Chevin Geoenviro Associates LTD

Land At:

Flaxmill House, Surfleet, Spalding

Phase 2 Site Investigation Report

November 2020

77 High Street, Yeadon, LS19 7SP

Tel: 01943 470363

Email: info@chevin-ltd.co.uk

Land at Flaxmill House, Surfleet, Spalding

Phase 2 Site Investigation Report

Report Title	Land at: Flaxmill House, Surfleet, Spalding Phase 2 Site Investigation Report	**Site Address**	36 Reservoir Road, Surfleet, Spalding, PE11 4DH Grid Ref: (527298,329030)
Author	Chevin Geoenviro Associates Ltd	**Contamination / Geotechnical /**	Geoenvironmental & Preliminary Geotechnical Phase 2
Work Stage	Phase 2 Site Investigation	**Report Date**	November 2020
Brief Description of the Report Contents	Assessment of all information obtained from carrying out the phase 2 geoenvironmental ground investigations, assessing contaminated land risks, and making initial geotechnical recommendations.		

Land at Flaxmill House, Surfleet, Spalding

Phase 2 Site Investigation Report

Document Control

Client: Mr T Forman
Job Number: C0362

Document Checking:

Prepared by:	**Tom Midgley MGeol**
Prepared by:	**Tom Roebuck-Rouse BSc MGeol FGS**
Checked by:	**David Wilkinson/Christiaan Wilkinson**
Issued by:	**Christiaan Wilkinson MRes CSci FGS SiLC**

Issue	Date	Status	Year
01	09th November	Final	2020

Contents Page

1.0 INTRODUCTION 1
1.1 Terms and Conditions 1
2.0 SITE DETAILS 2
2.1 Site Location 2
2.2 Site Description 2
2.3 Proposed End Use 2
2.4 Previous Studies 2
3.0 GEOLOGY HYDROLOGY AND HYDROGEOLOGY 3
3.1 Superficial & Solid Geology 3
3.2 Hydrogeology/Hydrology 3
4.0 FIELDWORK 4
4.1 Scope of Fieldwork 4
4.2 Sampling Strategy 4
4.3 Trial Pits 4
5.0 LABORATORY TESTING 4
5.1 Scope of Testing 4
5.2 Contamination Testing 5
5.3 Geotechnical Laboratory Testing 5
6.0 INVESTIGATION FINDINGS 6
6.1 Ground Conditions 6
6.2 Made Ground Topsoil 6
6.3 Made Ground 6
6.4 Superficial Deposits 6
6.5 Groundwater 7
7.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS 7
7.1 Foundations 7
7.2 Shrink and swell characteristics of site soils 8
7.3 Pavements and Roads 9
7.4 Buried Concrete 9

7.5 Excavations 9
7.6 Further Considerations 10
8.0 ENVIRONMENTAL ASSESSMENT OF GROUND 10
8.1 Scope of Sampling, Testing and Commentary 10
8.2 Human Health Assessment 11
8.3 Vegetation Assessment 12
8.4 Controlled Waters Assessment 12
8.5 Gas Risk Assessment for Structures 12
8.6 Statistical Analysis and Site Zoning 12
9.0 DISCUSSION OF RESULTS 13
9.1 Human Health Hazards 13
9.2 Vegetation Hazards 14
9.3 Ground Gas Assessment 15
10.0 CONCEPTUAL SITE MODEL 15
10.1 Introduction 15
10.2 Hazard Identification 16
10.3 Discussion of Risks 26
11.0 WASTE CLASSIFICATION 27
12.0 CONCLUSIONS AND RECOMMENDATIONS 27
12.1 Watching Brief 28
12.2 Protocol for the Importation of Topsoil 28
13.0 REFERENCES 30

APPENDIX CONTENTS

Appendix A	**Figures and Drawings**
Drawing No. C0362-01	Site Location Plan
Drawing No. C0362-02	Proposed Site layout
Drawing No. C0362-03	Exploratory Hole Location Plan & Site Photographs
Appendix B	Engineering Logs
Appendix C	Contamination Test Results
Appendix D	Geotechnical Laboratory Test Results
Appendix E	LQM PAH Profiling Chart

1.0 INTRODUCTION

Chevin Geoenviro Associates Ltd (CGA) were commissioned by Mr. T. Forman, to carry out a Phase 2 Site Investigation on land at Flaxmill House, 36 Reservoir Road, Surfleet, Spalding, PE11 4DH.

The purpose of this report is to provide factual and interpretative information required to comply with the requirements of a Phase 2 Site Investigation to assess contamination issues as required by the planning regime. The scope of the study is as follows:

- To provide general information on the site such as location and description;
- To summarise the geological setting of the site and previous assessments;
- To form exploratory holes;
- Provide factual information and descriptions of ground conditions;
- To make preliminary geotechnical recommendations;
- To provide a quantitative risk assessment for the proposed end use of the site; and
- To provide recommendations for further works where necessary.

1.1 Terms and Conditions

This report has been prepared for Mr. T. Forman, in support of a planning application. It should be noted that the investigation data on which this report is based is only indicative of the actual ground conditions that exist at the locations of the exploratory holes and may not be representative of the conditions that exist on the site as a whole.

Chevin Geoenviro Associates Ltd (CGA), accepts no liability for any adverse geotechnical or environmental impacts on the proposed development that result from ground not investigated as part of this project. Similarly, CGA is not liable for any adverse effects that arise as a result of conditions that exist on land adjacent to the subject site.

2.0 SITE DETAILS

2.1 Site Location

The site is located approximately 6.25km north east of Spalding town centre and is approximately 0.18ha in size. The site is centred on National Grid Reference: 527298,329030.

A Site Location Plan is presented as Drawing C0362 in Appendix A.

2.2 Site Description

The site is rectangular in shape, orientated slightly north west to south east. The site is directly bounded by neighbouring residential properties to the east and west, Reservoir Road to the south and agricultural field to the north. The northern and western site boundaries are not delineated, the eastern boundary is defined by a wood fence and the southern boundary is defined by the pavement. The surrounding areas are predominantly agricultural in usage, though there are residences along Reservoir Road in both directions. There is a corrugated metal stable building near the south western corner of the site on Reservoir Road.

At the time of investigation, the site interior was a thinly vegetated agricultural field with evidence of previous tilling. No evidence of crops was noted. Ground conditions appeared to be sandy and gravelly with brick fragments.

Topographically the site is flat and level.

2.3 Proposed End Use

The proposed development consists of the construction of two detached dwellings with private gardens and off-road parking.

2.4 Previous Studies

Phase 1 Desk Study:

A Phase 1 Desk Study for the site was compiled by CGA in December 2019 and should be read in conjunction with this report.

There were no potential sources of contamination noted during the site walkover.

The historical use of the site was reported to have been a disused flax mill in the late 19th Century which was removed by 1903. Maps from 1947-50 show two small adjacent buildings in the south of site which were removed by 1975-1977. No further change is seen on mapping.

The report concluded that a Moderate to Low level of risk to site users from potential made ground on the site was present. There was also an estimated Very Low risk from the made ground to controlled waters, and a Low risk from ground gases associated with historical made ground or potential peat deposits.

Natural ground hazards from natural ground subsidence from compressible ground or running sands were reported as moderate.

3.0 GEOLOGY HYDROLOGY AND HYDROGEOLOGY

3.1 Superficial & Solid Geology

Geological mapping recorded superficial deposits of Tidal Flat Deposits consisting of clays and silts underlying the site.

The solid geology recorded shows the site is underlain by the Oxford Clay Formation, predominantly consisting of Mudstone.

3.2 Hydrogeology/Hydrology

The Oxford Clay Formation and the Tidal Flat Deposits underlying the site are classified as Unproductive Strata. These are rock layers or superficial deposits with low permeability that have negligible significance for water supply or river base flow.

The River Glen is at surface level and located 27m south of site. Unnamed hydrological features are located 135m and 171m north west, 152m, 156m and 220m north, 190m north east and 204m east of site. These features are associated with agricultural field drainage.

4.0 FIELDWORK

4.1 Scope of Fieldwork

The fieldwork was carried out on the 6th October 2020, with the scope of the fieldwork being specified by Chevin Geoenviro Associates Ltd (CGA) and undertaken in general accordance with BS 5930 and BS10175.

CGA had responsibility for ensuring the correct setting out of exploratory holes, determining the sampling regime, supervision of the JCB driver and logging of soils. In order to comply with the HSE guidance for avoiding danger from underground utilities, each location was scanned for utility services using a Cable Avoidance Tool (CAT).

4.2 Sampling Strategy

The sampling strategy utilised both grid and targeted sampling to ensure potential sources of contamination and proposed garden areas were suitably investigated, and that full coverage of the site was achieved.

Both geotechnical and environmental samples were recovered from the trial pits for laboratory testing. The depths of the samples recovered are shown on the relevant exploratory hole logs presented in Appendix B of this report.

The exploratory hole location plan is shown in Appendix A.

4.3 Trial Pits

A total of six trial pits were excavated on the site. These were designated TP01 to TP06 and were excavated to depths of between 1.50m in TP02 toTP06 and to 2.50m in TP01 only.

5.0 LABORATORY TESTING

5.1 Scope of Testing

All chemical (contamination & geotechnical) testing was scheduled by CGA and intended to provide data for the specific areas sampled. The scope of the testing was designed to enable comments regarding characterisation of potential contamination on site, as well as assessing the geotechnical properties for foundations design purposes.

The results of the laboratory testing are presented within this report following an assessment of the data.

5.2 Contamination Testing

A total of six soil samples were sent to i2 Analytical Ltd, Watford, which is registered as UKAS Testing laboratory No. 4041.

Testing was carried out in accordance with a combination of the 'Methods for Examination of Water and Associated Materials' (the 'Blue Book') published by H.M.S.O., documented in-house methods and other published methods, to determine the presence of the analytes listed in Table 1.1.

Table 1.1 Chemical Analysis Summary Table

Analysis	Total No. Samples
SOILS	**SOILS**
9 Metals	6
SOM	6
pH	6
Total Cyanide	6
Speciated PAH	6
Total TPH	6
Asbestos ID	6
Leachate Test	2

The results of the contamination testing are presented in Appendix C of this report.

5.3 Geotechnical Laboratory Testing

A total of four soil samples were sent to the geotechnical department of i2, Watford (UKAS No. 4041).

Table 1.2 Geotechnical Testing Summary Table

Analysis	Total No. Samples
SOILS	
pH & Sulphate (water Sol)	1
Atterberg Test	2
CBR Remould	2

The results of the geotechnical testing are presented in Appendix D of this report.

6.0 INVESTIGATION FINDINGS

6.1 Ground Conditions

This investigation confirmed the ground conditions are broadly consistent with the geological mapping, which indicates the site is underlain by Tidal Flat deposits comprising silts and clays.

Made ground was generally located around the areas of historical buildings.

The following sections provide a summary of the ground conditions encountered during this investigation. The logs presented in Appendix B of this report provide a detailed description of all the strata observed.

6.2 Made Ground Topsoil

Made ground topsoil was encountered at every trial pit location, and consisted of brown slightly gravelly silt with angular to rounded gravel sized fragments of mixed lithologies, brick and ceramic found in TP04. This extended to 0.30m depth in TP01, TP02, TP03 and TP04, and 0.40m depth in TP05 and TP06.

6.3 Made Ground

Three of the six trial pit locations recorded additional layers of made ground underneath the made ground topsoil. In TP04 this was a slightly sandy gravelly silt from 0.30 to 0.60m depth with gravel sized fragments of mixed lithologies, brick, coal and tar covered aggregate. In TP05 it was described as a slightly gravelly sandy silt with gravel sized fragments of ceramic, coal, brick and burnt wood from 0.40 to 0.90m depth. A slightly silty gravelly sand was encountered in TP06 from 0.40 to 0.70m depth. A concrete footing was encountered in the north side of this trial pit. The gravel sized fragments comprised brick and mixed lithologies.

6.4 Superficial Deposits

Superficial deposits consisting of pale brown slightly clayey sandy silt underlay the made ground at every location. The sand was described as fine and subsequent laboratory testing on just two samples defined the site soils as both sandy silts and clays.

The trial pits were unstable and collapsed during excavation which would infer insufficient bearing properties at shallow depth.

6.5 Groundwater

Groundwater was not encountered within any exploratory holes, which extended to a maximum depth of 2.50m. Groundwater below these depths could potentially influence shallow foundations.

7.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

7.1 Foundations

The variable clay, silt and sand content of the soils and the recorded potential for settlement, has been endorsed by the plasticity testing results. This means that a safe bearing capacity could not be directly derived from the field observations. Initially raft foundations would be considered to be the most appropriate solution but this would require improvement of the near surface soils and consideration to the consolidation potential of deeper the soils at the site.

Ground Investigation

To address the issue of settlement an appropriate depth below the foundation requires to be investigated. Eurocode 7 Part 2 (2007) is currently recognised by planning authorities and provides methods to derive an appropriate investigation depth. With respect to raft foundations, a minimum depth equal to or greater than 1.5 and up to 3.0 times the smaller side of the structure should be investigated. From the preliminary drawings provided to CGA, this appears to be in the order of 12m depth and would best be achieved by a Cable Percussive drilling or Cone Penetration Test (CPT) method.

