GEO Environmental Engineering

PHASE 2: GROUND INVESTIGATION REPORT

PROPOSED RESIDENTIAL DEVELOPMENT OF

LAND AT SCURGILL, EGREMONT

CUMBRIA

FOR:

MR LEE WALKER

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DOCUMENT CONTROL SHEET

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Consultant:	~

CONTENTS

1.0 Introduction

1.1 Brief

GEO Environmental Engineering Ltd (GEO) were commissioned by Mr Lee Walker, herein referred to as the "Client", to carry out a ground investigation on land adjacent to Scurgill Terrace in Egremont, Cumbria as indicated on the Site Location Plan included in Appendix I.

The investigation was carried out to determine the ground conditions across the site to assess the risk to human health and environmental receptors from possible contamination and ground gas.

1.2 Site Location and Description

The site, occupying an area of 0.1ha comprises an area of gravel hardstand which leads to a steep bank covered with scrub vegetation. The bank rises c.2m to 3m and leads to an area of scrubland. It is understood that the area of hardstand has previously been used for domestic garages (lock-ups) and appears to have been levelled.

- National Grid Reference: 301682, 510027
- Post Code: CA22 2NS (approximate only)

The site is surrounded by a mixture of housing, scrubland and agricultural fields.

A topographical survey has not been provided, however, Ordnance Survey data indicates that the site is at an elevation of between 60 and 70m OD. It would be prudent to acquire a topographical survey of the site prior to development.

1.3 Proposed Development

It is the understood that the Client plans to re-develop the site for residential end use. A proposed site layout of the site has not been provided, however, it is understood following discussions with the land owner, that the site will be developed with a single two-storey house with private garden, driveway/parking and other associated infrastructure.

1.4 Other Reports/Studies

GEO have previously completed a Desk Top Study (DTS) for the site, details of which are included below:

- Phase 1: Desk Top Study Report (Preliminary Geo-Environmental Risk Assessment), Proposed Redevelopment of Land at Scurgill, Egremont, ref: 201-3547, dated: 13.02.2019.

It is recommended that the DTS is read in conjunction with this report.

2.0 Ground Investigation Report

2.1 Ground Investigation Aims and Objectives

The overall objective of this Ground Investigation is to provide information relating to the chemical properties of the ground and groundwater across the development area in order to determine any risks to human health or environmental receptors.

2.2 Guidelines, Codes of Practice and Third Part Accreditations

This report contains information relating to the geotechnical properties of the soils encountered on site to aid foundation and highway design by a Structural Engineer. The report also incorporates a Level 1 Ground Contamination and Ground Gas Risk Assessment for Human Health (Generic Quantitative Risk Assessment – GQRA) and Controlled Waters.

The laboratory testing (geotechnical and ground contamination) was completed by UKAS and MCERTS accredited laboratories with details given in Sections 6 and copies of the test reports contained in Appendix III.

This Ground Investigation Report has been completed in general accordance with the following documents:

- CLR11: Model Procedures for the Management of Land Contamination. DEFRA/EA, 2004.
- BS10175: 2011: Code of Practice for the Investigation of Potentially Contaminated Sites.
- BS5930: 2015: Code of Practice for Site Investigations.
- BS1377: 1990: Methods of test for soils for civil engineering purposes.
- BS8485: 2015: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.
- BS8576: 2013: Guidance on Ground Gas Investigations.
- CIRIA Report C665: 2015.
- Eurocode 7: Geotechnical Design (Part 1: General Rules, Part 2: Ground Investigation & Testing).
- UK Specification for Ground Investigation, 2nd Edition. Site Investigation Steering Group, 2011.
- Effective Site Investigation. Site Investigation Steering Group, 2013.
- SP1010 Development of Category 4 Screening Levels Main Report, 2014.
- The LQM/CIEH S4UL's for Human Health Risk Assessment, 2015.

2.3 Ground Investigation Limitations of Use

Although every effort is made to ensure a full and comprehensive investigation has been completed, it should always be borne in mind that ground conditions have the potential to vary between exploratory hole locations and it is recommended that the developer adopts a "watching brief" during the redevelopment works, to ensure that any potential variations encountered are identified and dealt with in an appropriate manner.

In addition, this Ground Investigation Report and its contents are limited to the boundaries of the site, as indicated on the Plans in Appendix I. No reliance, copying or use of this report (in part or whole) by any Third Party is permitted without prior written approval from Geo Environmental Engineering Ltd, with intellectual copyright remaining the sole property of the author. Reliance on the report and its associated information is strictly in accordance with Geo Environmental Engineering Ltd Terms and Conditions, copies of which are available on request.

2.4 Consideration for Residential End Use

It is proposed that the site will be re-developed for residential end use with private dwellings, gardens, car parking, access roads, and other associated infrastructure. Consequently, when considering the intended development, the site is considered suitable for can assessment using a Level 1 Generic Quantitative Risk Assessment (GQRA).

A GQRA provides details of potential future risks to Human Health (proposed end users) from any contamination which may be identified on site in made ground or natural soils. For the Human Health Risk Assessment, it is considered that the future residents will be subjected to the greatest exposure periods and consequently the most risk. Therefore, in accordance with current guidance and legislation, a CLEA end use classification of *residential* is considered the most appropriate.

3.0 Basis for Ground Investigation

3.1 Intrusive Investigation Fieldworks

The ground investigation fieldworks were completed during June 2021. The exploratory holes were located within close proximity to the proposed development. The Exploratory Hole Location Plan is provided in Appendix II.

The ground investigation works comprised the following:

- 2 No. Percussive Boreholes (BH01 and BH02) to depths of between c.2.60m and c.4.00m bgl.
- 3 No. trial pits (TP01 to TP03) excavated to depths of between c.0.50m and c.1.60m bgl using a mechanical excavator and hand digging tools.
- In-situ geotechnical testing - Standard Penetration Tests (SPT).
- Site supervision by a suitably qualified and experienced Geo-Environmental Engineer.
- Gas and groundwater monitoring (6 visits completed).
- Laboratory based chemical screening.

The investigation fieldworks were undertaken in general accordance with BS5930:1999, BS1377:1990 and Eurocode 7 (Part I and II).

At each exploratory hole location, the surfacing type, made ground, natural ground and groundwater conditions were observed, with in-situ testing undertaken and samples recovered. Details of the ground conditions are included on the exploratory hole logs which are included in Appendix II together with other relevant ground investigation data (Gas and Groundwater Monitoring results).

The results of the in-situ SPT tests are provided with the borehole logs included in Appendix II.

The results of the chemical laboratory screening are provided in Appendix III.

4.0 Ground and Groundwater Conditions

4.1 General

The following section provides a summary of the ground conditions encountered across the site during the investigation. Reference should be made to the exploratory hole logs included in Appendix II for detailed descriptions of the strata and groundwater conditions encountered.

4.1.1 Made Ground

Made ground was encountered across the site to depths of between 0.47m and 1.50m bgl. The made ground appears to have been used to level the site and generally becomes deeper to the west. As such, it is likely that the made ground will exceed 1.50m depth in the far western part of the site. None of the made ground encountered appeared suitable for re-use within a residential garden.

The made ground comprised grey silty loamy gravel of aggregate, clinker, brick and concrete with occasional ash and shale. Metal reinforcement bars (rebar) were also noted. Trial pit TP01 also included occasional slag and many boulders of sandstone, concrete and brick.

The made ground was noted as very unstable, collapsing during excavation.

