC5-EC7)	CE067	mg/kg	-	-	<0.01	-	<0.01	<0.01
VPH Aromatic (>EC7-EC8)	CE067	mg/kg	-	-	<0.01	-	<0.01	<0.01
VPH Aromatic (>EC8-EC10)	CE067	mg/kg	-	-	<0.01	-	<0.01	<0.01
EPH Aromatic (>EC10-EC12)	CE068	mg/kg	-	-	<1	-	<1	1
EPH Aromatic (>EC12-EC16)	CE068	mg/kg	-	-	<1	-	<1	1
EPH Aromatic (>EC16-EC21)	CE068	mg/kg	-	-	1	-	8	75
EPH Aromatic (>EC21-EC35)	CE068	mg/kg	-	-	<1	-	12	71
EPH Aromatic (>EC35-EC44)	CE068	mg/kg	-	-	<1	-	4	15
VPH Aliphatic (>C5-C6)	CE067	mg/kg	-	-	<0.1	-	<0.1	<0.1
VPH Aliphatic (>C6-C8)	CE067	mg/kg	-	-	<0.1	-	<0.1	<0.1
VPH Aliphatic (>C8-C10)	CE067	mg/kg	-	-	<0.1	-	<0.1	<0.1
EPH Aliphatic (>C10-C12)	CE068	mg/kg	-	-	<4	-	<4	6
EPH Aliphatic (>C12-C16)	CE068	mg/kg	-	-	6	-	<4	56
EPH Aliphatic (>C16-C35)	CE068	mg/kg	-	-	13	-	193	1033
EPH Aliphatic (>C35-C44)	CE068	mg/kg	-	-	<10	-	58	265
PCB								
PCB Congener 28	CE137 ^M	mg/kg	-	-	-	-	-	<0.004
PCB Congener 52	CE137 ^M	mg/kg	-	-	-	-	-	<0.004
PCB Congener 101	CE137 ^M	mg/kg	-	-	-	-	-	<0.008
PCB Congener 118	CE137 ^M	mg/kg	-	-	-	-	-	<0.006
PCB Congener 138	CE137 ^M	mg/kg	-	-	-	-	-	<0.006
PCB Congener 153	CE137 ^M	mg/kg	-	-	-	-	-	<0.009
PCB Congener 180	CE137 ^M	mg/kg	-	-	-	-	-	<0.008
PCB (total of ICES 7)	CE137 ^M	mg/kg	-	-	-	-	-	<0.045
Subcontracted analysis								
Asbestos (qualitative)	\$	-	-	-	NAD	NAD	NAD	-

Chemtech Environmental Limited

SOILS

Lab number Sample id Depth (m) Date sampled			77765-7 TPA 0.50 18/03/2019	77765-8 TPB 0.20 18/03/2019	77765-9 TPC 0.20 18/03/2019	77765-10 TPD 0.30 18/03/2019
Test	Method	Units				
Arsenic (total)	CE127 ^M	mg/kg As	34	30	12	20
Boron (water soluble)	CE063 ^M	mg/kg B	0.9	1.2	0.8	1.0
Cadmium (total)	CE127 ^M	mg/kg Cd	0.3	0.6	0.9	1.4
Chromium (total)	CE127 ^M	mg/kg Cr	41	42	40	64
Chromium (III)	-	mg/kg CrIII	41	42	40	64
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1
Copper (total)	CE127 ^M	mg/kg Cu	233	83	34	169
Lead (total)	CE127 ^M	mg/kg Pb	114	146	217	203
Mercury (total)	CE127 ^M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5
Nickel (total)	CE127 ^M	mg/kg Ni	38	27	25	38
Selenium (total)	CE127 ^M	mg/kg Se	1.5	1.2	0.9	1.1
Zinc (total)	CE127 ^M	mg/kg Zn	126	142	139	536
pH	CE004 ^M	units	7.6	7.9	7.8	7.7
Sulphate (2:1 water soluble)	CE061 ^M	mg/l SO ₄	32	187	81	51
Sulphide	CE079	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)	CE072 ^M	% w/w C	3.7	9.1	3.7	4.4
Estimate of OMC (calculated from TOC)	CE072 ^M	% w/w	6.3	15.7	6.3	7.6
PAH						
Acenaphthene	CE087 ^M	mg/kg	<0.02	0.32	0.08	0.67
Acenaphthylene	CE087 ^M	mg/kg	<0.02	0.26	0.05	0.10
Anthracene	CE087 ^U	mg/kg	0.09	1.11	0.32	2.79
Benzo(a)anthracene	CE087 ^U	mg/kg	0.15	2.37	0.57	5.33
Benzo(a)pyrene	CE087 ^U	mg/kg	0.19	1.79	0.48	4.33
Benzo(b)fluoranthene	CE087 ^M	mg/kg	0.21	2.27	0.52	5.96
Benzo(ghi)perylene	CE087 ^M	mg/kg	0.08	0.99	0.21	2.83
Benzo(k)fluoranthene	CE087 ^M	mg/kg	0.07	0.95	0.29	2.16
Chrysene	CE087 ^M	mg/kg	0.15	2.10	0.54	3.89
Dibenz(ah)anthracene	CE087 ^M	mg/kg	<0.02	0.21	<0.02	0.56
Fluoranthene	CE087 ^M	mg/kg	0.35	4.66	1.19	12.14
Fluorene	CE087 ^U	mg/kg	<0.02	0.39	0.08	0.45
Indeno(123cd)pyrene	CE087 ^M	mg/kg	0.07	1.10	0.22	3.15
Naphthalene	CE087 ^M	mg/kg	0.16	0.60	0.09	0.35
Phenanthrene	CE087 ^M	mg/kg	0.31	3.57	1.01	7.24
Pyrene	CE087 ^M	mg/kg	0.28	4.04	1.01	10.06
PAH (total of USEPA 16)	CE087	mg/kg	2.10	26.7	6.68	62.0