In either case soft clays should preferably be tested to provide a preliminary estimates for their coefficients of compressibility, lens thicknesses of clay, silt and or peat should also be measured and described in terms of shear strength and bearing parameters, plasticity limits and any depths of groundwater which may also be associated with running sands.

Raft Design:

The foundations and their associated earthworks should be designed by an appropriately qualified structural engineer, and the design should include sufficient width under load bearing walls and consideration of the site's potential for variable strength ground or locally deeper areas of made ground. All foundations must be inspected by over excavation beyond their limits, and should be defined prior to construction, and any

soft or made ground, reworked natural strata or structures should first be removed by a suitably qualified contractor, and the area of foundations proof rolled. The excavations should then be brought up to formation level using selected granular fill. Information supplied by warrantee providers such as NHBC Standards 2019 Chapters 4.4/5.1 suggest basics requirements for raft/earthworks design including suitability of site won materials, appropriate span distances and raft composition.

Vibro –Replacement:

An alternative to extensive preparation earthworks may be to increase the bearing capacity of dominantly granular surface soils by the use of vibro-compaction or vibro-replacement methods. Both use a vibrating hydraulic probe inserted into the ground at regular intervals on a grid layout between 1.5m and 3.0m spacing. The ground density is locally increased by the addition of stone in columns and these are then covered by a raft design. However, this method is not suited to soft clays or peat which should first be discounted by further investigation. Guidance is given by NHBC Standards 4.6 Vibrating Ground Improvement Techniques.

Mini Pile Design

This depth of investigation discussed above is also considered appropriate for a preliminary pile design. In low density unstable soils, mini piling is likely to be cheaper and potentially more effective than shallower foundations that require deep shoring or surface ground preparation. It seems unlikely that rockhead will be encountered at shallow depths and in this respect the design should be frictional rather than end bearing. A driven pile can achieve its full working load by being driven to a predesigned bearing potential “the set” and as such piles arranged in groups can overcome local ground differences. A sufficient number of pile tests can then be carried out to discount settlement. The designer will also require to account for potential negative skin friction caused by shallow ground water and/or compressible soils.

7.2 Shrink and swell characteristics of site soils

Where any foundations are located on cohesive ground, consideration should be given to the variability of these soils and their potential to shrink or swell. Two soil samples were subjected to Atterberg Limits Tests, one of which was found to be non-plastic due to the high proportion of granular material. The results are tabulated below.

1.3 Table of Atterberg Limits Tests

Location	Depth (m)	Moisture Content %	Plasticity Index Ip %	Modified Plasticity %	Volume change potential
TP01	1.10	29	10	10	Low
TP04	0.90 - 1.10	23	NP	NP	N/A

7.3 Pavements and Roads

Two California Bearing Ratio Remould tests were carried out on the natural sandy silt from TP03 and TP05 at depths of 0.70 – 0.90m and 1.00 – 1.30m respectively. The CBR results were found to be lower than 1%, and it was not appropriate to calculate an average result.

The Highways Agency document HD25 Interim Advice note 73/06 states that where a subgrade has a CBR value lower than 2.5% it is considered unsuitable support for a pavement foundation since it would tend to deform under traffic and therefore must be improved.

It is presumed that the proposed driveway on the site is not to be given adoptable status, however if it were it is likely that it would also require additional geogrids and the design would require to be approved by the regulator responsible for the adoption.

7.4 Buried Concrete

One pH and Water Soluble Sulphate test was carried out on a sample of the natural soil from TP04, with measured pH level at 8.8 and water soluble sulphate level of 29.4mg/l. After Building Research Establishment Special Digest No. 1 Concrete in Aggressive Ground (2005), a cement in accordance with a design sulphate class of DS-1 and ACEC class for location of AC-1s, could be used for all buried concrete structures on site. Nevertheless, basic sulphate resistance is always recommended for areas of made ground, which by its very nature is variable in consistency.

7.5 Excavations

Due to the nature of the shallow soils encountered, excavations are not expected to be self-supporting. It is likely that some form of shoring will be required.

7.6 Further Considerations

The desk study identified concerns regarding a moderate onsite risk from ground subsidence, compressible ground and running sand. In addition this report has been unable to establish suitable natural consolidation in near surface soils to provide a reliable preliminary bearing value. We have however outlined a number of potential foundation solutions which all require a degree of further ground investigation. This is however not definitive and does not preclude a designer requiring further or a greater amount of subsequent ground investigation.

8.0 ENVIRONMENTAL ASSESSMENT OF GROUND

8.1 Scope of Sampling, Testing and Commentary

The following assessment was performed in the context of the planning regime and considering Part 2A of the Environmental Protection Act (1990) to determine if unacceptable risks to humans, vegetation or to specific parts of the wider environment are present on the site. The risk assessment follows the source, pathway, receptor methodology, as described in Contaminated Land Report (CLR) 11, which is used to build a conceptual site model to determine the presence of any pollutant linkages at the site. Should pollutant linkages exist at the site it is deemed necessary to further develop the risk assessment by comparing contamination test results with generic or site specific assessment criteria in order to determine if an unacceptable level of risk is present at the site. If legislation or guidance changes, or the proposed end use is modified, then it will be necessary to reassess the risks which may require further sampling and testing.

We understand our brief to comprise the following items related to the contamination aspects of this investigation.

- Compare laboratory test results with generic assessment criteria
- Determine a conceptual site model and identify any pollutant linkages at the site
- Determine the level of risk posed by environmental hazards on site to human health, vegetation, controlled waters and structures
- Make recommendations for further work or remediation strategies

Soil samples were recovered in accordance with current industry practice and were sent to I2 Environmental Science to be analysed for the determinants listed in Section 5.0 of the factual part of this report.

The results of these analyses are included in Appendix C of this report.

8.2 Human Health Assessment

UK guidance recommends that a risk based approach is taken for the assessment of contaminated land and as such, DEFRA have introduced the CLEA methodology, SGV's and Category 4 Screening Values (C4SL). The CLEA methodology is a deterministic risk assessment model that estimates the long term exposure to contaminants in the soil for children and adults and predicts the amount of contaminant to which a person might be exposed based on a given soil concentration. By comparison with relevant health criteria on tolerable or acceptable intakes of various contaminants the model was used by DEFRA and the Environment Agency to generate SGV's and C4SL's.

At the time of writing this report the DEFRA and Environment Agency has not published SGV's/C4SL using the CLEA 1.071 software for all anthropogenic toxic substances with C4SL's for further contaminants due to be produced at some point in the future. As such, it was necessary to use other methods to generate target concentrations for contaminants of concern on site.

In order to generate generic assessment criteria which are protective of human health, for use in human health risk assessment, where CLEA SGV's and C4SL's are not available the Environment Agency recommends the use of the CLEA 1.071 software in conjunction with advice found on the GOV.UK CLEA web pages. Accordingly, the Chartered Institute of Environmental Health (CIEH) in partnership with Land Quality Management (LQM) derived a set of Generic Assessment Criteria Values following the approach set out in the DEFRA research project SP1010, C4SL. The GAC for missing contaminants of concern were calculated using the CLEA 1.06 software released in July 2009 and termed Suitable 4 Use Levels (S4UL's). The input parameters used for calculating each S4UL value are listed in the substance specific chapters of the reference document associated with the S4UL's, namely 'The LQM/CIEH S4ULs for Human Health Risk Assessment (Land Quality Press, 2015).

The current view of the Environment Agency is that the C4SL's are considered to be a trigger value at which an exceedance may cause concern for human health and generally requiring further investigation and/or assessment. This report has utilised the C4SL's and CIEH/LQM S4UL's derived using the UK technical documents referenced in this report.

The DEFRA C4SL and LQM/CIEH S4UL's for a residential with home grown produce land use has been selected to assess the proposed residential land use within the site.

8.3 Vegetation Assessment

As the CLEA methodology only takes account of the risks to human health, a different approach is required to determine the risks to vegetation. In order to determine if levels of phyto-toxic contaminants in soil, not normally considered to be harmful to humans, are suitable to maintain growth of vegetation the published reference values produced by the Ministry of Agriculture, Fisheries and Food (MAFF) have been used in the following assessment.

8.4 Controlled Waters Assessment

A preliminary Controlled Waters risk assessment will be carried out via a comparison of soil test results and any potential remediation.

8.5 Gas Risk Assessment for Structures

Although the risks from landfill gas are as likely to affect human health, they are considered in this section as they will contribute to the design of any structures on site. The assessment of gas risk will be carried out using the NHBC traffic light methodology which is applicable to low rise housing with suspended floor design.

8.6 Statistical Analysis and Site Zoning

Best practice guidance published by CL:AIRE/CIEH for statistical analysis of contaminated soils recommends the use of two statistical tests for normally distributed and skewed data sets. These tests are the one sample t-test as used in the CLR7 statistical guidance document for normally distributed data and a method based on the one-sided Chebychev Theorem for skewed data. The outcome of the appropriate test is then applied to the Null Hypothesis or the Alternative Hypothesis.

Null Hypothesis:

"Is the level of contamination in the natural soils above 1.0m the same as or higher than the level of the screening values. "

Alternative Hypothesis:

"The level of contamination in the natural soils above 1.0m is lower than the screening values."

It should be noted that the guidance document points out that statistical analysis of samples collected using a targeted or judgmental sampling strategy should avoid being used to infer about conditions in un-sampled locations. The sampling strategy for this site investigation has been based on the most appropriate sampling design required to gather geoenvironmental information.

Statistical analysis of the contamination test results was not carried out due to the low levels of contamination recorded within the site area. It should be noted further assessment of localised areas of contaminant elevation should be undertaken at a later date, most especially in areas to be redeveloped or from soils destined for reuse or removal from the site.

9.0 DISCUSSION OF RESULTS

9.1 Human Health Hazards

In order to assess the risks from speciated PAH, the surrogate marker approach was adopted as described within Public Health England, September 2017. Contaminated land information sheet: risk assessment approaches for polycyclic aromatic hydrocarbons (PAHs)*. To confirm this approach is appropriate the LQM, 4th October 2019, PAH profiling Tool (Full Version). Release: 1.3 was used. (See Appendix E for LQM charts).

The comparison of the analytical results with human health assessment criteria shown in Table 1.3 indicate that the made ground topsoil at TP02 and the cohesive made ground at TP04 contain minor elevated concentrations of the benzo(a)pyrene surrogate marker. No further benzo(a)pyrene concentrations were recorded in excess of the assessment criteria.

In addition, no significant exceedances in the concentrations of determinands were found from the leachate suite in the made ground samples taken from WS04 and TP06.

Maximum concentrations of organic matter were 2.9%, and maximum depths of made ground encountered were 0.90m. Superficial deposits with high organic matter content were not encountered during the site investigation.

Table 1.4 Comparison of Soil Test Results with Home Grown Produce End Use

Determinant	Assessment Criteria (mg/kg)		Recorded Concentrations Across The Site (mg/kg)	
	C4SL Screening Levels	S4UL Generic Assessment Criteria	Highest Recorded Value	Location of Exceedances
Metals, semi- metals and non-metals				
Arsenic	37	37	16	-
Cadmium	17	11	0.4	-
Copper	NC	2400	18	-
Chromium Total	NC	910	19	-
Lead	200	NC	100	-
Mercury (elemental)	NC	1.2	<0.3	-
Nickel	NC	130	16	-
Selenium	NC	250	<1	-
Zinc	NC	3700	100	-
pH	NC	NC	8.7	-
PAH (total)	NC	NC	74.5	-
TPH (total)	NC	NC	170	-
Naphthalene	NC	1.5	0.28	-
Benzo(a)pyrene surrogate marker	3.2	-	6.3	TP02, TP04
Others				
SOM (%)	NC	NC	2.9	-
Cyanide (total)	NC	NC	<1	-
Asbestos ID	<0.001% fibres		Not detected	-

NOTES:
(1) C4SL/LQM S4UL 2015 for Residential with home grown produce land use scenario at 1% organic matter content
(2) NC = No criterion.
(3) ND = None Detected

9.2 Vegetation Hazards

The concentrations of the various phytotoxic contaminants encountered in the upper layer of made ground and natural topsoil on the site were recorded at concentrations below the MAFF criteria.

Table 1.5 Soil Test Results Vs Phyto - Toxic Chemical Assessment Criteria

Determinant	MAFF Reference Value (mg/kg)		Recorded Concentrations Across Sampled Area (mg/kg)	
	Maximum Permissible Concentration		Highest Recorded Value	Locations of Exceedances
	pH 5.0-5.5	pH >7		
Metals and semi- metals				
Arsenic	50	NL	16	-
Cadmium	3	NL	0.4	-
Copper	80	200	18	-
Lead	300	NL	100	-
Nickel	50	110	16	-
Selenium	3	NL	<1	-
Zinc	200	300	100	-
NOTES: (1) NL = indicates that no level has been set				

9.3 Ground Gas Assessment

The desk study established a Low Risk for Ground Gasses. No gas monitoring installations were installed as only trial pits were required.

10.0 CONCEPTUAL SITE MODEL

10.1 Introduction

The information within this investigation has been collated and evaluated to develop a refined Conceptual Model for the site.