Samples of the made ground were recovered for laboratory chemical screening. During the investigation, GEO did not identify any visual or olfactory evidence of fuel/oil type contamination (no staining, odour or free product).

4.1.2 Natural Drift Deposits

Natural drift deposits were encountered in the boreholes and trial pit TP01 at depths of between c.0.47m and c.1.50m bgl. The drift deposits typically comprised firm and stiff (occasionally soft) red brown slightly sandy very gravelly clay. SPT tests within the clay gave ‘N’ values of between 6 and 22 indicating low and medium strength deposits.

The clay was underlain at depths of between c.1.30m and c.1.80m bgl by granular deposits comprising silty gravelly sand in borehole BH01 and sandy gravel of mixed lithology in borehole BH02. SPT tests within the granular deposits gave ‘N’ values of between 6 and 9 (loose), increasing to more than 50 blows (refusal) at c.2.60m bgl in borehole BH01 possibly due to a cobble or boulder.

4.1.3 Solid Geological Deposits (Bedrock)

Bedrock was not encountered during the ground investigation.

4.2 Groundwater

During the progression of the boreholes, groundwater strikes were recorded at depths of between 1.50m and 4.00m bgl. Upon completion of the boreholes, standing water was recorded at depths of between c.0.70m and c.1.40m bgl.

Groundwater monitoring of installations placed in boreholes BH01 and BH02 has been carried out on five occasions between July and September 2021. Groundwater levels in the boreholes varied between c.0.60m and c.1.70m bgl.

It is recommended that an allowance is made for dewatering excavations, especially during periods of heavy rainfall as the materials encountered may be unstable during excavation, especially the made ground.

5.0 Exploratory Hole Testing

In-situ site testing and monitoring was generally undertaken in accordance with BS5930:1999, BS1377:1990 and Eurocode 7 (Part I and II).

5.1 Standard Penetration Tests

5.1.1 Standard Penetration Test Methodology

To determine the relative density and strength of the underlying soils (natural drift deposits), Standard Penetration Tests (SPT's) were completed within the boreholes. The test uses a "split spoon" sample tube (external diameter of c.50mm, internal diameter of c.35mm and a length of around c.650mm) driven from the base of the borehole as it is progressed, usually at c.1.00m spacing's/intervals.

The sample tube is driven by blows of a slide hammer with a weight of c.63.5kg falling over a c.760mm drop. The sample tube is driven c.150mm into the ground (seating blows) and then the number of blows needed for the tube to penetrate each c.75mm increment up to a depth of c.450mm is recorded.

The number of blows for the final c.300mm of penetration is referred to as the "standard penetration resistance" or "N" value, which are presented on the exploratory hole logs adjacent to each sample depth. Where 50 blows are insufficient to advance the test through a c.75mm interval the amount of penetration after 50 blows is recorded and the test is referred to as a "refusal".

5.1.2 Standard Penetration Test Results

SPT tests within the clay gave 'N' values of between 6 and 22 indicating low and medium strength deposits. Tests within the granular deposits gave 'N' values of between 6 and 9 (loose), increasing to more than 50 blows (refusal – very dense) at c.2.60m bgl in borehole BH01, possibly due to a cobble or boulder.

5.2 Ground Gas Monitoring

To assess the on-site potential for hazardous ground gases, boreholes BH01 and BH02 were installed with ground gas monitoring wells to facilitate a period of ground gas monitoring.

The boreholes were installed to a depth of c.2.30m bgl with a 50mm diameter HDPE standpipe with a bentonite seal for the upper section and a gravel surround for the majority of the pipe, finished with a plastic end cap and rubber gas bung. The installation details presented on each borehole log in Appendix II.

The monitoring and assessment has been completed in accordance with BS8485: 2007: Code of practice for the characterisation and remediation from ground gas affected developments, CIRIA Report C665, November 2007 and the NHBC Document; Guidance on the evaluation of development proposals on site where methane and carbon dioxide are present, March 2007.

Due to the residential nature of the development, the monitoring of ground gas monitoring must comprise at least six site visits over a minimum period of three months. The monitoring has been completed on six occasions between 7th July and the 23rd September 2021.

The monitoring has been completed in general accordance with CIRIA C665 (Table 5.5a and 5.5b) using a GA2000 Ground Gas Analyser with external flow pod. The results of monitoring are included on the Ground Gas Monitoring Record Sheets within Appendix II. The ground gas risk assessment is presented in Section 8 of this report.

6.0 Laboratory Testing

6.1 Chemical Screening

6.1.1 Determination of pH and Water-Soluble Sulphate

To determine the appropriate concrete classification for buried structures (foundations), 5 No. samples of the made ground from depths of between c.0.10m and c.0.50m were scheduled to chemical laboratory screening to determine the pH levels and water-soluble sulphate (SO_4) concentrations. The testing was completed in general accordance with BS1377:1990: Part 1 to 4 at the following UKAS and MCERTS accredited laboratories:

- Chemtech Environmental Testing of Stanley (DETS), County Durham.

6.1.2 Contamination Testing for Human Health

To enable the completion of a Level 1 Generic Quantitative Risk Assessment (GQRA) for Human Health, 5 No. samples of the made ground from across the site at depths of between c.0.10m and c.0.50m bgl were subjected to chemical screening at the following UKAS and MCERTS accredited laboratory:

- Chemtech Environmental Testing of Stanley, County Durham.

The samples were screened for Potential Contaminants of Concern (PCOC's) based on the description of the materials and the past land use. Consequently, the samples were scheduled to the following range of determinands:

- **Inorganic Soil Suite (Human Health Risk Assessment):** Metals (*Arsenic, Cadmium, Chromium (III and VI), Copper, Lead, Mercury, Nickel, Selenium, Zinc*), Cyanide (total), Asbestos and Total Organic Carbon.
- **Organic Soil Suite (Human Health Risk Assessment):** Speciated Polycyclic Aromatic Hydrocarbons (PAH – USEPA 16), Petroleum Hydrocarbons (TPH), BTEX and MTBE.
- **Other:** Asbestos

The full catalogue of soil screening results and test detection limits can be seen in the Chemtech report (ref: 97679) contained in Appendix III.

7.0 Generic Quantitative Risk Assessment (GQRA)

7.1 Methodology for Assessing Risks to Human Health

Within the UK, the current framework for assessing potential ground contamination is utilising the Contaminated Land Exposure Assessment (CLEA) model as set out by the Department of the Environment, Farming and Rural Affairs (DEFRA) which comprises an established pollutant linkage model of *Source – Pathway – Receptor*. For a risk to be present to the proposed end user (*Receptor*) there must be an identified *Source* and a plausible *Pathway*. Where one or more of the links are missing then risk is negated. For the land to be classified as contaminated under Part IIa of the Environmental Protection Act (EPA) 1990 all three elements of the pollutant linkage must be present.

An assessment can be made for the contamination levels in the ground for human health risk assessment purposes using published assessment criteria, such as CLEA Soil Guideline Values (SGV's), Category 4 Screening Levels (C4SLs), Land Quality Management (LQM), Chartered Institute of Environmental Health (CIEH) S4UL Values and Atkins ATRISK^{SOIL} Soil Screening Values (SSV's), which consider the below listed proposed end uses and act as intervention values.

- *Residential (with or without plant uptake)*
- *Allotments*
- *Commercial*

Where the previously mentioned land uses are not deemed appropriate, other land use values can be considered with the DEFRA C4SLs, LQM S4UL's values and the ATRISK^{SOIL} SSV's (i.e. parks/playing fields/Public Open Space). Alternatively, it is possible to determine site specific intervention values as part of a Detailed Quantitative Risk Assessment (DQRA).