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SOILS

Lab number			77765-7	77765-8	77765-9	77765-10
Sample id			TPA	TPB	TPC	TPD
Depth (m)			0.50	0.20	0.20	0.30
Date sampled			18/03/2019	18/03/2019	18/03/2019	18/03/2019
Test	Method	Units				
BTEX & TPH						
Benzene	CE057 ^U	mg/kg	-	<0.01	-	-
Toluene	CE057 ^U	mg/kg	-	<0.01	-	-
Ethylbenzene	CE057 ^U	mg/kg	-	<0.01	-	-
m & p-Xylene	CE057 ^U	mg/kg	-	<0.01	-	-
o-Xylene	CE057 ^U	mg/kg	-	<0.02	-	-
VPH Aromatic (>EC5-EC7)	CE067	mg/kg	-	<0.01	-	-
VPH Aromatic (>EC7-EC8)	CE067	mg/kg	-	<0.01	-	-
VPH Aromatic (>EC8-EC10)	CE067	mg/kg	-	<0.01	-	-
EPH Aromatic (>EC10-EC12)	CE068	mg/kg	-	<1	-	-
EPH Aromatic (>EC12-EC16)	CE068	mg/kg	-	2	-	-
EPH Aromatic (>EC16-EC21)	CE068	mg/kg	-	14	-	-
EPH Aromatic (>EC21-EC35)	CE068	mg/kg	-	11	-	-
EPH Aromatic (>EC35-EC44)	CE068	mg/kg	-	2	-	-
VPH Aliphatic (>C5-C6)	CE067	mg/kg	-	<0.1	-	-
VPH Aliphatic (>C6-C8)	CE067	mg/kg	-	<0.1	-	-
VPH Aliphatic (>C8-C10)	CE067	mg/kg	-	<0.1	-	-
EPH Aliphatic (>C10-C12)	CE068	mg/kg	-	<4	-	-
EPH Aliphatic (>C12-C16)	CE068	mg/kg	-	48	-	-
EPH Aliphatic (>C16-C35)	CE068	mg/kg	-	209	-	-
EPH Aliphatic (>C35-C44)	CE068	mg/kg	-	38	-	-
PCB						
PCB Congener 28	CE137 ^M	mg/kg	-	-	-	-
PCB Congener 52	CE137 ^M	mg/kg	-	-	-	-
PCB Congener 101	CE137 ^M	mg/kg	-	-	-	-
PCB Congener 118	CE137 ^M	mg/kg	-	-	-	-
PCB Congener 138	CE137 ^M	mg/kg	-	-	-	-
PCB Congener 153	CE137 ^M	mg/kg	-	-	-	-
PCB Congener 180	CE137 ^M	mg/kg	-	-	-	-
PCB (total of ICES 7)	CE137 ^M	mg/kg	-	-	-	-
Subcontracted analysis						
Asbestos (qualitative)	\$	-	-	NAD	NAD	-

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PREPARED LEACHATES

Lab number Sample id Depth (m)			77765-2L BH4 0.20	77765-8L TPB 0.20
Test	Method	Units		
Arsenic (dissolved)	CE128 ^U	µg/l As	8.83	8.99
Boron (dissolved)	CE128 ^U	µg/l B	16	9
Cadmium (dissolved)	CE128 ^U	µg/l Cd	<0.07	<0.07
Chromium (dissolved)	CE128 ^U	µg/l Cr	9.2	0.3
Copper (dissolved)	CE128 ^U	µg/l Cu	7.0	6.2
Lead (dissolved)	CE128 ^U	µg/l Pb	16.2	2.8
Mercury (dissolved)	CE128 ^U	µg/l Hg	0.010	0.019
Nickel (dissolved)	CE128 ^U	µg/l Ni	3.4	1.1
Selenium (dissolved)	CE128 ^U	µg/l Se	0.49	0.38
Zinc (dissolved)	CE128 ^U	µg/l Zn	5	3
pH	CE004 ^U	units	7.2	7.5
Sulphate	CE049 ^U	mg/l SO ₄	<10	<10
Sulphur (dissolved)	CE128 ^U	mg/l S	1.8	1.1
Sulphide	CE079	µg/l S ²⁻	<100	<100
Cyanide (free)	CE147	µg/l CN	<20	<20
Cyanide (total)	CE147	µg/l CN	<20	<20
Thiocyanate	CE014	µg/l SCN	<200	<200
Phenols (total)	CE148	µg/l PhOH	<10	<10
PAH				
Acenaphthene	CE051	µg/l	0.4	3.2
Acenaphthylene	CE051	µg/l	<0.1	<0.1
Anthracene	CE051	µg/l	0.4	0.3
Benzo(a)anthracene	CE051	µg/l	<0.1	<0.1
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	0.2
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	0.9	0.5
Fluorene	CE051	µg/l	0.7	3.1
Indeno(123cd)pyrene	CE051	µg/l	<0.1	<0.1
Naphthalene	CE051	µg/l	0.3	5.2
Phenanthrene	CE051	µg/l	2.4	3.2
Pyrene	CE051	µg/l	0.5	0.3
PAH (total of USEPA 16)	CE051	µg/l	5.6	16.0