The site has been assessed in line with current UK guidelines, namely the Contaminated Land (England) Regulations 2000 and Part IIA of the Environmental Protection Act 1990 and follows the procedures set out in the Environmental Agency 'Model Procedures for the Management of Land Contamination – Contamination Land Report (CLR).11'.

CLR.11 provides the technical framework for structured decision making about land contamination and builds on previous work carried out under the Contaminated Land Research Programme of the former Department of the Environment. CLR 11 has adopted and refined the methodology and terminology that has been used in contaminated land risk assessment for a number of years.

CLR.11 defines the three essential elements to any risk:

- A contaminant **source** - a substance that is in, on or under land and has the potential to cause harm or to cause pollution of controlled waters.
- A **receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property or a water body.
- A **pathway** - a route or means by which a receptor can be exposed to, or affected by a contaminant.

Each of these elements can exist independently, but they create a risk only where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of source-pathway-receptor is described as a **pollutant linkage**.

This report presents a Phase 2 Conceptual Model and Quantitative Risk Assessments for the site, based on the proposed conservative end use of residential with home grown produce.

10.2 Hazard Identification

10.2.1 Potential Contamination Sources

The ground investigation confirmed a source of contamination to be localised elevated concentrations of PAH compounds within made ground / topsoil materials in two locations.

No potential on-site sources of ground gas were encountered.

A summary of potentially significant sources of contamination identified during this study are presented in Table 1.6.

Table 1.6 Summary of Contaminant Sources & Contaminants

Structure / Process	Contaminants Present on Site
On-site	
Made Ground at TP02, TP04 (**S1**)	PAH

10.2.2 Potential Receptors

The following are considered as potential receptors in relation to the current and proposed use of the site.

- **Future Residential users** – Female child aged 0-6 years using gardens & landscaped areas;
- **Utility / Construction / Demolition / Site Investigation workers** – Workers undertaking routine / non-routine work involving ground disturbance works and maintenance of below ground services (assuming workers are only wearing standard construction / utility worker PPE);
- **Underlying Unproductive Strata** – Tidal Deposits, Oxford Clay Formations;
- **Surface Water** – River Glen 27m south of site;
- **New potable water supply pipes** – Ingress of PAH into drinking water;
- **Structures** – Ingress of ground gas.

10.2.3 Potential Contamination Pathways

The following are considered plausible contamination pathways given the nature of the site and the potential contaminative sources identified, and assuming a residential end use with gardens.

- Dermal contact and ingestions of soils;
- Inhalation of dust/fibres and vapours;
- Ingestion of home grown produce;
- Migration of leachable contaminants;
- Risk from ground gases, asphyxiation;
- Ingress of PAH into drinking water supply.

10.2.4 Quantitative Risk Assessment

By considering the sources, pathways and receptors, an assessment of the environmental risks is made with reference to the significance and degree of the risk. This assessment is based on consideration of whether the source contamination can reach a receptor and hence whether it is of major or minor significance.

An initial conceptual model of the source-pathway-receptor linkages has been developed based on the information derived from the CGA desk study and this study. The Conceptual Site Model has been used to identify Relevant Pollutant Linkages for the current and proposed end uses which have been assessed quantitatively and qualitatively using CIRIA 552 guidance, as described below in Table 1.6 and Table 1.7.

Table 1.7 Methodology for Assessing Consequence of Harm

Consequence	Criteria
Severe	Short term (acute) risk to Human Health likely to result in "significant harm" as defined by the Environmental Protection Act 1990, Part IIa. Short term risk of pollution of sensitive water resource. Catastrophic damage to buildings / property
Moderate	Chronic damage to Human Health likely, over a long term, to result in "significant harm" as defined by the Environmental Protection Act 1990, Part IIa. Pollution of sensitive water resources
Mild	Health effects to Human Health that are unlikely to result in "significant harm" as defined by the Environmental Protection Act 1990, Part IIa. Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings / structures / services or the environment
Negligible	Non-permanent health effects to Human Health that are unlikely to result in "significant harm" as defined by the Environmental Protection Act 1990, Part IIa. Those that are easily prevented by means such as personal protective clothing. Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve

Table 1.8 Methodology for Assessing Likelihood of Consequence Occurring

Probability	Criteria
Almost Certain	Circumstances are such that an event either appears very likely in the short term and almost inevitable over the long term or there is evidence of currently harm occurring
Likely	Circumstances are such that an event, whilst not inevitable, is possible in the short term and is likely to occur over the long term
Unlikely	Circumstances are such that it is possible an event could occur but it is by no means certain to occur even over a longer period, and it is less likely in the shorter term
Very Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable even in the medium to long term
Extremely Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are highly improbable even in the long term

The risk assessment table and apportioned scores presented in Table 1.8 are in general accordance with CIRIA 552. The main exception is that irreversible risks to human health are considered to have a severe consequence irrespective of whether the effects are chronic or acute in nature. The risks are scored from 0 to 48 with increasing significance with increasing scores.

Table 1.9 Summary of Risk Scoring

Consequence / Probability	Severe (4)	Moderate (3)	Mild (2)	Negligible (1)
Almost Certain (12)	Very High Risk (48)	High Risk (36)	Moderate Risk (24)	Low Risk (12)
Likely (9)	High Risk (36)	Moderate Risk (27)	Moderate/ Low Risk (18)	Low Risk (9)
Unlikely (6)	Moderate Risk (24)	Moderate/ Low Risk (18)	Low Risk (12)	Very Low Risk (6)
Very Unlikely (3)	Low Risk (12)	Low Risk (9)	Very Low Risk (6)	Very Low Risk (3)
Extremely Unlikely (0)	Very Low Risk (0)	Very Low Risk (0)	Very Low Risk (0)	Very Low Risk (0)

The categories of risk are defined as follows:

Very High Risk: There is a probability that severe harm is almost certain to arise to a designated receptor from an identified source, or there is evidence that severe harm to a designated receptor is currently occurring.

High Risk: There is a probability that severe harm is likely to arise to a designated receptor from an identified source, or there is a probability that moderate harm is almost certain to arise.

Low Risk: There is a possibility that harm could arise to a designated receptor from an identified source, but it is likely that this harm, if realised, would be mild at worst.

Very Low Risk: There is a very low possibility that harm could arise to the receptor, but it is likely that this harm, if realised, would be mild at worst.

In accordance with CLR11, professional judgement has been employed to evaluate the risk on a qualitative basis using available information.

A summary of the pollution linkages are provided in Table 2.0.

Table 2.0 Phase 2 Conceptual Site Model

Area / Structure	Pollutants (Chemicals of Concern)	Critical Receptor	Pathway	Potential Consequence of Complete S-P-R Linkage	Potential Likelihood of Complete S-P-R Linkage	Risk Score and Equivalent CIRIA Risk Classification	Remedial Option(s) / Next steps	Comments
Made Ground (**S1**)	PAH	Future child site user	Direct contact / Dust inhalation Penetration of pipes	Moderate	Unlikely	Moderate/ Low Risk (18)	Remediation Required	Minor elevations of PAH in topsoil and made ground in two areas of proposed gardens.
		Current site users		Mild	Unlikely	Low Risk (12)	No Further Assessment Required	The site is an unsecured agricultural field with no public thoroughfare.
		Ground disturbance workers		Mild	Unlikely	Low Risk (12)	No Further Assessment Required	Potential for ground workers to be exposed to contaminated soil. Appropriate use of PPE would mitigate this risk.
		New Potable water supply pipes		Mild	Unlikely	Low Risk (12)	No Further Assessment required	Concentrations of contaminants are low, and not present in the probable route of potable water pipes.
		Unproductive strata	Leaching / dissolution from contaminated soil followed by migration	Negligible	Unlikely	Very Low Risk (3)	No Further Assessment Required	Migration of contaminants to aquifers very unlikely due to cohesive superficial strata and solid geology.
		Surface water (27m south)	Leaching / dissolution from contaminated soil followed by migration	Mild	Unlikely	Low Risk (12)	No Further Assessment Required	Onsite contaminants unlikely to migrate beyond the site boundary without significant dilution.
	Methane & Carbon Dioxide	Dwelling	Ingress of ground gases and vapours into structures	Mild	Very Unlikely	Very Low Risk (3)	No Further Assessment Required	No evidence of peat with minimal made ground records.

10.3 Discussion of Risks

The risk assessment presented in the above sections and summarised within the CSM presented Table 1.9 above has shown that theoretical Contaminant Linkages were identified to be present at the site. The following sections provide a discussion of the environmental risks based on the ground investigation and laboratory data as well as the desk study information.

10.3.1 Human Health

Proposed Residential Site Users

The laboratory testing shows that the made ground soils in two locations on the site contain concentrations of PAH contamination which exceed the screening criteria for residential gardens.

These soils will need to be removed from the proposed garden areas, as there is a **MODERATE to LOW** level of risk from the made ground soils to the proposed site users.

Utility / Construction / Demolition / Site Investigation (i.e. Ground Disturbance) Workers

The probability of contact with contaminated soils increases for workers involved with ground excavation (e.g. during development, site investigation or maintenance works) with the risk is estimated to be **LOW**. However, assuming that appropriate PPE will be worn and site hygiene rules applied the risks to site operatives within the western half of the site is reduced to **VERY LOW**.

10.3.2 Controlled Waters

The strata beneath the site are known to be unproductive, and because of the comparatively low concentrations of contaminants, of which only a small fraction have been shown to be leachable, it is highly unlikely that controlled waters will be impacted. Therefore, the risk to underlying aquifer and nearby surface water features has been assess to be **LOW**. Removal of these soils during redevelopment of the site will serve to mitigate this risk further**.**

10.3.3 Potable Water Supply Pipes

Low concentrations of PAH were recorded on the site close to the rear garden areas. Although it is not expected that potable water pipes will be lain in this area, there is an estimated **LOW** risk to new potable

water pipes. Excavation and removal of contaminated made ground from the site will reduce the risk further. As with any site where contamination has been found to be present, we would recommend early consultation with the statutory water supplier in order to ascertain their requirements prior to the instalments of any new pipes.

10.3.4 Ground Gas Risks

No viable source of ground gas was recorded during this investigation with minimal made ground and no evidence of peat deposits seen. Therefore, a **VERY LOW** level of risk from potential ground gas has been estimated.

11.0 WASTE CLASSIFICATION

It is recommended that the contaminated made ground be segregated and tested prior to disposal. Should any material require disposing off site a Waste Acceptance Criteria (WAC) test is likely to be required by the receiving landfill site prior to accepting the waste. We would recommend the laboratory testing results be forward to the receiving landfill for confirmation of this assessment.

In general the majority of made ground, possible natural reworked soils and underlying natural soils within the site can be classified as Stable Non-reactive, Non-Hazardous soils which following a Waste Acceptance Criteria (WAC) test may be suitable for disposal at an inert landfill site.

The current laboratory testing indicates the following waste code can be applied to made ground;

17 05 04 soil and stones other than those mentioned in 17 05 03 (containing hazardous substances)

12.0 CONCLUSIONS AND RECOMMENDATIONS

The site investigation found made ground topsoil, with some areas of cohesive made ground overlaying low strength sandy silt with clay.

In two locations the made ground was found to have concentrations of PAH in excess of the screening value for private residential gardens, with a **MODERATE to LOW** risk to future site users and a **LOW** risk applicable to controlled waters, potable water supplies, ground workers and site users. Remediation of the site soils

by supervised excavation followed by validation sampling is recommended and should be documented with a remediation statement.

The sandy silt associated with tidal deposits on the site are variable and have been shown to contain clay making them highly vulnerable to settlement. The potential for running sand and or shallow deposits of peat should also be discounted at the site. It is recommended that further site investigation is carried out and this should be to depts. not less than 12m below proposed site levels. It is recommended to undertake either Cable Percussive boreholes with associated Standard Penetration Testing (SPT) or Cone Penetration testing (CPT) tests at the site, with associated sampling and testing of the recovered soils All foundation options should be designed by an appropriately qualified structural engineer.

The ground conditions on site may be unstable with the use of shoring potentially being required for shallow depths, and it is recommended that an appropriate risk assessment be carried out prior to any entry into excavations.

12.1 Watching Brief

In addition to recommending further investigation, any unforeseen contamination should be reported in writing immediately to the LPA. An investigation and risk assessment should then be undertaken and where remediation is necessary a remediation scheme should be submitted to and approved in writing by the LPA.

Should unidentified areas of contaminated soils be encountered during the remediation works the soils should be left in situ and examined by a suitably qualified geo-environmental engineer.

12.2 Protocol for the Importation of Topsoil

All imported soils should meet the specification for topsoil as set out in BS: 3882:2007 and be accompanied by the appropriate testing certificates to demonstrate compliance. The frequency and laboratory testing requirements for imported subsoil/topsoil are dependent on the type and location of the soil's importation. A general guide to testing requirements is give below for information only.

Sampling Frequency:

a. Greenfield/manufactured soils: Minimum of 3 No. or 1 No. standard suite of contamination testing per 250m^3 of topsoil/subsoil imported whichever is the greater or;

b. Brownfield soils: Minimum of 6 No. or 1 No. standard suite of contamination testing per 100m^3 whichever is the greater.