For the purposes of this basic Human Health ground contamination risk assessment, the maximum site recorded values have been compared to the most relevant and appropriate Generic Assessment Criteria (GAC) to determine if a potential risk is present to the proposed end users.

The proposed development will incorporate private gardens, therefore, the assessment criteria *Residential with plant uptake end use* has been used to determine the risk to Human Health.

The results of the chemical screening and analysis of the results is presented on the 'Chemical Assessment Sheet' which is presented in Appendix IV.

7.2 Human Health Risk Assessment – Comparison with Guidance Levels MxVT

7.2.1 Inorganic Contaminants – Soil

The maximum concentration (C_M) value for each inorganic analyte at each sample location has been compared to the most relevant and appropriate published generic assessment criteria as part of the Maximum Value Test. The assessment criteria are based on the following guidance documents:

- LQM CIEH S4UL 2014 (residential with plant uptake end use).
- CL:AIRE Category 4 Screening Levels - C4SL (residential with plant uptake end use)
- ATRISK^{SOIL} SSV (residential with plant uptake end use).

As discussed in Section 7, the contaminant concentrations have been assessed against generic assessment criteria for residential end use with plant uptake as it is anticipated that the proposed development will incorporate private gardens. The results of the inorganic concentrations and the assessment are included on the 'Chemical Assessment Sheet' including in Appendix IV.

The results of the chemical assessment indicate elevated concentrations of arsenic within three of the five samples of made ground that were screened. Consequently, the made ground materials could pose a risk to the proposed end users if exposed within garden areas and remediation is considered necessary to mitigate these risks. This is discussed further in Section 9.

7.2.2 Organic Contaminants – Soil

The maximum concentration values for the screened organic analytes (i.e. Speciated PAH, TPH, MTBE and BTEX) have been compared to the most appropriate published Generic Assessment Criteria (GAC). The assessment criteria are based on the following guidance document:

- CL:AIRE GAC (2010) (Residential end use with plant uptake).

The assessment has been based on a SOM of 2.5% in view of the average Total Organic Carbon (TOC) content.

From a review of the Contaminant Analysis Sheet contained in Appendix IV, it can be seen that elevated concentrations of PAH compounds are present within the made ground in borehole BH02. The PAH compounds include: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene and dibenz(ah)anthracene.

The elevated PAH compounds are likely to be associated with the presence of anthropogenic materials, especially clinker and ash within the made ground material.

Consequently, based on the results of the chemical assessment, the made ground materials could pose a risk to the proposed end users if exposed within garden areas and remediation is considered necessary to mitigate these risks. This is discussed further in Section 9.

7.2.3 Asbestos Containing Materials (ACM's) – Soil

5 No. samples of made ground have been subjected to laboratory microscopic analysis to determine the presence or not of Asbestos Containing Materials (ACM's – microscopic fibres) in accordance with the methodology within HSG 248.

All the samples tested returned a negative result for ACM's and were recorded as NAD (No Asbestos Detected). Consequently, the site is not considered to pose a risk to Human Health from ACMs.

7.2.4 Human Health Risk Assessment – Summary

Based on the Human Health risk assessment above, the following contaminants have been identified as posing a potential risk to human health for a *Residential End Use with Plant Uptake*:

- **Inorganic Contamination:** Elevated arsenic within the made ground.
- **Organic Contamination:** Elevated PAH compounds in the made ground.
- **Asbestos:** None

Based on the Human Health risk assessment above, elevated concentrations of arsenic and PAH compounds have been identified in the made ground. The elevated determinands are likely to be associated with the presence of anthropogenic materials including ash and clinker.

Based on the results of the testing, there is a potential risk to human health from the made ground on the site, however, the risk is only present where there is a plausible pathway (direct contact, inhalation of dust, ingestion) such as proposed gardens.

7.3 Ground Gas Risk Assessment

To assess the on-site potential for hazardous ground gases, two of the boreholes (BH01 and BH02) were installed with ground gas monitoring wells to facilitate a period of in-situ ground gas monitoring.

The wells have been monitored on three occasions, between July and August 2021. During the monitoring, atmospheric air pressures varied between 999mb and 1007mb during both rising and falling atmospheric pressure trends.

A maximum Carbon Dioxide (CO_2) concentration of 7.5%v/v has been recorded and zero Methane (CH_4) have been detected. The minimum Oxygen (O_2) concentration noted was 13.2%. The flow rate was <0.1l/h throughout.

In accordance with CIRIA C665 the maximum recorded CO_2 concentration has been converted to a Gas Screening Value (GSV), summarised as follows.

In this instance, the CO_2 GSV is:

- **CO_2 GSV = (Max CO_2 (%) / 100) x Max Flow (l/hr),**
- **Therefore: (7.5 / 100) x 0.1 = 0.0075 l/hr GSV**

Since no Methane have been detected, no GSV has or can be formulated.

The results of the gas monitoring indicate marginally elevated concentrations of carbon dioxide. However, given the negligible flow rates, there is no mechanism by which the gas will be forced into the proposed development and as such, the risk is considered negligible. Therefore, at this stage, taking into consideration the maximum gas concentrations and the GSV, the site falls within Characteristic Situation 1 (CS1) or the Green Classification when utilising the NHBC Characterisation System. This indicates that gas protection measures are **not** necessary.

In accordance with information presented within the P1 DTS, the site is not located within a Radon Affected Area, as less than 1% of properties are above the Action Level as defined by the Health Protection Agency (HPA) and radon protection measures are not considered necessary (BR211).

7.4 Determination of pH and Water-Soluble Sulphate

As indicated in Section 6, selected samples of the made ground have been screened to determine their pH and soluble sulphate potential to aid the specification of buried concrete. The results of the chemical screening are presented in the Chemtech report (ref: 97679) contained in Appendix III.

From the results, the following observations can be seen:

- pH values in the soils ranged from 7.8 to 8.2 (Neutral to slightly alkali).
- Water Soluble Sulphate (SO_4) levels were recorded as ranging from 40mg/l to 286mg/l.

In accordance with BRE Special Digest 1: 2005 the results recorded equate to a classification of DS-1 (Design Sulphate for brownfield locations). With respect to the pH levels, the results equate to a slightly alkali chemical environment which is unlikely to be aggressive with respect to buried concrete. Therefore, an (ACEC) classification of AC-1 should therefore be adopted (for mobile groundwater on a brownfield location).

8.0 Construction Related Excavations and Off-Site Disposal

During the construction works it is likely that materials will be excavated on site (i.e. future foundations and buried utilities, etc.) that will not be able to be accommodated on site during to space and level constraints, ultimately requiring removal off site.

During the construction works different materials should be kept separate, as it may be the case that uncontaminated natural materials can be classified as Inert and transferred to an Inert Landfill site. A separate assessment will be required for any topsoil (naturally occurring organic materials) that may be encountered as they cannot be classified as inert due to their natural organic content.

Where made ground materials or disturbed natural strata is to be removed, the results of the soil testing undertaken within this report can be used as a preliminary assessment and the anticipated waste disposal facility should be provided with a copy of the results for review. It may be the case that the waste facility requires additional contamination screening to aid the characterisation of the made ground for off-site disposal (i.e. Waste Acceptance Criteria – WAC) and it is recommended that this be confirmed by the design team prior to commencing on site.