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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	M	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
-	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	M	10	mg/l SO ₄
CE079	Sulphide	Extraction, Continuous Flow Colorimetry	As received		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
CE072	Total Organic Carbon (TOC)	Removal of IC by acidification, Carbon Analyser	Dry	M	0.1	% w/w C
CE072	Estimate of OMC (calculated from TOC)	Calculation from Total Organic Carbon	Dry	M	0.1	% w/w
CE087	Acenaphthene	Solvent extraction, GC-MS	As received	M	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	U	0.02	mg/kg
CE087	Benzo(a)anthracene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Benzo(a)pyrene	Solvent extraction, GC-MS	As received	U	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	M	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	M	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
CE057	Benzene	Headspace GC-FID	As received	U	0.01	mg/kg
CE057	Toluene	Headspace GC-FID	As received	U	0.01	mg/kg
CE057	Ethylbenzene	Headspace GC-FID	As received	U	0.01	mg/kg
CE057	m & p-Xylene	Headspace GC-FID	As received	U	0.02	mg/kg
CE057	o-Xylene	Headspace GC-FID	As received	U	0.01	mg/kg

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
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
CE068	EPH Aromatic (>EC10-EC12)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC12-EC16)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC16-EC21)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC21-EC35)	Solvent extraction, GC-FID	As received		1	mg/kg
CE068	EPH Aromatic (>EC35-EC44)	Solvent extraction, GC-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
CE068	EPH Aliphatic (>C10-C12)	Solvent extraction, GC-FID	As received		4	mg/kg
CE068	EPH Aliphatic (>C12-C16)	Solvent extraction, GC-FID	As received		4	mg/kg
CE068	EPH Aliphatic (>C16-C35)	Solvent extraction, GC-FID	As received		4	mg/kg
CE068	EPH Aliphatic (>C35-C44)	Solvent extraction, GC-FID	As received		10	mg/kg
CE137	PCB Congener 28	Solvent extraction, GC-MS	As received	M	0.004	mg/kg
CE137	PCB Congener 52	Solvent extraction, GC-MS	As received	M	0.004	mg/kg
CE137	PCB Congener 101	Solvent extraction, GC-MS	As received	M	0.008	mg/kg
CE137	PCB Congener 118	Solvent extraction, GC-MS	As received	M	0.006	mg/kg
CE137	PCB Congener 138	Solvent extraction, GC-MS	As received	M	0.006	mg/kg
CE137	PCB Congener 153	Solvent extraction, GC-MS	As received	M	0.009	mg/kg
CE137	PCB Congener 180	Solvent extraction, GC-MS	As received	M	0.008	mg/kg
CE137	PCB (total of ICES 7)	Solvent extraction, GC-MS	As received	M	0.045	mg/kg
\$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

Chemtech Environmental Limited

METHOD DETAILS

METHOD	PREPARED LEACHATES	METHOD SUMMARY	STATUS	LOD	UNITS
CE001	Leachate preparation (EA)	L:S 10:1		-	-
CE128	Arsenic (dissolved)	ICP-MS	U	0.06	µg/l As
CE128	Boron (dissolved)	ICP-MS	U	6	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
CE004	pH	Based on BS 1377, pH Meter	U	-	units
CE049	Sulphate	Ion Chromatography	U	10	mg/l SO ₄
CE128	Sulphur (dissolved)	ICP-MS	U	0.2	mg/l S
CE079	Sulphide	Continuous Flow Colorimetry		100	µg/l S ²⁻
CE147	Cyanide (free)	Continuous Flow Colorimetry		20	µg/l CN
CE147	Cyanide (total)	Continuous Flow Colorimetry		20	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)
77765-1	BH3	1.00	N	
77765-2	BH4	0.20	N	
77765-3	BH6	0.50	N	
77765-4	BH7	0.10	N	
77765-5	BH8	0.50	N	
77765-6	BH9	1.50	N	
77765-7	TPA	0.50	N	
77765-8	TPB	0.20	N	
77765-9	TPC	0.20	N	
77765-10	TPD	0.30	N	