Laboratory Suites of Testing:

a. Virgin Quarried Material to include standard metals and metalloids.

b. Greenfield & Brownfield Screened Soils to include standard metals & metalloids, PAH (EPA 16), TPHCWG, Asbestos (ID and or Quantification), pH and SOM.

Note: Importation of all materials to be used within the construction of the cover system are required to be tested to confirm the levels of contaminants. Should materials not listed in this report be imported consultation with CGA is recommended.

13.0 REFERENCES

- BRE Special Digest 1:2005, Concrete in Aggressive Ground
- BS 5930: (2015)+A1: 2020: Code of Practice for Site Investigation. British Standards Institution
- BS 10175(2011)+A2: 2017: Code of Practice for the Investigation of Potentially Contaminated Sites. British Standards Institution
- BS 8485: (2015)+A1: 2019; Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings
- CIRIA (1995) The Standard Penetration Test (SPT): Methods and Use. CIRIA Report 143. C.R.I Clayton.
- CL:AIRE (2013) SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination
- DEFRA and Environment Agency (2004) Model Procedures for the Management of Land Contamination, R&D Publication CLR11.
- Environment Agency (2009) CLEA Software (Version 1.06) Handbook, Scientific Report SC050021/SR4
- Environment Agency (2009) Updated technical background to the CLEA Model, Scientific Report SC050021/SR3
- Environment Agency (2000) Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, R&D Technical Report P5-066/TR.
- Ministry of Agriculture, Fisheries and Food (1998) Code of Good agricultural Practice for the Protection of Soil. MAFF Publications, London
- Nathanail, C.P., McCafferey. C., Gillett, A., Ogden, R.C., and Nathanail, J.F. (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.
- NHBC March 2007, Guidance on Evaluation of development Proposals on Sites Where Methane and Carbon Dioxide are Present. Report Edition No.:04.
- Peck, R. B., Hanson, W.E. and Thornburn, T.H. (1953). Foundation Engineering. John Wiley. New York.
- NHBC Standards 2019
- Eurocode 7 Geotechnical Design Part 2: Ground Investigation and Testing BSEN1997-2:2007

Appendices

Figures and Drawings

Appendix A – Site Location Plan

Site Location Plan

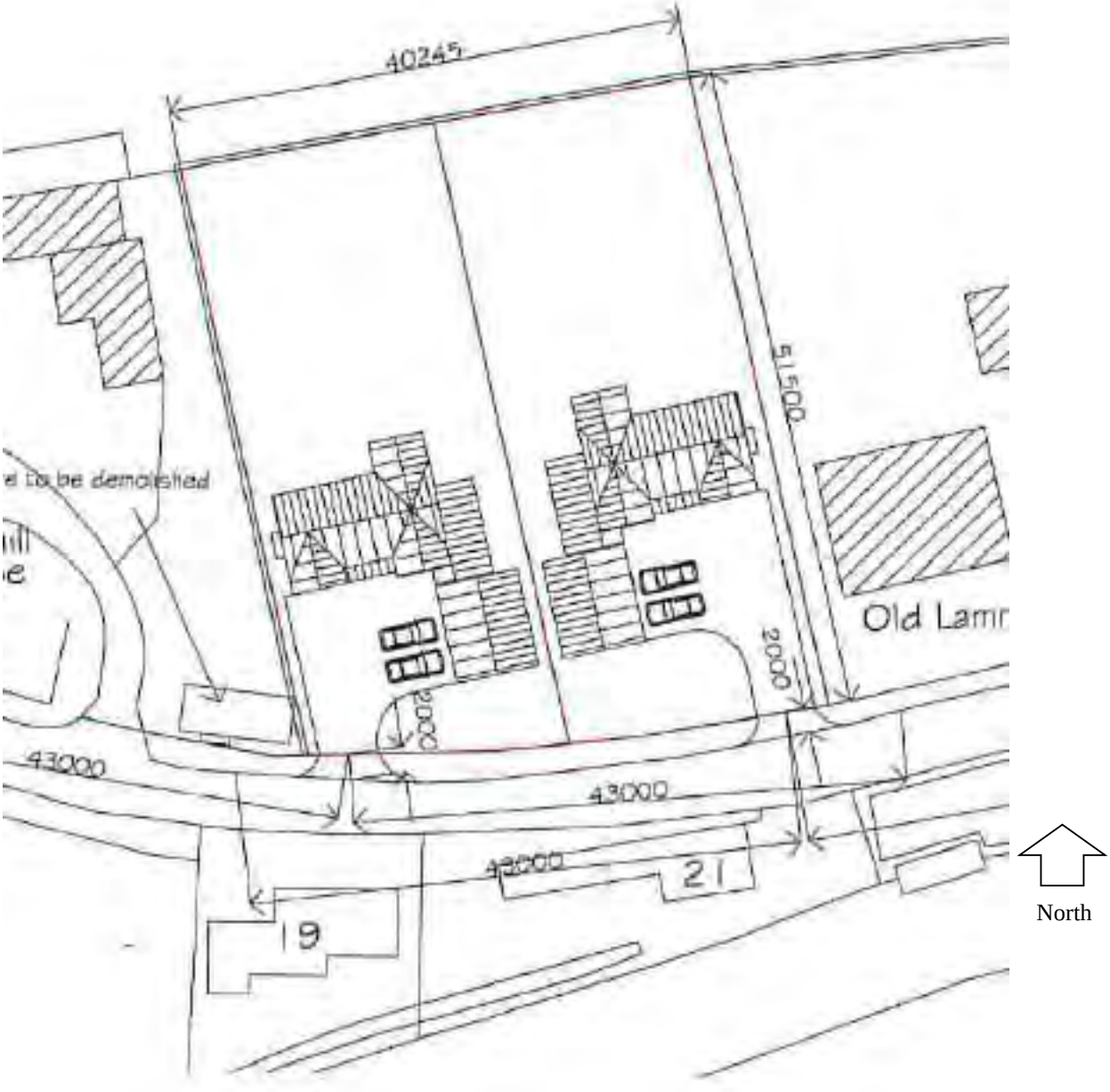
Drawing:C0362-01

Chevin Geoenviro Associates LTD **Tel: 01943 470363** **E-mail info@chevin-ltd.co.uk** **Geo-environmental Consultancy** **Ground Technologies & Investigation & Remediation**	**Project : Reservoir Road, Surfleet, Spalding** **Client. Mr. T. Forman** **Project No.** C0362 — **Date** 13/12/2019

Appendix A – Proposed Site Layout

Proposed Site Layout

Drawing:C0362-02



Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project : Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362

Date 13/12/2019

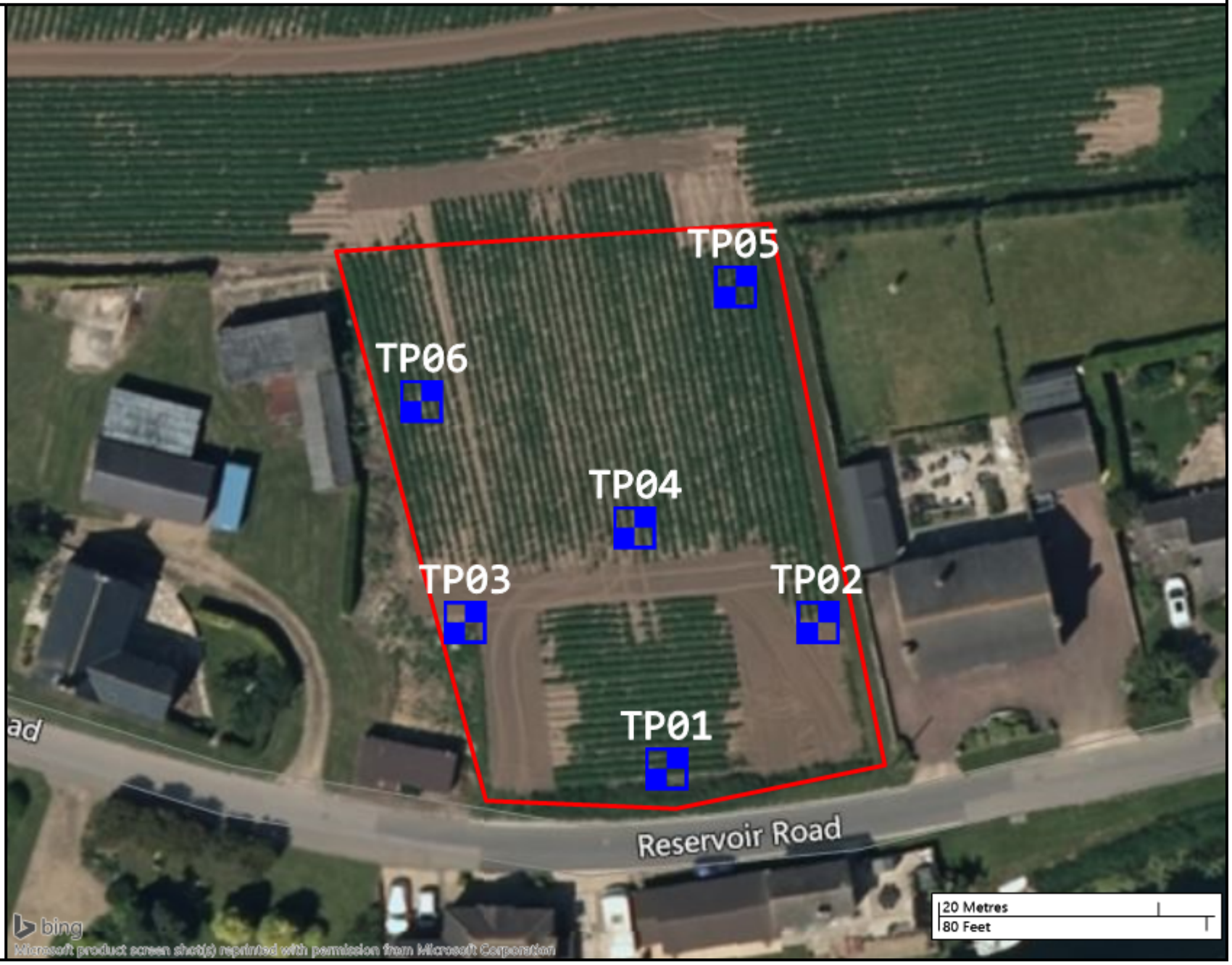
Appendix A – Exploratory Hole Location Plan & Photos

Project Id:	C0362	Title:	As Dug Ground Investigation Plan
Project Title:	Flaxmill House	Scale:	1:500
Location:	Surfleet, Spalding	Engineer:	
Client:	Tim Forman	Contractor:	

Chevin Geoenviro Associates LTD

Legend Key

- Locations By Type - TP
- Project Bounds - Project Bounds



Photograph No.1: TP01

Photograph No.2: TP01

Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project: Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362	**Date: 09/11/2020**

Photograph No.3: TP02

Photograph No.4: TP02

Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project: Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362

Date: 09/11/2020

Photograph No.5: TP03

Photograph No.6: TP03

Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project: Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362

Date: 09/11/2020

Photograph No.5: TP04

Photograph No.6: TP04

Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project: Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362

Date: 09/11/2020

Photograph No.5: TP05 (concrete footing near bottom of photograph)

Photograph No.6: TP05

Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project: Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362

Date: 09/11/2020

Photograph No.5: TP06

Photograph No.6: TP06

Chevin Geoenviro Associates LTD

Tel: 01943 470363

E-mail info@chevin-ltd.co.uk

Geo-environmental Consultancy
Ground Technologies & Investigation & Remediation

Project: Reservoir Road, Surfleet, Spalding

Client. Mr. T. Forman

Project No. C0362

Date: 09/11/2020

Appendix B – Engineering Logs

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP01**

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527301 - 329010 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 2.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES		0.30			MADE GROUND: Brown sightly gravelly silty topsoil. Angular to rounded gravel sized fragments of mixed lithologies.
	1.10	D					Soft pale brown slightly clayey sandy SILT. Sand is fine.

1

2

Continued on next sheet

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable.

AGS

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP01**

Sheet 2 of 2

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527301 - 329010 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 2.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				2.10			Soft pale brown slightly clayey sandy SILT. Sand is fine. Gravel sized pockets of black silt.
				2.50			End of pit at 2.50 m

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable.