During the construction phase, it may be the case that WAC screening is required to aid classification for disposal and it is recommended that all materials are classified prior to excavation and disposal off site.

Conversely, if materials are required to be brought to site to raise site levels then certification and/or soil testing results should be reviewed by a suitably experienced and qualified Geo-Environmental engineer to ensure that potentially contaminated materials are not being brought to site.

Any material movements may require a Material Management Plan (MMP) in accordance with CL:AIRE.

9.0 Discussion and Recommendations

9.1 Ground and Groundwater Conditions Summary

The ground investigation has encountered variable granular made ground including much aggregate, clinker, brick, concrete and occasional ash, slag, shale and rebar. Boulders of sandstone, concrete and brick we also noted. The made ground was not considered suitable for re-use within the proposed gardens.

The made ground was underlain by natural drift deposits comprising clays, sands and gravels. Groundwater was noted at depths of between c.1.50m and c.4.00m bgl, rising up to c.0.70m bgl following completion.

During the investigation, GEO did not identify any visual or olfactory evidence of fuel/oil type contamination (no staining, odour or free product).

9.2 Ground Contamination

Following the results of the contamination assessment it can be seen that an elevated concentrations of arsenic and PAH compounds are present in the made ground that pose a risk to human health where it is exposed at the surface such as in the proposed garden.

Remediation is recommended to mitigate these risks. It is beyond the scope of this report to detail suitable remediation strategies. However, the most suitable form of remediation based on the results of the investigation would be to cap the made ground with suitable, clean, inert soils as part of a Clean Cover System.

The Clean Cover System (CCS) would need to be at least 600mm thick and should incorporate a no-dig layer (150mm thick layer of type 1 crushed quarry stone) and a geomembrane at the base to prevent intermixing and to act as a marker layer.

It may be necessary to reduce levels to accommodate the CCS. Where the made ground is fully removed there would be no requirement for a no-dig layer or the geomembrane, however, imported clean soil would be required to replace the excavated materials and provide a suitable growing medium for plants, shrubs and trees. Deepening of the Clean Cover System will be required where trees are proposed.

Alternatively, consideration should be given to further risk assessment (Detailed Quantitative Risk Assessment – DQRA) or other protection measures to ensure the future suitability of the site for the proposed residential development.

The elevated arsenic and PAH contamination is only considered to pose a risk to future users where there is a plausible pathway such as proposed gardens. Any hardcover (roads, car parks, buildings, etc…) will effectively break the established Source – Pathway – Receptor pollutant linkage model, by removing the Pathway element.

Granular made ground materials may be suitable for re-use beneath areas of hardstand or buildings as an engineered fill where it will not pose a risk to the end user. However, this would be subject to approval of the Civil/Structural Engineer and the volume of material present.

Any remediation works would be subject to the approval of the Local Authority. It is recommended that a Remediation Strategy be agreed with the Planning Authority prior to implementation on site. Once the remedial works have been agreed and implemented on site, the Planning Authority will require the

completion of Validation/Verification works and reporting to confirm the remedial works have been completed in accordance with the agreed remedial strategy.

If topsoil is brought on to site, the materials should be as specified in BS 3882:2015 as 'suitable for the intended purpose'. BS3882:2015 relates to nutrient content of topsoil and phytotoxic contamination and does not consider contaminants that pose a risk specifically to human health. Soils should be tested for contaminants that are considered to pose a risk to human health in addition to BS3882:2015 to ensure that they are suitable for their intended use. All materials brought on to site that are to be used as part of soft landscaped areas should be assessed with regards to human health criteria.

9.3 Ground Gas

The results of the ground gas monitoring indicate no methane, marginally elevated concentrations of carbon dioxide and low flow rates. Gas protection measures are not considered necessary.

Radon protection measures are not considered necessary.

9.4 General Comments

Consideration must be made for variations to occur in the ground conditions between the exploratory hole locations for which GEO holds no responsibility and areas where limited access was available. It is therefore recommended that a "watching brief" and "observational technique" be applied to this site to ensure that if ground conditions appear to vary from those identified within this investigation report then advice should be sought from a suitably qualified and experienced Engineering Geologist, Geotechnical or Geo-Environmental Engineer.

The recommendations and opinions expressed in this report are based on the strata observed within the exploratory holes in addition to the results of the site and laboratory tests commissioned by GEO. Consequently, GEO takes no responsibility for conditions that have not been revealed or which occur between them. GEO takes no responsibility for the accuracy of third party information provided by sub-contract drillers or laboratories.

The conclusions and recommendations presented within this report are considered reasonable based on the available information. However, these cannot be guaranteed to gain regulatory approval. Therefore, the report should be passed to the appropriate regulatory authorities and/ or other key stakeholders in order to seek their approval of the findings prior to undertaking any works on site.

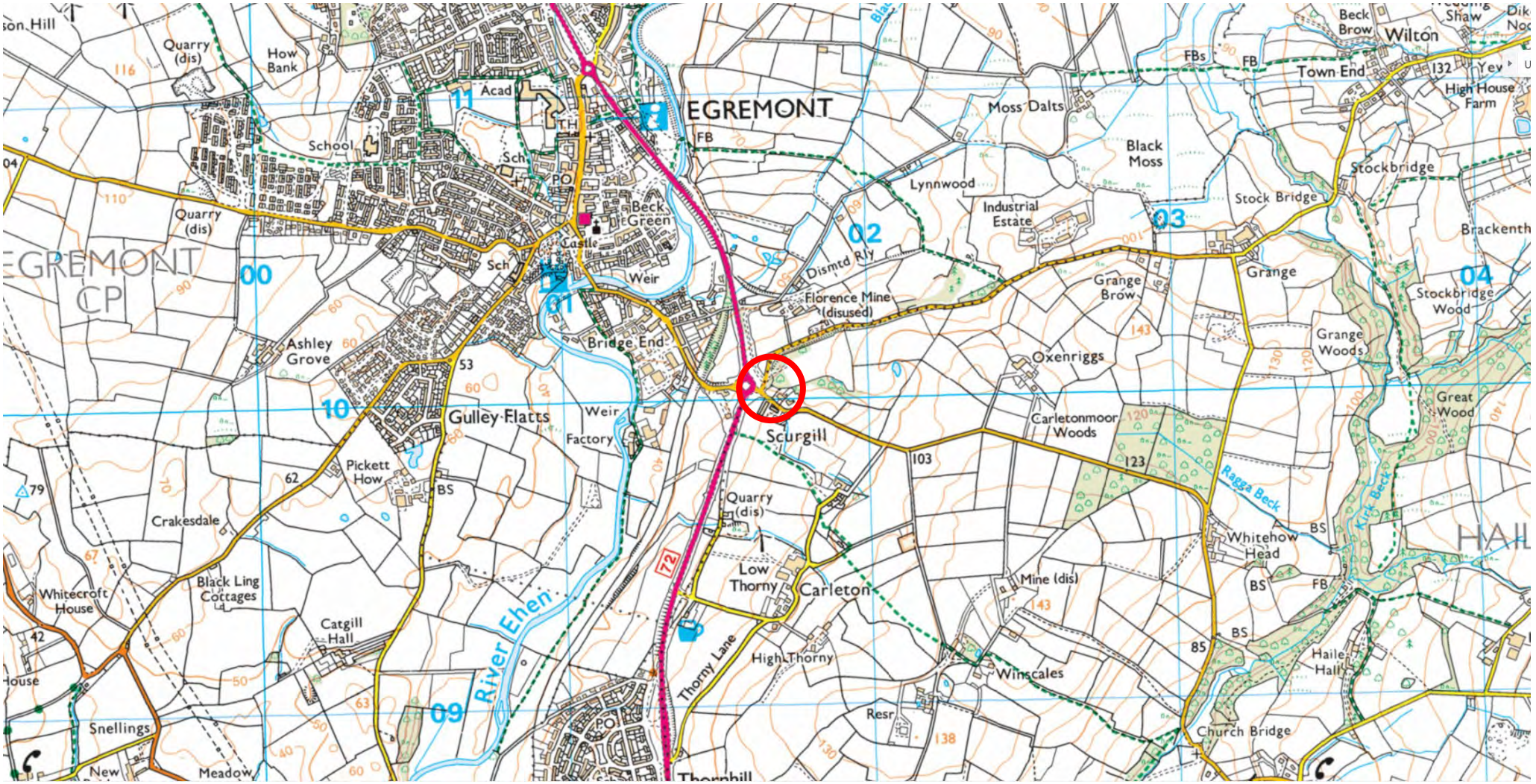
End of Report

Appendix I

- Site Location Plan
- Exploratory Hole Location Plan

GEO Environmental Engineering

GEO2021-4817: Scurgill, Egremont, Cumbria – Site Location



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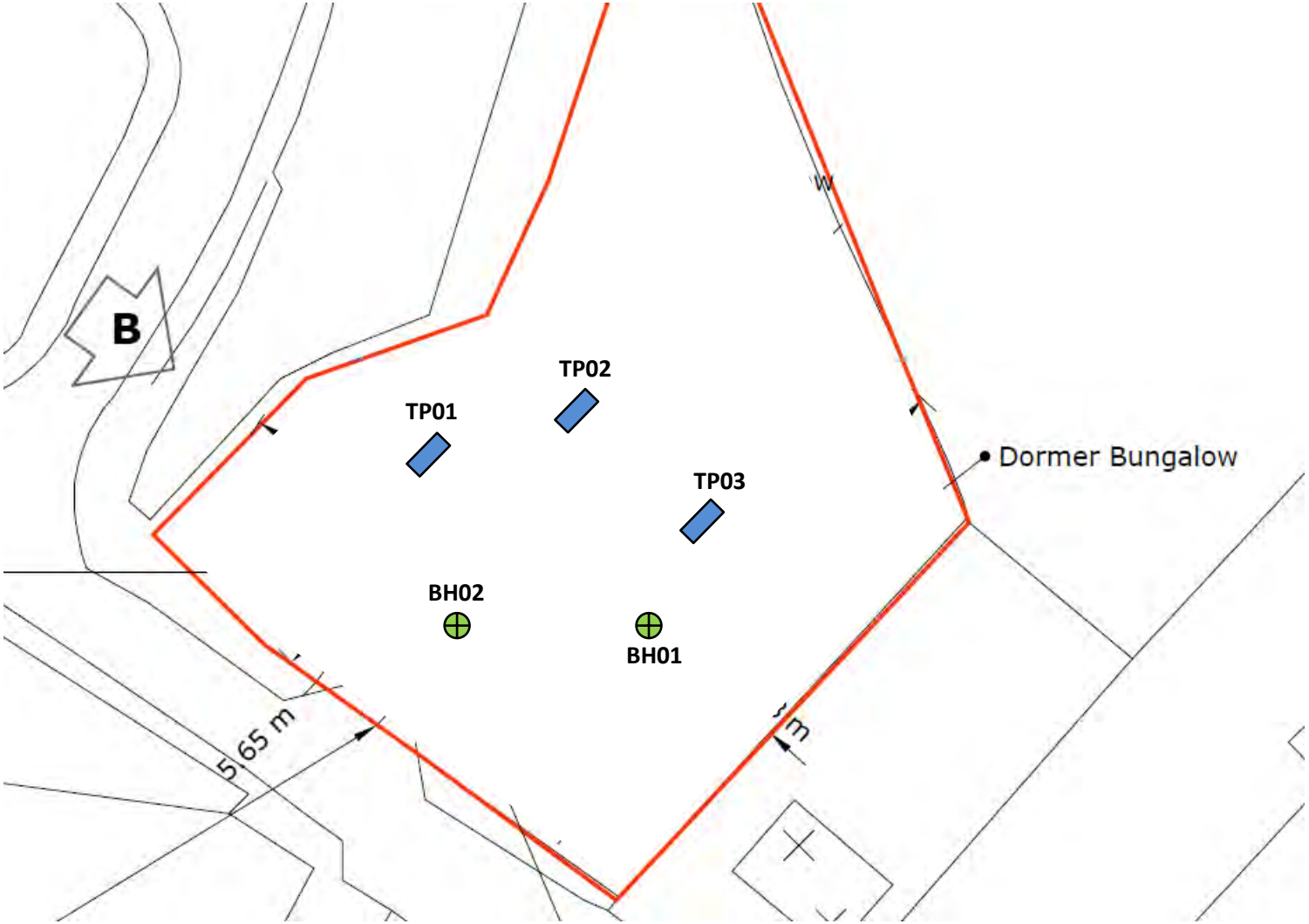
GEO2021-4817: Scurgill, Egremont, Cumbria – Exploratory Hole Location Plan



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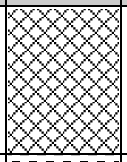
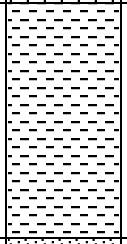
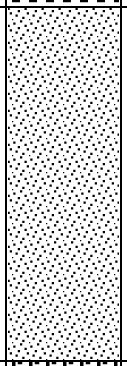
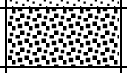
Appendix II

- Exploratory Hole Logs
- Ground Gas and Groundwater Monitoring Record Sheets

GEO Environmental Engineering

GEO2021-4817: Scurgill, Egremont, Cumbria – BH01

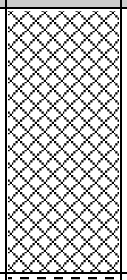
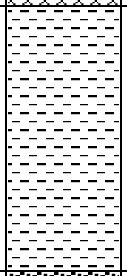
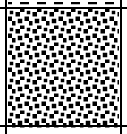
Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.47	MADE GROUND: Dark grey brown sandy loamy angular GRAVEL of mixed aggregate with occasional angular cobbles and boulders.		0.30 - J
0.47	1.30	Stiff red brown slightly sandy very gravelly CLAY.		0.90 - T 1.00 SPT = N12
1.30	2.50	Loose brown slightly silty gravelly medium SAND. Becoming increasingly gravelly with depth.		2.00 SPT = N6
2.50	2.60	Dense brown slight silty very sandy sub-rounded to sub-angular GRAVEL of mixed lithology.		2.60 SPT = N>50 (LP)
		End of borehole at 2.60m due to sample tube and SPT refusal. Groundwater strike at 1.50m bgl. Standing groundwater at 1.40m bgl on completion. Borehole installed: GL to 0.50m plain pipe and bentonite seal. 0.50m to 2.30m slotted pipe and gravel.		Hand dug to 1.00m

Engineer: J.Brock
Site Works Date: 18/06/2021
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO Environmental Engineering