AGS

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP02**

Sheet 1 of 1

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527315 - 329024 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 1.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES					MADE GROUND: Brown sightly gravelly silty topsoil. Angular to rounded gravel sized fragments of mixed lithologies.
				0.30			Soft pale brown slightly clayey sandy SILT. Sand is fine.
				1.50			End of pit at 1.50 m

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable

AGS

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP03**

Sheet 1 of 1

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527283 - 329023 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 1.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES					MADE GROUND: Brown sightly gravelly silty topsoil. Angular to rounded gravel sized fragments of mixed lithologies.
				0.30			Soft pale brown slightly clayey sandy SILT. Sand is fine.
	0.70 - 0.90	D					
				1.50			End of pit at 1.50 m

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable

AGS

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP04**

Sheet 1 of 1

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527298 - 329032 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 1.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES		0.30			MADE GROUND: Brown sightly gravelly silty topsoil. Angular to rounded gravel sized fragments of mixed lithologies, brick and ceramic.
	0.50	ES		0.60			MADE GROUND: Brown speckled yellow grey slightly sandy gravelly silt. Angular to rounded gravel sized fragments of mixed lithologies, brick, coal and tar covered aggregate. Angular cobble sized fragments of concrete.
	0.90 - 1.10	D		1.50			Soft pale brown slightly clayey sandy SILT. Sand is fine.
							End of pit at 1.50 m

1

2

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable

AGS

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP05**

Sheet 1 of 1

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527306 - 329054 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 1.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	
							MADE GROUND: Brown sightly gravelly silty topsoil. Angular to rounded gravel sized fragments of mixed lithologies.	
				0.40			MADE GROUND: Brown and red-brown slightly gravelly sandy silt. Angular gravel sized fragments of ceramic, coal, brick and burnt wood.	
	0.60	ES						
				0.90			Soft pale brown slightly clayey sandy SILT. Sand is fine.	
	1.00 - 1.30	B						1
				1.50			End of pit at 1.50 m	
								2

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable

AGS

Chevin Geoenviro Associates LTD

Trial Pit Log

Trialpit No **TP06**

Sheet 1 of 1

Project Name: Flaxmill House	Project No. C0362	Co-ords: 527278 - 329043 Level:	Date 06/10/2020
Location: Surfleet, Spalding		Dimensions (m): 4 × 1 Depth 1.50	Scale 1:10
Client: Tim Forman			Logged TR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	ES					MADE GROUND: Brown sightly gravelly silty topsoil. Angular to rounded gravel sized fragments of mixed lithologies and brick.
				0.40			Light brown slightly silty gravelly SAND. Angular gravel sized fragments of brick and mixed lithologies.
	0.60	ES					
				0.70			Soft pale brown slightly clayey sandy SILT. Sand is fine. *Concrete footing found in northern side of pit.*
				1.50			End of pit at 1.50 m

Remarks: No groundwater entries.
Pit sides unstable.
Backfilled with arisings on completion.

Stability: Pit sides unstable

AGS

Appendix C – Contamination Laboratory Test Results

Tom R-Rouse
Chevin Geoenviro Associates LLD
Tarn House
77 High Street
Yeadon
LS19 7SP

t: 01943470363

e: Chevin

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 20-34536

Project / Site name:	Flaxmill House	**Samples received on:**	08/10/2020
Your job number:	C0362	**Samples instructed on/ Analysis started on:**	08/10/2020
Your order number:		**Analysis completed by:**	16/10/2020
Report Issue Number:	1	**Report issued on:**	16/10/2020
Samples Analysed:	3 leachate samples - 7 soil samples		

Signed: Karolina Marek

Karolina Marek
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 20-34536
Project / Site name: Flaxmill House

Lab Sample Number				1645551	1645552
Sample Reference				TP04	TP06
Sample Number				None Supplied	None Supplied
Depth (m)				0.50	0.60
Date Sampled				06/10/2020	06/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
General Inorganics					
pH	pH Units	N/A	ISO 17025	7.8	7.5
Sulphate as SO4	mg/l	0.1	ISO 17025	3.9	4
Total Phenols					
Total Phenols (monohydric)	µg/l	1	ISO 17025	< 1.0	< 1.0
Speciated PAHs					
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01	< 0.01
Total PAH					
Total EPA-16 PAHs	µg/l	0.2	NONE	< 0.2	< 0.2
Heavy Metals / Metalloids					
Arsenic (dissolved)	µg/l	1.1	ISO 17025	8.4	1.8
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08	< 0.08
Chromium (dissolved)	µg/l	0.4	ISO 17025	2.9	< 0.4
Copper (dissolved)	µg/l	0.7	ISO 17025	5.2	6.2
Lead (dissolved)	µg/l	1	ISO 17025	5.1	3.4
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5	< 0.5
Nickel (dissolved)	µg/l	0.3	ISO 17025	1.4	3
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0	< 4.0
Zinc (dissolved)	µg/l	0.4	ISO 17025	32	18
Monoaromatics & Oxygenates					
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	10	NONE	< 10	< 10

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-34536
Project / Site name: Flaxmill House

Lab Sample Number				1645551	1645552
Sample Reference				TP04	TP06
Sample Number				None Supplied	None Supplied
Depth (m)				0.50	0.60
Date Sampled				06/10/2020	06/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Petroleum Hydrocarbons					
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10

U/S = Unsuitable Sample I/S = Insufficient Sample

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-34536
Project / Site name: Flaxmill House

Lab Sample Number				1644707	1644708	1644709	1644710
Sample Reference				TP01	TP02	TP04	TP05
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.20	0.50	0.60
Date Sampled				07/10/2020	07/10/2020	07/10/2020	07/10/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	15	16	13	17
Total mass of sample received	kg	0.001	NONE	1.6	1.6	1.6	1.6

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	8.5	8.5	8.5
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1
Organic Matter	%	0.1	MCERTS	2.7	2.9	2.8	2.8

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	0.28	< 0.05	0.24	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	0.83	0.42	0.71	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	0.88	0.44	0.5	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	5.4	4.6	7.9	0.34
Anthracene	mg/kg	0.05	MCERTS	2.3	1.5	2.2	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	6.7	7.9	15	0.74
Pyrene	mg/kg	0.05	MCERTS	5.2	6.2	11	0.61
Benzo(a)anthracene	mg/kg	0.05	MCERTS	3.7	5	8.2	0.51
Chrysene	mg/kg	0.05	MCERTS	2.6	2.8	5.4	0.35
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	3	3.7	7.5	0.43
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	1.8	2.3	3.1	0.22
Benzo(a)pyrene	mg/kg	0.05	MCERTS	2.7	3.4	6.3	0.36
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.2	1.6	2.9	0.21
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.25	0.57	0.91	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.2	1.6	2.9	0.26

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	37.9	42.2	74.5	4.03

Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	12	12	16	15
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	0.4	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	19	18	17	17
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	14	16	17
Lead (aqua regia extractable)	mg/kg	1	MCERTS	51	49	72	59
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	15	16	15	14
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	80	85	95	100

Petroleum Hydrocarbons

TPH C10 - C40	mg/kg	10	MCERTS	170	160	110	44

U/S = Unsuitable Sample I/S = Insufficient Sample

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-34536
Project / Site name: Flaxmill House

Lab Sample Number				1644711	1644712
Sample Reference				TP06	TP06
Sample Number				None Supplied	None Supplied
Depth (m)				0.30	0.60
Date Sampled				07/10/2020	07/10/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	13	16
Total mass of sample received	kg	0.001	NONE	1.6	1.6

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.1	8.7
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1
Organic Matter	%	0.1	MCERTS	2.4	1

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.43	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.87	< 0.05
Pyrene	mg/kg	0.05	MCERTS	0.72	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.43	< 0.05
Chrysene	mg/kg	0.05	MCERTS	0.45	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.53	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.22	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.42	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.24	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.24	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	4.55	< 0.80

Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	15	9.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	19	15
Copper (aqua regia extractable)	mg/kg	1	MCERTS	15	7
Lead (aqua regia extractable)	mg/kg	1	MCERTS	100	85
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	16	13
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	78	64

Petroleum Hydrocarbons

TPH C10 - C40	mg/kg	10	MCERTS	66	130

U/S = Unsuitable Sample I/S = Insufficient Sample

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number : 20-34536
Project / Site name: Flaxmill House

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1644707	TP01	None Supplied	0.2	Brown loam and clay with vegetation and gravel
1644708	TP02	None Supplied	0.2	Brown loam and clay with vegetation and gravel
1644709	TP04	None Supplied	0.5	Brown loam and clay with rubble and vegetation.
1644710	TP05	None Supplied	0.6	Brown loam and clay with vegetation and gravel
1644711	TP06	None Supplied	0.3	Brown loam and clay with vegetation and gravel
1644712	TP06	None Supplied	0.6	Light brown clay nd sand with vegetation and gravel.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 20-34536
Project / Site name: Flaxmill House

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Monohydric phenols in leachate - LOW LEVEL 1 ug/l	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In house method.	L005-PL	W	ISO 17025
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TPHCWG (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 20-34536
Project / Site name: Flaxmill House

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Appendix D – Geotechnical Laboratory Results

Tom R-Rouse
Chevin Geoenviro Associates LLD
Tarn House
77 High Street
Yeadon
LS19 7SP

t: 01943470363

e: Chevin

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 20-34493

Project / Site name:	Flaxmill House	**Samples received on:**	08/10/2020
Your job number:	C0362	**Samples instructed on/ Analysis started on:**	08/10/2020
Your order number:		**Analysis completed by:**	16/10/2020
Report Issue Number:	1	**Report issued on:**	16/10/2020
Samples Analysed:	1 soil sample		

Signed: A. Czerwińska

Agnieszka Czerwińska
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 20-34493
Project / Site name: Flaxmill House

Lab Sample Number				1644385
Sample Reference				TP04
Sample Number				None Supplied
Depth (m)				0.90-1.10
Date Sampled				06/10/2020
Time Taken				None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**	
Stone Content	%	0.1	NONE	< 0.1
Moisture Content	%	N/A	NONE	17
Total mass of sample received	kg	0.001	NONE	0.5

General Inorganics

pH - Manual	pH Units	N/A	MCERTS	8.8
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	59
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.029
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	29.4

U/S = Unsuitable Sample I/S = Insufficient Sample

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number : 20-34493
Project / Site name: Flaxmill House

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1644385	TP04	None Supplied	0.90-1.10	Light brown sandy clay with vegetation.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 20-34493
Project / Site name: Flaxmill House

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
pH at 20oC in soil	Determination of pH in soil by addition of water followed by electrometric measurement.	In house method.	L005-PL	W	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.4 and 5

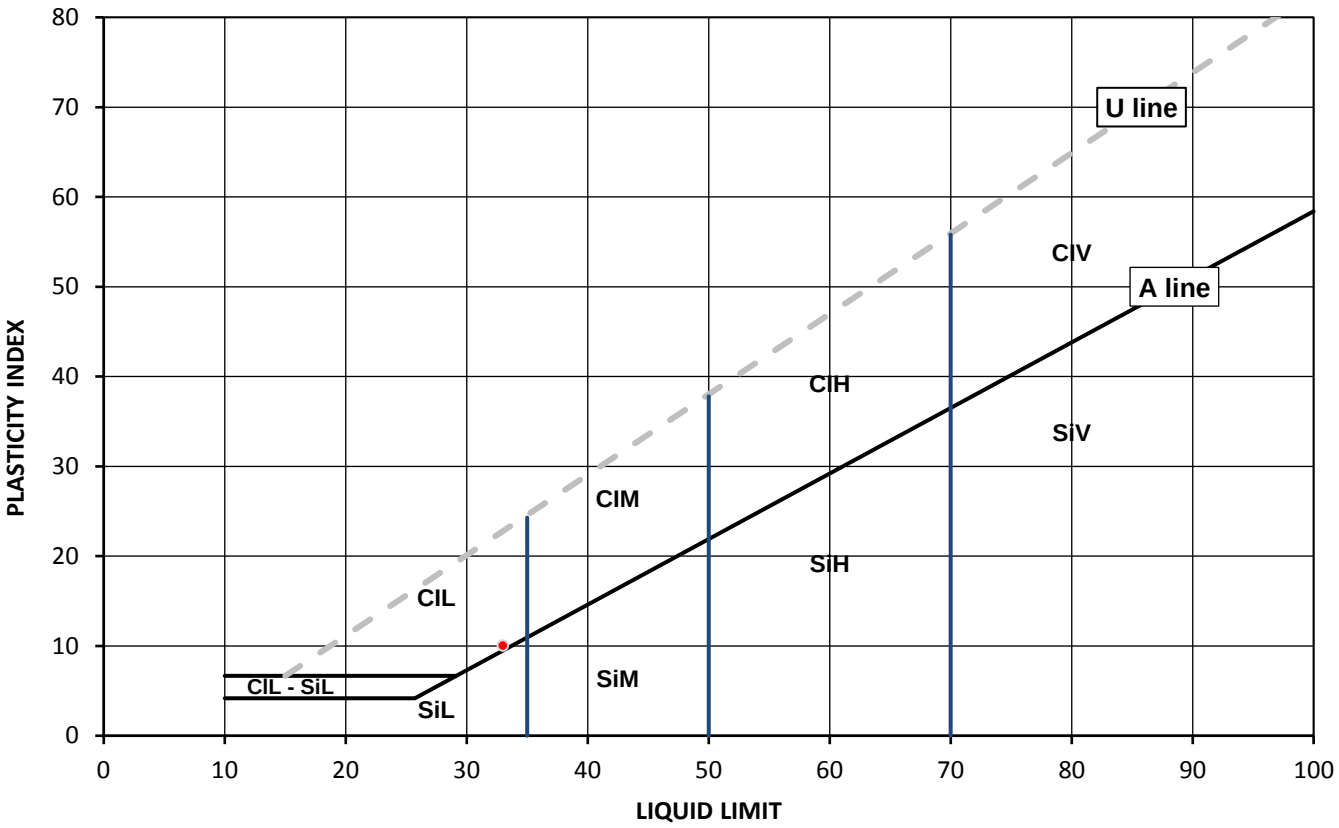
Client:	Chevin Geoenviro Associates LLD	Client Reference:	C0362
Client Address:	Tarn House, 77 High Street, Yeadon, LS19 7SP	Job Number:	20-34489
		Date Sampled:	06/10/2020
		Date Received:	08/10/2020
Contact:	Tom R-Rouse	Date Tested:	13/10/2020
Site Address:	Flaxmill House	Sampled By:	Client - TR

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	1644369	Depth Top [m]:	1.10
Hole No.:	TP01	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Brown sandy silty CLAY		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
29	33	23	10	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.