GEO2021-4817: Scurgill, Egremont, Cumbria – BH02

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.88	MADE GROUND: Dark grey silty sandy loamy GRAVEL of aggregate, clinker and occasional brick and concrete. Layers of meshed rebar.		0.20 - J
0.88	1.80	Firm red brown slightly sandy very gravelly CLAY.		1.00 SPT = N6
1.80	2.20	Loose brown silty very sandy fine to coarse sub-rounded GRAVEL of mixed lithology. Occasional cobbles.		2.00 SPT = N9
2.20	4.00	No recovery 2.20m to 3.00m. SPT probe 3.00m to 4.00m (SPT values only)		3.00 SPT = N26 3.50 SPT = N7 4.00 SPT = N29
		End of borehole at 4.00m. Groundwater strike at 4.00m bgl. Standing groundwater at 0.70m bgl on completion. Borehole installed: GL to 0.50m plain pipe and bentonite seal. 0.50m to 2.30m slotted pipe and gravel.		Hand dug to 1.00m

Engineer: J.Brock
Site Works Date: 18/06/2021
Plant: Archway Competitor C130 Superheavy

Log Notes:
SPT = Standard Penetration test (N value)
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO Environmental Engineering

GEO2021-4817: Scurgill, Egremont, Cumbria – TP01

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	1.50	MADE GROUND: Dark grey slightly silty sandy angular GRAVEL and COBBLES of aggregate, clinker, ash, shale, brick, concrete and occasional slag. Many boulders. Very unstable (collapsing). Made ground is too unstable to sink borehole.		0.50 - J
1.50	1.60	Soft to firm brown slightly sandy very gravelly CLAY.		
		End of trial pit at 1.60m. Trial pit is dry on completion. Trial pit backfilled with arisings.		

Engineer: J.Brock
Site Works Date: 18/06/2021
Plant: 3CX Backhoe Excavator

Log Notes:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

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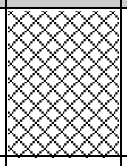
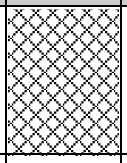
GEO2021-4817: Scurgill, Egremont, Cumbria – TP02

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.50	MADE GROUND: Dark grey slightly silty, sandy, loamy angular GRAVEL and COBBLES of aggregate with occasional clinker, ash, shale, brick and concrete.		0.30 - J
		End of trial pit at 0.50m. Trial pit is dry on completion. Trial pit backfilled with arisings.		

Engineer: J.Brock **Site Works Date:** 18/06/2021 **Plant:** 3CX Backhoe Excavator	**Log Notes:** HSV = Hand Shear Vane (kN/m^2) LP = Limited Penetration (HSV/CBR) B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO2021-4817: Scurgill, Egremont, Cumbria – TP03

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.50	MADE GROUND: Dark grey slightly silty, sandy, loamy angular GRAVEL and COBBLES of aggregate with occasional brick and concrete.		0.10 - J
		End of trial pit at 0.50m. Trial pit is dry on completion. Trial pit backfilled with arisings.		

Engineer: J.Brock **Site Works Date:** 18/06/2021 **Plant:** Hand Digging Equipmement	**Log Notes:** HSV = Hand Shear Vane (kN/m^2) LP = Limited Penetration (HSV/CBR) B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 01

Site: Scurgill, Egremont, Cumbria

Project No: 2021-4817

Date: 07/07/2021

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1003 F	0.0	0.0	2.7	2.9	18.6	18.4	<0.1	1.45	2.30	-
BH02	1003 F	0.0	0.0	1.8	1.8	19.8	19.7	<0.1	0.70	2.30	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure
Nm – Not Monitored

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Sunny and Dry

Temperature 17.0°C

Notes:

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 02

Site: Scurgill, Egremont, Cumbria

Project No: 2021-4817

Date: 26/07/2021

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	999 F	0.0	0.0	5.0	4.4	18.2	17.4	<0.1	1.60	2.30	-
BH02	999 F	0.0	0.0	2.1	2.0	19.1	19.0	<0.1	0.95	2.30	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure
Nm – Not Monitored

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry

Temperature 18.0°C

Notes:

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 03

Site: Scurgill, Egremont, Cumbria

Project No: 2021-4817

Date: 06/08/2021

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1007 R	0.0	0.0	5.2	5.8	15.6	14.8	<0.1	1.70	2.30	-
BH02	1007 R	0.0	0.0	1.8	1.8	19.3	19.3	<0.1	1.05	2.30	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure
Nm – Not Monitored

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry

Temperature 20.0°C

Notes:

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 04

Site: Scurgill, Egremont, Cumbria

Project No: 2021-4817

Date: 17/08/2021

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1010 F	0.0	0.0	5.6	5.7	13.5	13.2	<0.1	1.30	2.20	-
BH02	1010 F	0.0	0.0	1.3	1.3	20.0	20.0	<0.1	0.60	2.20	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure
Nm – Not Monitored

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Raining

Temperature 15.0°C

Notes:

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 05

Site: Scurgill, Egremont, Cumbria

Project No: 2021-4817

Date: 20/09/2021

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1012 R	0.0	0.0	0.6	0.4	19.7	20.0	<0.1	1.40	2.20	-
BH02	1012 R	0.0	0.0	0.2	0.2	20.4	20.5	<0.1	0.80	2.20	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure
Nm – Not Monitored

Monitoring Completed By: SG

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Sunny and Dry

Temperature 17.0°C

Notes:

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GEO Environmental Engineering

Ground Gas & Groundwater Monitoring Record Sheet 06

Site: Scurgill, Egremont, Cumbria

Project No: 2021-4817

Date: 23/09/2021

Borehole	Pressure (mb)	Methane Initial (% v/v)	Methane Residual (% v/v)	Carbon Dioxide Initial (% v/v)	Carbon Dioxide Residual (% v/v)	Oxygen Initial (% v/v)	Oxygen Residual (% v/v)	Flow Rate (l/h)	Water Level (m)	Depth of base (m)	Water Sample Recovered?
BH01	1016 F	0.0	0.0	6.1	7.5	16.5	14.2	<0.1	Nm	2.20	-
BH02	1016 F	0.0	0.0	1.5	1.5	20.0	19.8	<0.1	Nm	2.20	-

Notes:
Initial Value = First recorded concentration taken immediately upon opening the gas valve; Residual Value = Constant or "steady" reading following peak.
Monitoring undertaken for a minimum of three minutes. Where high concentrations are initially noted then the monitoring should be increased to five minutes.
F = Falling Atmosphreic Pressure, R = Rising Atmosphreic Pressure, S = Steady Atmospheric Pressure
Nm – Not Monitored

Monitoring Completed By: JB

Equipment Used: GA2000 Gas Analyser with External Flow Pod. Geotechnical Instruments Dipmeter.

Weather Conditions: Dry, Overcast

Temperature 16.0°C

Notes:

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Appendix III

- Laboratory Test Results

ANALYTICAL TEST REPORT

Contract no:	97679
Contract name:	Scurgill, Egremont
Client reference:	GEO2021-4817
Clients name:	Geo Environmental Engineering
Clients address:	4 Culgarth Avenue Cockermouth Cumbria CA13 9PL
Samples received:	23 June 2021
Analysis started:	23 June 2021
Analysis completed:	30 June 2021
Report issued:	30 June 2021

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.

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:

Rachael Burton
Customer Support Squad Leader

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
97679-1	BH01	0.30	Clayey Sand with Gravel	-	-	15.5
97679-2	BH02	0.20	Clayey Sand with Gravel	-	-	5.1
97679-3	TP01	0.50	Clayey Sand with Gravel	-	-	9.2
97679-4	TP02	0.30	Clayey Sand with Gravel	-	-	7.1
97679-5	TP03	0.10	Clayey Sand with Gravel	-	-	5.3

Chemtech Environmental Limited

SOILS

Lab number			97679-1	97679-2	97679-3	97679-4	97679-5
Sample id			BH01	BH02	TP01	TP02	TP03
Depth (m)			0.30	0.20	0.50	0.30	0.10
Date sampled			21/06/2021	21/06/2021	21/06/2021	21/06/2021	21/06/2021
Test	Method	Units					
Arsenic (total)	CE127 M	mg/kg As	31	47	86	47	26
Cadmium (total)	CE127 M	mg/kg Cd	0.3	0.5	0.3	0.2	0.4
Chromium (total)	CE127 M	mg/kg Cr	82	66	56	60	70
Chromium (III)	CE208	mg/kg CrIII	82	66	56	60	70
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1	<1
Copper (total)	CE127 M	mg/kg Cu	16	30	53	64	41
Lead (total)	CE127 M	mg/kg Pb	54	43	28	33	121
Mercury (total)	CE127 M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel (total)	CE127 M	mg/kg Ni	20	45	98	117	46
Selenium (total)	CE127 M	mg/kg Se	1.3	1.6	2.3	2.0	1.7
Zinc (total)	CE127 M	mg/kg Zn	68	110	51	53	197
pH	CE004 M	units	7.9	8.0	8.1	8.2	7.8
Sulphate (2:1 water soluble)	CE061 M	mg/l SO_4	54	40	56	85	286
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1	<1
Total Organic Carbon (TOC)	CE197	% w/w C	1.9	4.3	5.4	5.3	3.1
PAH							
Naphthalene	CE087 M	mg/kg	<0.02	0.17	<0.02	0.12	0.03
Acenaphthylene	CE087 M	mg/kg	<0.02	0.16	<0.02	<0.02	0.02
Acenaphthene	CE087 M	mg/kg	0.04	1.96	<0.02	<0.02	<0.02
Fluorene	CE087 U	mg/kg	0.03	1.84	<0.02	<0.02	0.02
Phenanthrene	CE087 M	mg/kg	0.54	15.28	0.10	0.27	0.44
Anthracene	CE087 U	mg/kg	0.12	3.55	<0.02	0.03	0.08
Fluoranthene	CE087 M	mg/kg	1.27	29.01	0.22	0.35	1.04
Pyrene	CE087 M	mg/kg	1.06	22.65	0.18	0.30	0.88
Benzo(a)anthracene	CE087 U	mg/kg	0.66	13.05	0.10	0.20	0.52
Chrysene	CE087 M	mg/kg	0.78	14.23	0.12	0.24	0.64
Benzo(b)fluoranthene	CE087 M	mg/kg	1.19	18.36	0.16	0.26	0.73
Benzo(k)fluoranthene	CE087 M	mg/kg	0.44	7.95	0.04	0.10	0.27
Benzo(a)pyrene	CE087 U	mg/kg	0.91	17.57	0.13	0.20	0.50
Indeno(123cd)pyrene	CE087 M	mg/kg	0.73	12.64	0.10	0.16	0.45
Dibenz(ah)anthracene	CE087 M	mg/kg	0.12	2.36	<0.02	0.03	0.08
Benzo(ghi)perylene	CE087 M	mg/kg	0.56	9.80	0.07	0.16	0.36
PAH (total of USEPA 16)	CE087	mg/kg	8.44	171	1.21	2.39	6.07
BTEX & TPH							
MTBE	CE192 U	mg/kg	<0.02	<0.02	<0.02	-	-
Benzene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-
Toluene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-
Ethylbenzene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-
m & p-Xylene	CE192 U	mg/kg	<0.02	<0.02	<0.02	-	-
o-Xylene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-
VPH Aromatic (>EC5-EC7)	CE067	mg/kg	<0.01	<0.01	<0.01	-	-

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SOILS

Lab number			97679-1	97679-2	97679-3	97679-4	97679-5
Sample id			BH01	BH02	TP01	TP02	TP03
Depth (m)			0.30	0.20	0.50	0.30	0.10
Date sampled			21/06/2021	21/06/2021	21/06/2021	21/06/2021	21/06/2021
Test	Method	Units					
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	3	<1	-	-
EPH Aromatic (>EC16-EC21)	CE068	mg/kg	4	73	<1	-	-
EPH Aromatic (>EC21-EC35)	CE068	mg/kg	6	87	<1	-	-
EPH Aromatic (>EC35-EC44)	CE068	mg/kg	<1	11	<1	-	-
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	<4	-	-
EPH Aliphatic (>C12-C16)	CE068	mg/kg	<4	16	<4	-	-
EPH Aliphatic (>C16-C35)	CE068	mg/kg	49	1864	11	-	-
EPH Aliphatic (>C35-C44)	CE068	mg/kg	21	1614	<10	-	-
Subcontracted analysis							
Asbestos (qualitative)	$	-	NAD	NAD	NAD	NAD	NAD

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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
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	M	10	mg/l SO_4
CE077	Cyanide (total)	Extraction, Continuous Flow Colorimetry	As received		1	mg/kg CN
CE197	Total Organic Carbon (TOC)	Carbon Analyser	Dry		0.1	% w/w C
CE087	Naphthalene	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	Acenaphthene	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	Phenanthrene	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	Fluoranthene	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	Benzo(a)anthracene	Solvent extraction, GC-MS	As received	U	0.02	mg/kg
CE087	Chrysene	Solvent extraction, GC-MS	As received	M	0.03	mg/kg
CE087	Benzo(b)fluoranthene	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	Benzo(a)pyrene	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	Dibenz(ah)anthracene	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	PAH (total of USEPA 16)	Solvent extraction, GC-MS	As received		0.34	mg/kg
CE192	MTBE	Headspace GC-FID	As received	U	0.02	mg/kg
CE192	Benzene	Headspace GC-FID	As received	U	0.01	mg/kg
CE192	Toluene	Headspace GC-FID	As received	U	0.01	mg/kg
CE192	Ethylbenzene	Headspace GC-FID	As received	U	0.01	mg/kg
CE192	m & p-Xylene	Headspace GC-FID	As received	U	0.02	mg/kg
CE192	o-Xylene	Headspace GC-FID	As received	U	0.01	mg/kg
CE067	VPH Aromatic (>EC5-EC7)	Headspace GC-FID	As received		0.01	mg/kg
CE067	VPH Aromatic (>EC7-EC8)	Headspace GC-FID	As received		0.01	mg/kg
CE067	VPH Aromatic (>EC8-EC10)	Headspace GC-FID	As received		0.01	mg/kg
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

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
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
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

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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)
97679-1	BH01	0.30	N	
97679-2	BH02	0.20	N	
97679-3	TP01	0.50	N	
97679-4	TP02	0.30	N	
97679-5	TP03	0.10	N	