Signed:

Aleksandra Jurochnik
PL Technical Reviewer
for and on behalf of i2 Analytical Ltd

Date Reported: 20/10/2020

GF 232.10

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.4 and 5

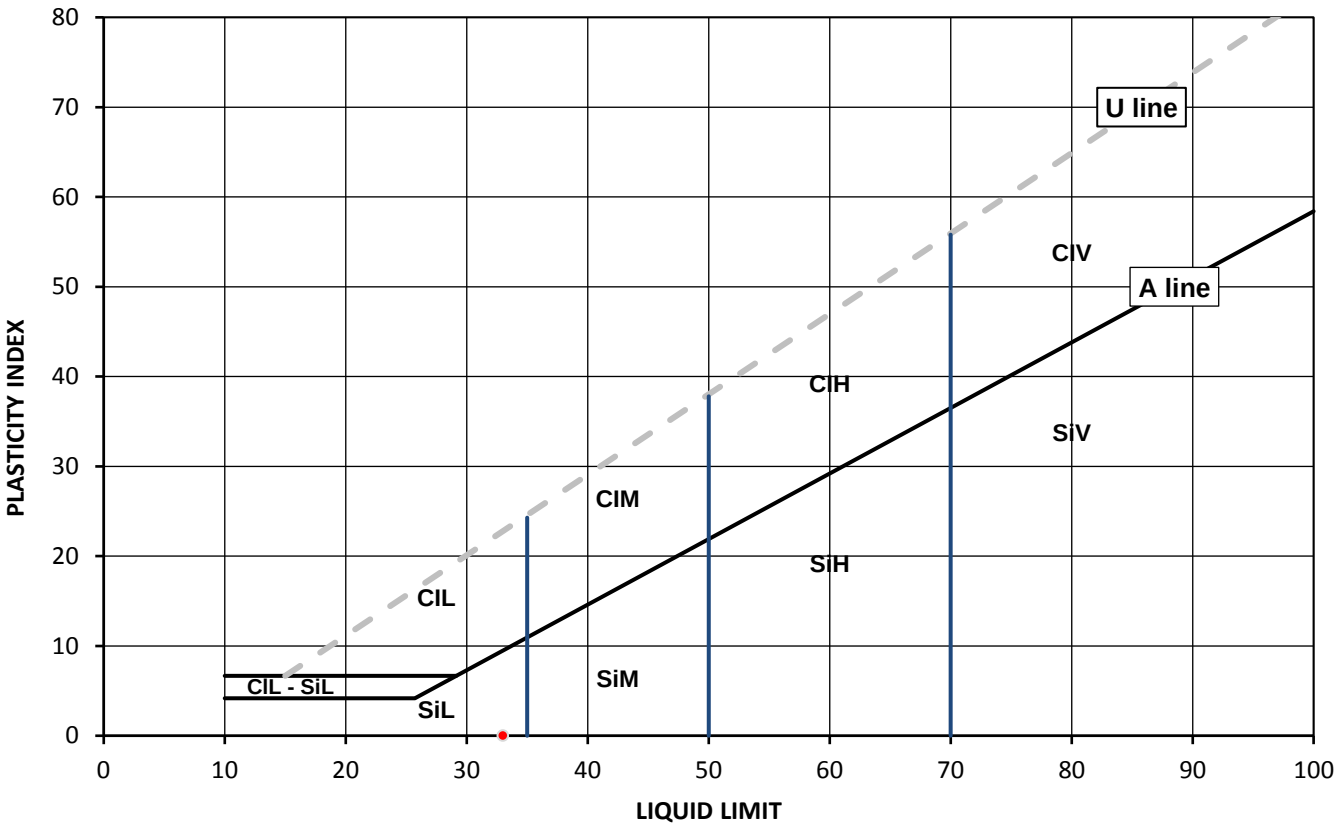
Client:	Chevin Geoenviro Associates LLD	Client Reference:	C0362
Client Address:	Tarn House, 77 High Street, Yeadon, LS19 7SP	Job Number:	20-34489
		Date Sampled:	06/10/2020
		Date Received:	08/10/2020
Contact:	Tom R-Rouse	Date Tested:	13/10/2020
Site Address:	Flaxmill House	Sampled By:	Client - TR

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	1644371	Depth Top [m]:	0.90
Hole No.:	TP04	Depth Base [m]:	1.10
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Brown slightly clayey SILT		
Sample Preparation:	Tested in natural condition		

As Received Moisture Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
23	33	NP	NP	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks: NP - non plastic

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.

Signed:

Aleksandra Jurochnik
PL Technical Reviewer
for and on behalf of i2 Analytical Ltd

Date Reported: 20/10/2020

GF 232.10

SUMMARY REPORT

Summary of Classification Test Results

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

Environmental Science

4041

Tested in Accordance with:

Moisture Content by BS 1377-2: 1990: Clause 3.2; Water Content by BS EN 17892-1: 2014; Atterberg by BS 1377-2: 1990: Clause 4.3 (4 Point Test), Clause 4.4 (1 Point Test) and 5; PD by BS 1377-2: 1990: Clause 8.2

Client: Chevin Geoenviro Associates LLD

Client Address: Tarn House, 77 High Street, Yeadon, LS19 7SP

Contact: Tom R-Rouse

Site Address: Flaxmill House

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Client Reference: C0362
Job Number: 20-34489
Date Sampled: 06/10/2020
Date Received: 08/10/2020
Date Tested: 13/10/2020
Sampled By: Client - TR

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	Moisture Content [W]	Water Content [W]	Atterberg				Density			Total Porosity#		
		Reference	Depth Top	Depth Base	Type					% Passing 425um	WL	Wp	Ip	bulk	dry	PD			
			m	m				%	%	%	%	%	%	Mg/m3	Mg/m3	Mg/m3	%		
1644369	TP01	Not Given	1.10	Not Given	D	Brown sandy silty CLAY	Atterberg 1 Point	29		100	33	23	10						
1644371	TP04	Not Given	0.90	1.10	D	Brown slightly clayey SILT	Atterberg 1 Point	23		100	33	NP	NP						

Note: # Non accredited; NP - Non plastic

Comments:

Signed:

Aleksandra Jurochnik
PL Technical Reviewer
for and on behalf of i2 Analytical Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.

Date Reported: 20/10/2020

GF 234.12

TEST CERTIFICATE

Determination of California Bearing Ratio

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Tested in Accordance with: BS 1377-4: 1990: Clause 7

Client:	Chevin Geoenviro Associates LLD	Client Reference:	C0362
Client Address:	Tarn House, 77 High Street, Yeadon, LS19 7SP	Job Number:	20-34489
		Date Sampled:	06/10/2020
		Date Received:	08/10/2020
Contact:	Tom R-Rouse	Date Tested:	19/10/2020
Site Address:	Flaxmill House	Sampled By:	Client - TR

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

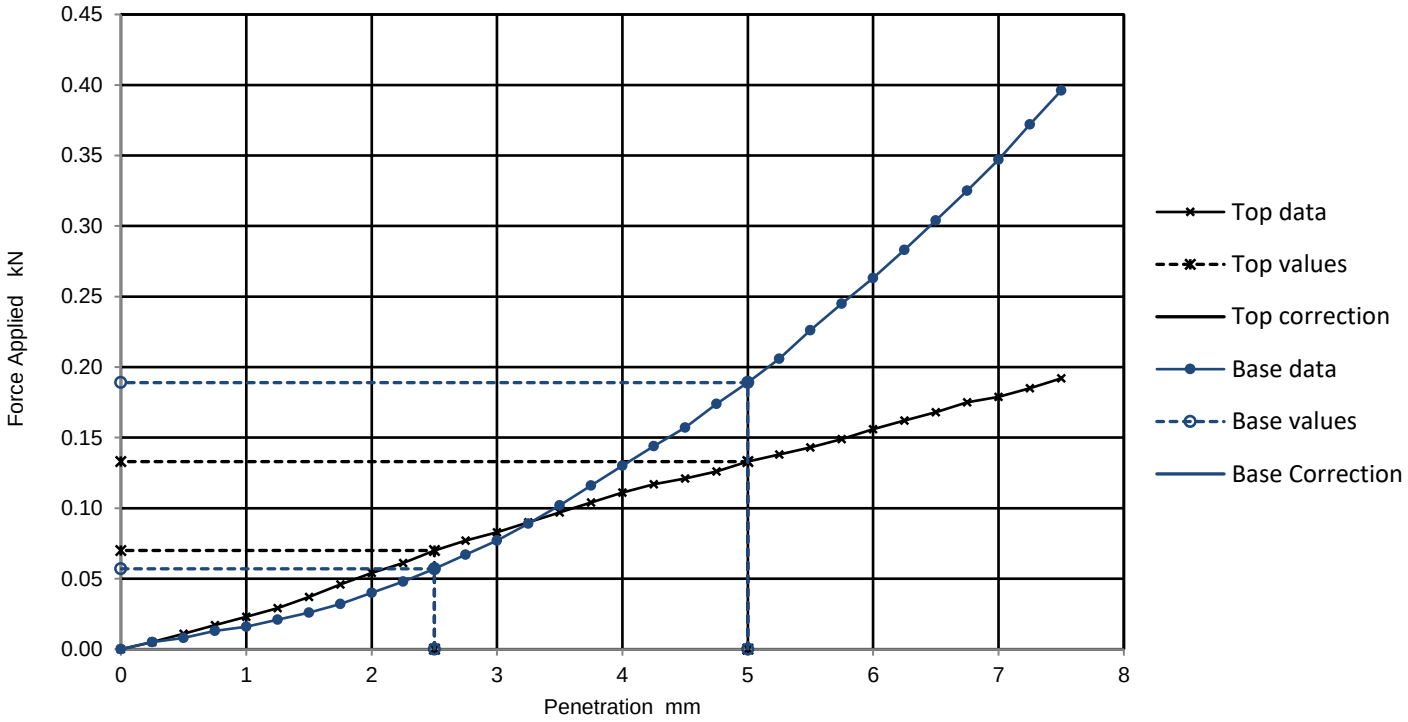
Test Results:

Laboratory Reference:	1644370	Depth Top [m]:	0.70
Hole No.:	TP03	Depth Base [m]:	0.90
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Yellowish brown slightly clayey SAND		

Specimen Preparation:

Condition	Remoulded			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		0	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	1.89	Mg/m3	Surcharge applied	8	kg
	Dry density	1.54	Mg/m3		4.8	kPa
	Moisture content	23	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, %				Moisture Content %
		2.5mm	5mm	Highest	Average	
TOP	No	0.5	0.7	0.7		23
BASE	No	0.4	1.0	1.0		22

Remarks:

Test/ Specimen specific remarks:

Signed:

Aleksandra Jurochnik
PL Technical Reviewer
for and on behalf of i2 Analytical Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.

Date Reported: 20/10/2020

GF 108.15

TEST CERTIFICATE

Determination of California Bearing Ratio

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Tested in Accordance with: BS 1377-4: 1990: Clause 7

Client:	Chevin Geoenviro Associates LLD	Client Reference:	C0362
Client Address:	Tarn House, 77 High Street, Yeadon, LS19 7SP	Job Number:	20-34489
		Date Sampled:	06/10/2020
		Date Received:	08/10/2020
Contact:	Tom R-Rouse	Date Tested:	19/10/2020
Site Address:	Flaxmill House	Sampled By:	Client - TR

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

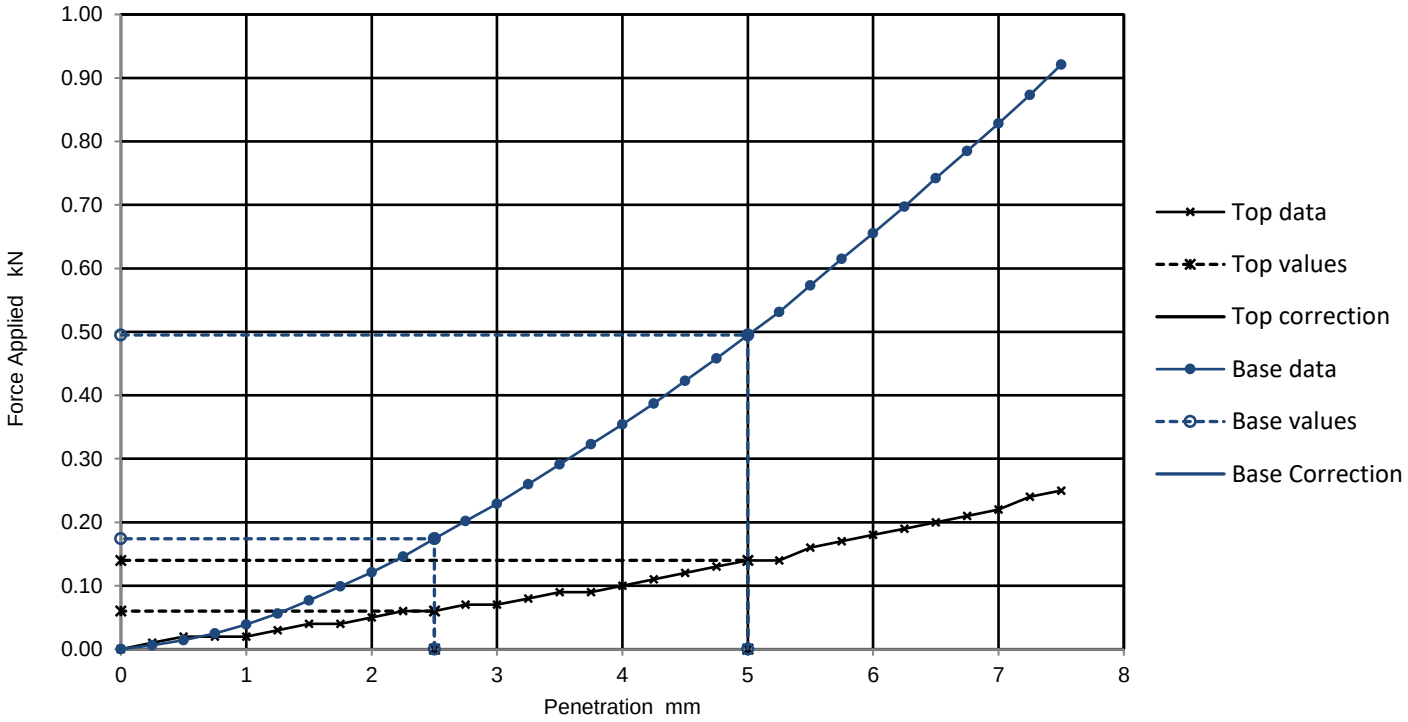
Laboratory Reference:	1644372	Depth Top [m]:	1.00
Hole No.:	TP05	Depth Base [m]:	1.30
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Yellowish brown slightly clayey SAND		

Specimen Preparation:

Condition	Remoulded	Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer	Period of soaking	days
		Time to surface	days
		Amount of swell recorded	mm
Material retained on 20mm sieve removed	0 %	Dry density after soaking	Mg/m3

Initial Specimen details	Bulk density	1.88	Mg/m3	Surcharge applied	8	kg
	Dry density	1.51	Mg/m3		4.8	kPa
	Moisture content	24	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, %				Moisture Content %
		2.5mm	5mm	Highest	Average	
TOP	No	0.5	0.7	0.7		25
BASE	No	1.3	2.5	2.5		24

Remarks:

Test/ Specimen specific remarks:

Signed:

Aleksandra Jurochnik
PL Technical Reviewer
for and on behalf of i2 Analytical Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.

Date Reported: 20/10/2020

GF 108.15

Appendix E – LQM PAH Profiling Chart

LQM PAH profiling Tool (Full Version)

Release: **1.3**
Release date: **4th October 2019**
Licensee: Chevin Associates Ltd

Licensed Office: Yeadon, Leeds

LICENCE AGREEMENT (Version 2)

PLEASE READ THE TERMS OF THIS AGREEMENT CAREFULLY BEFORE USING THIS SOFTWARE. YOUR RIGHT TO USE THIS SOFTWARE IS GOVERNED BY THE TERMS OF THIS AGREEMENT. USING THIS SOFTWARE INDICATES YOUR ACCEPTANCE OF THESE TERMS. **IF YOU DO NOT ACCEPT THESE TERMS, DO NOT USE OR ENTER ANY DATA INTO THIS SOFTWARE.**

This is a legal agreement ("Agreement") between you ("you", the "Licensee") and Land Quality Management Ltd. (the "Licensor", "us", "we" or "our").
This Agreement applies to the LQM PAH profiling Tool (Full Version) Release: 1.3 ("Software") and associated documentation ("Documentation").
You agree to be bound by the terms of this Agreement and any other terms which we may publish from time to time. The terms of this licence may be modified by us at any time and your continued use of the Software and Documentation after publication of any modification shall be an acceptance of such modification.
The Software and Documentation are proprietary products of the Land Quality Management Ltd. and are protected by copyright and other laws governing intellectual property. Title to the copyright and intellectual property in the Software and Documentation, and any copy, modification or merged portion of them or either of them shall at all times be and remain ours, and you shall have no right, title or interest in them, except as expressly set out in this Agreement. Nothing in this Agreement shall restrict our rights.

1. Licence

Permissions: Subject to this Agreement, we hereby grant you a non-exclusive, non-transferable, terminable licence to use the Software and Documentation subject to the following conditions ("Licence"):
a) You may install the Software and Documentation on one or more computers which are within your control in one physical office location. For organisations with multiple offices, a separate copy of the software is required for each office.

b) You may make one copy of the Software and Documentation for back-up purposes, provided any such copy is clearly labelled and contains all the original copy's proprietary notices and is kept safely in your possession.
c) Use of the Software and Documentation is permitted for private use, for educational, scientific and non-commercial purposes, and may also be used in providing services in your business subject always to the stated limitations on use.

Limitations on use: You must not, nor permit others to:
a) Sell, rent, lease, lend, transmit, sub-licence, or otherwise transfer or distribute any copies of the Software or Documentation to others, or make the Software and Documentation available on the internet;
b) reverse engineer, decompile, disassemble, modify, merge, adapt or otherwise attempt to discover the source code, or create derivative works based on the Software except as permitted by law;
c) make copies of the Software and Documentation in whole or in part, except for back-up purposes as permitted in this Agreement or by law;
d) distribute the Software and Documentation, except as permitted by this Agreement;
e) adapt, modify, delete or translate the Software and Documentation in any way for any purpose whatsoever;
f) alter, destroy or otherwise remove any proprietary notices or labels on the Software or Documentation;
g) avoid, circumvent or disable any security mechanism, procedure or protocol, or any copyright protection, provided or included in connection with the Software;
h) use the Software other than for its permitted uses and intended purpose, the intended purpose being defined in the "Background & Instructions" sheet which should be read in its entirety; or
i) use the Software for any criminal or corrupt purpose or in a manner that violates any applicable law.
If you do any of the foregoing, your Licence is automatically terminated; such termination shall be in addition to and not instead of any criminal, civil or other remedies available to us.
In all uses of the Software and Documentation, Land Quality Management Ltd must be acknowledged as the source.
Use of the Software and Documentation for any purposes other than those set out above is prohibited without our express prior written agreement. Any permission granted may be subject to a fee. To apply for permission, please contact: Land Quality Management, The Sir Colin Campbell Building, University of Nottingham Innovation Park, Triumph Road, Nottingham, NG7 2TU

2. Term and termination

This Agreement shall commence as soon as you use or enter any data into the Software. You may terminate this Agreement at any time by destroying all copies of the Software and Documentation in your possession including all copies of any parts of them. This Agreement shall also automatically terminate if you fail to comply with any term or condition of this Agreement, in which event you agree to destroy the original and all copies of the Software and Documentation in your possession including all copies of any parts of them. If requested by us, you shall provide us with written certification of such destruction of the Software and Documentation in your possession. All sections of this Agreement, with the exception of the permissions provided under Section 1 (Licence) shall survive termination of this Agreement.

3. No warranty

The Software and Documentation are provided on an "as-is" basis and with no warranties, express or implied, of any kind and we disclaim any implied warranties to the fullest extent permitted by law. We do not make any representations nor give any warranties as to the content, accuracy, completeness, quality, merchantability, noninfringement, as well those arising from any course of dealing, usage or trade practice, fitness for purpose, performance or freedom from errors of the Software and Documentation.

We do not make any representations nor give any warranties that the Software will meet your requirements or that its operation will be uninterrupted or error-free, that it is free of viruses, trojan horses, software locks, spyware or any other similar defects or effects of using the Software, or as to any conflict or damage to any of your hardware or software, or that the Software will be compatible with your hardware or software.

4. No other obligations

This Agreement creates no obligations on the part of the Licensor other than as specifically set out in this Agreement. Specifically, and without limitation, this Agreement creates no training, maintenance or service obligations.

5. Limitation of liability

Any liability of the Licensor in respect of the Software and Documentation will be limited to refund of purchase price (if any).

We exclude all liability whatsoever, to the fullest extent permitted by law, in respect of any and all loss or damage of any kind arising from or out of the use or inability to use or the unavailability of the Software and Documentation and the information and material contained in them or your use of the Software and Documentation for any purposes other than the intended uses set out in Section 1 . In no event shall we or any of our officers, employees, agents or contractors be liable to you or any other person for any direct, indirect, incidental, special or consequential loss or damage (in each case including but not limited to damages for computer failure or malfunction, loss of data or data being rendered inaccurate, or failure of the Software to operate with other computer programs or any loss of profits, loss of contracts, business opportunity, revenue, goodwill, or anticipated savings, even if we have been advised of the possibility of such damages or loss) of any kind arising out of the use or inability to use or unavailability of the Software or Documentation, whether resulting from tort (including negligence) breach of contract, product liability or other form of action, even if we have been advised of the possibility of such damages.

You accept all responsibility for your use of the Software and Documentation and agree to indemnify and hold us harmless from any liability or claim of any person or organisation arising from your use of the Software and Documentation. In no event do we authorise you to use the Software in applications or systems where it or your failure to perform can reasonably be expected to result in physical injury, or in loss of life. Any use by you is entirely at your own risk, and you agree to indemnify and hold us harmless from any claims or losses relating to such unauthorised use.

You install the Software entirely at your own risk, and where you rely on any information or other material contained in the Software and Documentation you do so entirely at your own risk.

6. Confidentiality

You acknowledge that the Software and Documentation and other materials supplied by us to you are owned by us and shall be treated as confidential information. You agree that (i) you will not use this confidential information in any way not expressly permitted by this Agreement, (ii) you will not disclose this confidential information to anyone other than to your own employees who require access, (iii) you shall maintain and protect the confidentiality of this information and shall keep the Software and Documentation, and any other materials supplied under this Agreement in whatever format (including but not limited to machine-readable form) under restrictions for access and use that are no less restrictive than those applied to your most valuable and sensitive information, and (iv) that you will take all additional necessary and proper precautions to prevent any unauthorised use or disclosure of this confidential information. You agree to notify us in writing immediately of any unauthorised possession or use of the Software, Documentation or other materials or information supplied or made available to you under this Agreement by any third party.

You acknowledge that any breach of your obligations concerning confidentiality will subject us to immediate and irreparable harm for which money damages would not adequately compensate and, accordingly, you hereby consent to the granting of injunctive relief (whether preliminary, temporary or permanent) against it without the posting of bond or other security or proof of damages.

7. Third Party Software

You understand and acknowledge that to the extent that proper operation of the Software requires the use of any software developed, owned or marketed by third parties ("Third-Party Software"), you must obtain your own separate licence for such Third-Party Software at your own expense.

8. Severability

If any provision of this Agreement is held to be void, unlawful or unenforceable, then that part shall be deemed to have been severed from this Agreement and the remaining provisions shall remain valid and enforceable to the fullest extent permissible by law.

9. Modification and amendment

We provide the Software and the associated Documentation in order to assist in the assessment of risks posed by ground gases as set out in Section 1. Our goal is to make this information as complete and accurate as possible, but the Software and Documentation may contain typographical errors, technical inaccuracies or errors of fact.

We may make changes to or update the Software and Documentation from time to time without notice and without obligation to do so. Changes will be noted on the LQM website and users should check whether they possess the most recent updated version.

10 Entire agreement

This Agreement contains the entire agreement between the parties in relation to the subject matter and supersedes all previous agreements, understandings, negotiations, representations, statements and discussions between the Parties, whether oral or written.

11. Governing law and jurisdiction

This Agreement shall be governed by and construed in accordance with the laws of England and Wales and the parties agree to submit to the exclusive jurisdiction of the courts of England and Wales.