Appendix IV

- GEO Chemical Assessment Sheet

Geo Environmenta Engineering Ltd

Chemical Assessment Sheet - Soils

Lab number			97679-1	97679-2	97679-3	97679-4	97679-5	Generic Assessment Criteria Residential With Plant Uptake 2.5% SOM		
Sample id			BH01	BH02	TP01	TP02	TP03	GAC	GAC Exceeded?	GAC Ref:
Depth (m)			0.30	0.20	0.50	0.30	0.10			
Date sampled			21/06/2021	21/06/2021	21/06/2021	21/06/2021	21/06/2021			
Test	Method	Units								
Arsenic (total)	CE127 M	mg/kg As	31	47	86	47	26	37	YES	LQM S4UL
Cadmium (total)	CE127 M	mg/kg Cd	0.3	0.5	0.3	0.2	0.4	11	No	LQM S4UL
Chromium (III)	CE208	mg/kg CrIII	82	66	56	60	70	910	No	LQM S4UL
Chromium (VI)	CE146	mg/kg CrVI	<1	<1	<1	<1	<1	6	No	LQM S4UL
Copper (total)	CE127 M	mg/kg Cu	16	30	53	64	41	2400	No	LQM S4UL
Lead (total)	CE127 M	mg/kg Pb	54	43	28	33	121	200	No	CL:AIRE C4SL
Mercury (total)	CE127 M	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	<0.5	40	No	LQM S4UL
Nickel (total)	CE127 M	mg/kg Ni	20	45	98	117	46	130	No	LQM S4UL
Selenium (total)	CE127 M	mg/kg Se	1.3	1.6	2.3	2.0	1.7	250	No	LQM S4UL
Zinc (total)	CE127 M	mg/kg Zn	68	110	51	53	197	3700	No	LQM S4UL
pH	CE004 M	units	7.9	8.0	8.1	8.2	7.8	N/A	N/A	N/A
Sulphate (2:1 water soluble)	CE061 M	mg/l SO_4	54	40	56	85	286	N/A	N/A	N/A
Cyanide (total)	CE077	mg/kg CN	<1	<1	<1	<1	<1	34	No	ATRISK SSV
Total Organic Carbon (TOC)	CE197	% w/w C	1.9	4.3	5.4	5.3	3.1	-	-	-
PAH										
Naphthalene	CE087 M	mg/kg	<0.02	0.17	<0.02	0.12	0.03	5.6	No	LQM S4UL
Acenaphthylene	CE087 M	mg/kg	<0.02	0.16	<0.02	<0.02	0.02	420	No	LQM S4UL
Acenaphthene	CE087 M	mg/kg	0.04	1.96	<0.02	<0.02	<0.02	510	No	LQM S4UL
Fluorene	CE087 U	mg/kg	0.03	1.84	<0.02	<0.02	0.02	400	No	LQM S4UL
Phenanthrene	CE087 M	mg/kg	0.54	15.28	0.10	0.27	0.44	220	No	LQM S4UL
Anthracene	CE087 U	mg/kg	0.12	3.55	<0.02	0.03	0.08	5400	No	LQM S4UL
Fluoranthene	CE087 M	mg/kg	1.27	29.01	0.22	0.35	1.04	560	No	LQM S4UL
Pyrene	CE087 M	mg/kg	1.06	22.65	0.18	0.30	0.88	1200	No	LQM S4UL
Benzo(a)anthracene	CE087 U	mg/kg	0.66	13.05	0.10	0.20	0.52	11	YES	LQM S4UL
Chrysene	CE087 M	mg/kg	0.78	14.23	0.12	0.24	0.64	22	No	LQM S4UL
Benzo(b)fluoranthene	CE087 M	mg/kg	1.19	18.36	0.16	0.26	0.73	3.3	YES	LQM S4UL
Benzo(k)fluoranthene	CE087 M	mg/kg	0.44	7.95	0.04	0.10	0.27	93	No	LQM S4UL
Benzo(a)pyrene	CE087 U	mg/kg	0.91	17.57	0.13	0.20	0.50	2.7	YES	LQM S4UL
Indeno(123cd)pyrene	CE087 M	mg/kg	0.73	12.64	0.10	0.16	0.45	36	No	LQM S4UL
Dibenz(ah)anthracene	CE087 M	mg/kg	0.12	2.36	<0.02	0.03	0.08	0.28	YES	LQM S4UL
Benzo(ghi)perylene	CE087 M	mg/kg	0.56	9.80	0.07	0.16	0.36	340	No	LQM S4UL
PAH (total of USEPA 16)	CE087	mg/kg	8.44	171	1.21	2.39	6.07	-	-	-
BTEX & TPH										
MTBE	CE192 U	mg/kg	<0.02	<0.02	<0.02	-	-	84	No	CL:AIRE GAC (2010)
Benzene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-	0.17	No	LQM S4UL
Toluene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-	290	No	LQM S4UL
Ethylbenzene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-	110	No	LQM S4UL
m & p-Xylene	CE192 U	mg/kg	<0.02	<0.02	<0.02	-	-	130	No	LQM S4UL
o-Xylene	CE192 U	mg/kg	<0.01	<0.01	<0.01	-	-	140	No	LQM S4UL
VPH Aromatic (>EC5-EC7)	CE067	mg/kg	<0.01	<0.01	<0.01	-	-	140	No	LQM S4UL
VPH Aromatic (>EC7-EC8)	CE067	mg/kg	<0.01	<0.01	<0.01	-	-	290	No	LQM S4UL
VPH Aromatic (>EC8-EC10)	CE067	mg/kg	<0.01	<0.01	<0.01	-	-	83	No	LQM S4UL
EPH Aromatic (>EC10-EC12)	CE068	mg/kg	<1	<1	<1	-	-	180	No	LQM S4UL
EPH Aromatic (>EC12-EC16)	CE068	mg/kg	<1	3	<1	-	-	330	No	LQM S4UL
EPH Aromatic (>EC16-EC21)	CE068	mg/kg	4	73	<1	-	-	540	No	LQM S4UL
EPH Aromatic (>EC21-EC35)	CE068	mg/kg	6	87	<1	-	-	1500	No	LQM S4UL
EPH Aromatic (>EC35-EC44)	CE068	mg/kg	<1	11	<1	-	-	1500	No	LQM S4UL
VPH Aliphatic (>C5-C6)	CE067	mg/kg	<0.1	<0.1	<0.1	-	-	78	No	LQM S4UL
VPH Aliphatic (>C6-C8)	CE067	mg/kg	<0.1	<0.1	<0.1	-	-	230	No	LQM S4UL
VPH Aliphatic (>C8-C10)	CE067	mg/kg	<0.1	<0.1	<0.1	-	-	65	No	LQM S4UL
EPH Aliphatic (>C10-C12)	CE068	mg/kg	<4	<4	<4	-	-	330	No	LQM S4UL
EPH Aliphatic (>C12-C16)	CE068	mg/kg	<4	16	<4	-	-	2400	No	LQM S4UL
EPH Aliphatic (>C16-C35)	CE068	mg/kg	49	1864	11	-	-	92000	No	LQM S4UL
EPH Aliphatic (>C35-C44)	CE068	mg/kg	21	1614	<10	-	-	92000	No	LQM S4UL
Subcontracted analysis										
Asbestos (qualitative)	$	-	NAD	NAD	NAD	NAD	NAD	Present	No	Presence

Notes:
GAC = Generic Assessment Criteria
YES = GAC Exceeded
CLEA SGV = Clea Soil Guideline Value (Residential with Plant Uptake End Use based on 2.5% SOM)
LQM S4UL = LQM/CIEH 'Suitable 4 Use Levels' S4ULs (Residential with Plant Uptake End Use based on 2.5% SOM)
CL:AIRE C4SL = Category 4 Screening Levels (Residential with Plant Uptake End Use based on 2.5% SOM)
ATRISK SSV = Atkins Soil Screening Values (Residential with Consumption of Home Grown Produce at 1% SOM)

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