Background:

Polyaromatic Hydrocarbon (PAH) mixtures are commonly encountered in urban and periurban soils. These PAHs can be associated with a diverse range of contaminative PHE (2017) recommended the use of benzo[a]pyrene (BaP) as a surrogate marker approach in the assessment of carcinogenic risks posed by PAHs in soils. It was recommended that such assessments should be based on toxicological benchmarks derived from the data for 2 assessment of PAH mixtures in soil. However, PHE (2017) caution that this approach is only applicable if the mixture of (genotoxic) PAHs in the soil is sufficiently similar to that of the coal tar mixtures used as the basis for the toxicological benchmarks used in the assessment. PHE (2017) presented a graphical analysis method that compared the proportions of eight genotoxic PAHs within soil samples (as ratios relative to BaP) with those in the two coal tars tested by Culp et al. (1998). They cited the International Programme on Chemical Safety The generic assessment criteria have currently been published for BaP as a surrogate marker; a C4SL (Defra 2014) and a S4UL (Nathanail et al. 2015). However, before these assessment criteria (or any other criteria based on the Culp et al. coal tars) can justifiably be used to assess PAH mixtures in soils, the PAH profile in the soil should be assessed and This spreadsheet facilitates a graphical comparison of PAHs in soil samples with that of the Culp et al coal tars, similar to that presented by the PHE (2017). This can provide a basis for a competent risk assessor to determine whether an assessment based on BaP as a

Instructions:

cells highlighted in grey shadng in the "PAH data" sheet; ensure that the correct data is entered into each column. It is not important what unit the data is reported in (i.e. mg/kg, ug/kg, %), as long as all the data is reported in the same unit. It is recommended that concentration of one or more of the genotoxic PAHs (particularly BaP) is below the method limit of detection (i.e. <LoD). **Careful consideration should be given to such samples** plots them on the two charts relative to composition of the the two coal mixtures used by Culp et al. (the plus/minus an order of magnitude limits suggested by PHE (2017) are also shown). The further these ratios diverage from the composition of the Culp *at al.* coal tars, In addition, in the **full version only** (available at **www.iqm.co.uk**) the relative proportions of the genotoxic congeners are also presented as ratios in columns X-AD in the "PAH data" sheet. These have been colour coded using a traffic light system, to allow the individual samples that fall at, or close to the order of magnitude limits to be identified. These samples **statement, etc is not obscured or removed. We recommend pasting the charts as a picture/image rather than embedding the workbook or linking the data, as this tends to**

References:

Culp S, Gaylor D, Sheldon W, Goldstein L, & Beland F. (**1998**). A comparison of the tumors induced by coal tar and benzo[a]pyrene in a 2-year bioassay. *Carcinogenesis* , *19* (1), 117–124. Accessed from: http://carcin.oxfordjournals.org/content/19/1/117.full.pdf

Defra. (**2014**). *SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. December 2014* . Department for Environment Food and Rural Affairs (London, UK). Accessed from: **http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=18341**

PHE. (**2017**). *Contaminated land information sheet: risk assessment approaches for polycyclic aromatic hydrocarbons (PAHs)* (London, UK). Accessed from: **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/671075/Contaminated-land-information-sheet-PAHs.pdf**

IPCS. (**1998**). *Environmental Health Criteria 202: Selected non-heterocyclic polycyclic aromatic hydrocarbons*. World Health Organisation, International Programme On Chemical Safety: Geneva, Switzerland. Accessed from: http://www.inchem.org/documents/ehc/ehc/ehc202.htm

Nathanail CP, McCaffrey C, Gillett AG, Ogden RC, & Nathanail JF. (**2015**). *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press, a Division of Land Quality Management Ltd: Nottinghamshire, UK. Available from: http://www.lqm.co.uk/publications/s4ul/

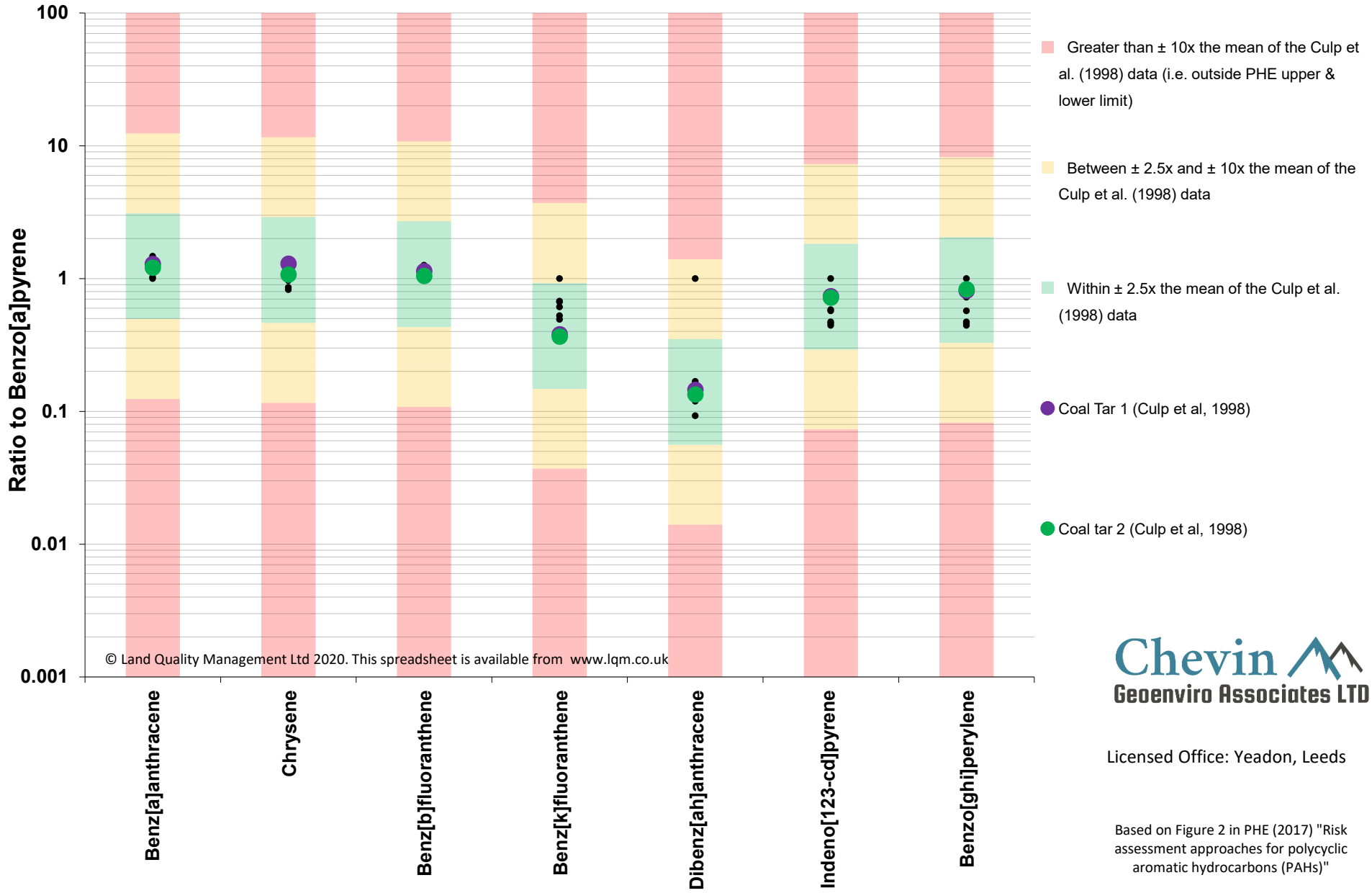
Number	Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[ghi]fluoranthene	Benzo[g,h,i]perylene	Chrysene	Dibenzo[a,h]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-c,d]pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH	Notes and Observations
1	**TP01**	0.05	0.83	2.3	3.7	2.7	3	1.8	1.2	2.6	0.25	6.7	0.88	1.2	0.28	5.4	5.2	37.9	
2	TP02	0.05	0.42	1.5	5	3.4	3.7	2.3	1.6	2.8	0.57	7.9	0.44	1.6	0.05	4.6	6.2	42.2	
3	TP04	0.05	0.71	2.2	8.2	6.3	7.5	3.1	2.9	5.4	0.91	15	0.5	2.9	0.24	7.9	11	74.5	
4	TP05	0.05	0.05	0.05	0.51	0.36	0.43	0.22	0.26	0.35	0.05	0.74	0.05	0.21	0.05	0.34	0.61	4.03	
5	TP06	0.05	0.05	0.05	0.43	0.42	0.53	0.22	0.24	0.45	0.05	0.87	0.05	0.24	0.05	0.43	0.72	4.55	
6	TP06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.8	Deviations in TP06 due to all values being at LOD

BaA:BaP	CHR:BaP	BbFA:BaP	BkFA:BaP	DBahA:BaP	IP:BaP	BghiP:BaP
1.370370	0.962963	1.111111	0.666667	0.092593	0.444444	0.444444
1.470588	0.823529	1.088235	0.676471	0.167647	0.470588	0.470588
1.301587	0.857143	1.190476	0.492063	0.144444	0.460317	0.460317
1.416667	0.972222	1.194444	0.611111	0.138889	0.583333	0.722222
1.023810	1.071429	1.261905	0.523810	0.119048	0.571429	0.571429
1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

Key:

- Within ± 2.5x the mean of the Culp *et al.* (1998) data
- Between ± 2.5x and ± 10x the mean of the Culp *et al.* (1998) data
- Greater than ± 10x the mean of the Culp *et al. (1998)* data (*i.e.* outside PHE upper & lower limit)

C:\Users\chris\Chevin Geoenviro Dropbox\Projects 2019\C0362-Flaxmill House, Surfleet, Spalding\Lab\C0362 PAH profiling TR



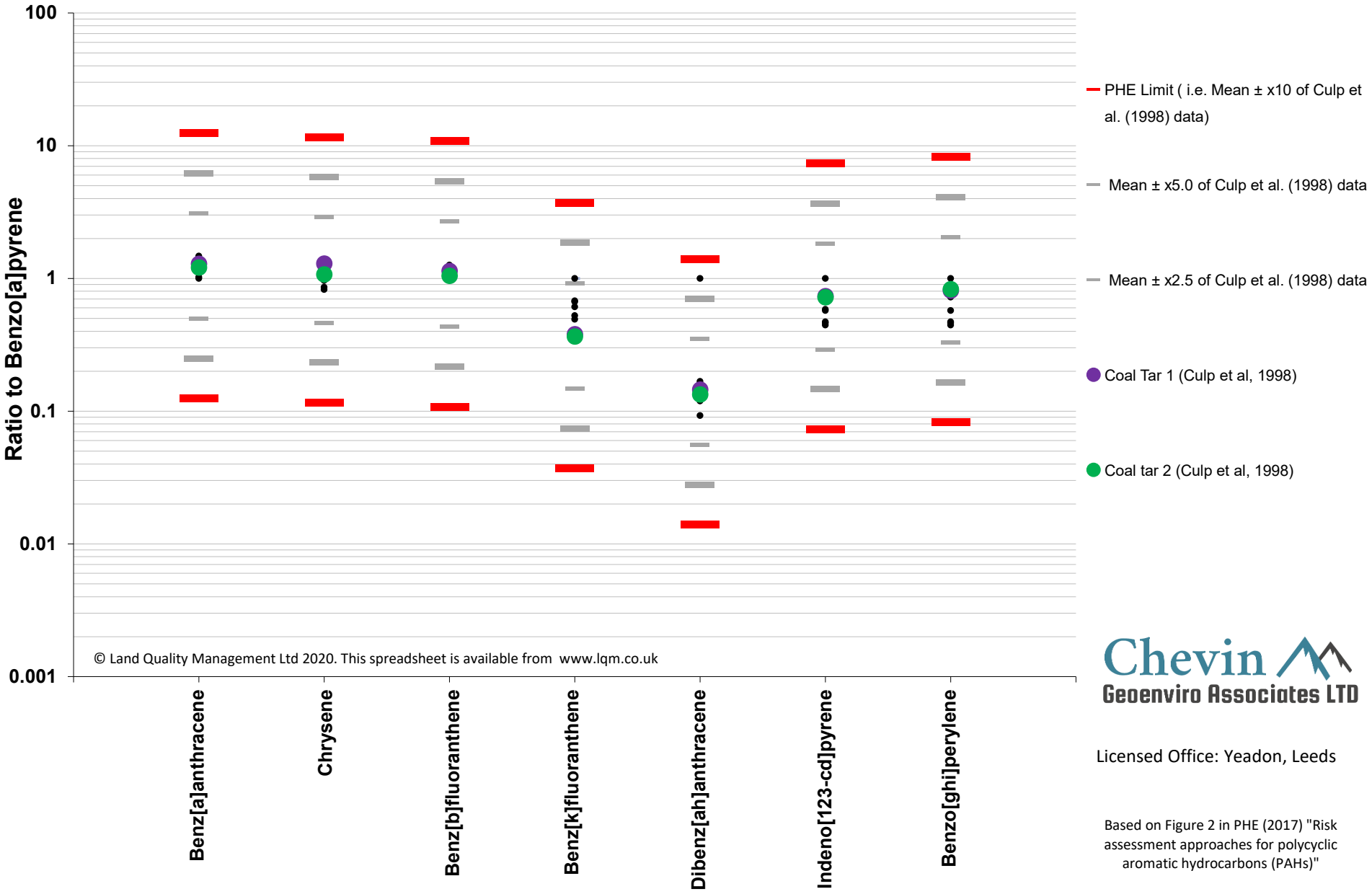
© Land Quality Management Ltd 2020. This spreadsheet is available from www.lqm.co.uk

Chevin Geoenviro Associates LTD

Licensed Office: Yeadon, Leeds

Based on Figure 2 in PHE (2017) "Risk assessment approaches for polycyclic aromatic hydrocarbons (PAHs)"

C:\Users\chris\Chevin Geoenviro Dropbox\Projects 2019\C0362-Flaxmill House, Surfleet, Spalding\Lab\C0362 PAH profiling TR



© Land Quality Management Ltd 2020. This spreadsheet is available from www.lqm.co.uk

Chevin Geoenviro Associates LTD

Licensed Office: Yeadon, Leeds

Based on Figure 2 in PHE (2017) "Risk assessment approaches for polycyclic aromatic hydrocarbons (PAHs)"