GroundSolve Ltd
Consulting Geotechnical Engineers

PHASE 2 GROUND INVESTIGATION: DOLWAR, COEDPOETH

GSL3035

VERSION 1

17 APRIL 2024

FINAL

Prepared for:

Miss Kate Jarvis

Prepared by: Alex Ridge

GroundSolve Ltd

DOCUMENT CONTROL

Report No. :	GSL3035
Report Status:	FINAL
Version No.:	1
Project Engineer:	Alex Ridge
Date of Issue:	17/04/2024

This report has been prepared by GroundSolve Ltd with all reasonable care and diligence, within the best practice and guidance current at the time of issue within the proposed redline boundary and proposed Site end use as presented by the Client.

This report is confidential to the Client and GroundSolve Ltd accepts no responsibility whatsoever to third parties to whom this report is presented.

Version No.	Description of Issue / Revision	Date of Issue	Author	Reviewed By	Approved By
1	FINAL	17/04/2024	Alex Ridge	Phillip Windslow	J Thorburn
			BSc FGS	Msci, MSc(eng), FGS	BSc FGS

CONTENTS

1 INTRODUCTION 8
1.1 Proposed Development 8
1.2 Objectives 9
1.3 Previous Investigations 9
1.4 Limitations 10
2 SITE DETAILS AND DESCRIPTION 11
3 PREVIOUS INVESTIGATIONS 13
4 FIELDWORK 14
4.1 Introduction 14
4.2 Dynamic (Window) Sample Boreholes 14
4.3 Samples and Sample Containers 14
5 LABORATORY TESTING 15
5.1 Chemical Laboratory Testing 15
5.2 Physical Laboratory Testing 16
6 GROUND CONDITIONS 17
6.1 General 17
6.2 Ground Surface / Topsoil 17
6.3 Anthropogenic Materials 17
6.4 Natural Deposits 17
6.5 Bedrock ..... **Error! Bookmark not defined.**
6.6 Groundwater 17
6.7 Surface Water 18
7 GENERIC QUANTITATIVE RISK ASSESSMENT 19
7.1 Assessment for the Protection of Human Health 19
7.2 Restrictions 19
7.3 Results 19
7.4 Assessment for the Protection of Controlled Waters 22
7.5 Permanent Ground Gases 23
7.6 Risks to Human Health (Construction Phase) 25
7.7 Conceptual Site Model 26
8 WASTE ASSESSMENT 30
8.1 Waste Hierarchy 30
8.2 Waste Characterisation and Classification 30

9 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS 32
9.1 Fieldwork and Laboratory Data Review 32
9.2 Trees 33
9.3 Foundation Recommendations 33
9.4 Ground Floor Slab Recommendations 34
9.5 Groundwater Conditions 34
9.6 Reuse of Materials 34
9.7 Groundwater & Excavations 34
9.8 Buried Concrete and Pipework 35
10 CONCLUSIONS AND RECOMMENDATIONS 36
10.1 Remediation and Validation Recommendations 36
10.2 Capping Layer 36
10.3 Radon Protection 36
10.4 Gas Monitoring 37
10.5 Validation of Subsoil / Topsoil 37
10.6 Site Completion Report 38
10.7 Regulatory Liaison 38
10.8 Health and Safety 38
11 REFERENCES 39
12 DEFINITIONS 41

TABLES

Table 2.1: Current Site Overview. 11
Table 2.2: Summary of Description of the Site and its Environs 12
Table 3.1: Summary of Previous Investigations. 13
Table 5.1: Suites of Analysis for Environmental Soil Samples 16
Table 5.2: Summary of Physical Testing 16
Table 7.1: Metals Suite 20
Table 7.2: Polyaromatic Hydrocarbons 20
Table 7.3: Petroleum Hydrocarbons 21
Table 7.4: Summary of Ground Gas Monitoring 23
Table 8.1: Laboratory Sampling Testing Frequencies 31
Table 9.1: Summary of Classification Testing 32
Table 9.2: Summary of SPT N Values 33

Table 10.1: Imported Material Sampling Requirements 37

FIGURES

Figure 1: Extract from proposed development plan. 9
Figure 2: Existing Site Layout 11

APPENDICES

APPENDIX A – SITE PHOTOGRAPHS
APPENDIX B – EXPLORATORY HOLE RECORDS
APPENDIX C – CHEMICAL TEST RESULTS
APPENDIX D – PHYSICAL TEST RESULTS
APPENDIX E – SUMMARY OF GAS AND GROUNDWATER MONITORING
APPENDIX F – CURRENT GUIDANCE FOR GROUND GAS RISK ASSESSMENT
APPENDIX G – GUIDANCE FOR CLASSIFICATION OF SOIL FOR OFF SITE DISPOSAL AT A LANDFILL SITE
APPENDIX H – UNFORESEEN GROUND CONTAMINATION

EXECUTIVE SUMMARY

Introduction	GroundSolve Ltd (GSL) was commissioned by Miss Kate Jarvis "the Client" to undertake a ground investigation at the Site. This report presents the findings of the site investigation and makes recommendations based upon those findings. It is to be read in conjunction with the desk study and Preliminary Risk Assessment (GSL report ref: 3035/PRA/01).
Site Location and Name:	Dolwar, Coedpoeth, LL11 3DT (328346E, 350964N).
Report Objective	This report presents the findings of the ground investigation, the environmental risk assessment and geotechnical assessment relating to the proposed development.
Land Use History	Site was agricultural grazing until its development as a residential property in 1968 and has remained in its current form to date.
Development	The proposed development includes the demolition of the existing dwelling and the erection of a replacement residential dwelling.
Geoenvironmental Setting	**Topography:** The site generally is elevated to the east. The western portion of the site lays ~3.00m below the east of the site which measures at 240.84m AOD. **Geology:** Published data suggests that no superficial deposits are located on the site, with bedrock geology comprising Sandstone (Cefn Rock). **Hydrogeology:** The bedrock onsite is classified as a Secondary A aquifer. The nearest groundwater abstraction points are > 1000m of the site. The site does not lay within a source protection zone. **Hydrology:** Onsite groundwater flow direction is unknown at this stage, however likely flows east due to local topographic features. **Mining & Quarrying:** On the basis of the geology of the area, the Coal Authority Report and the historic maps, it is considered that the site is not likely to be at risk from ground movements due to previous mines or quarrying. **Unexploded Ordnance:** A non-specialist UXO screening exercise in general accordance with CIRIA report C681 indicates a low risk.
Phase 1 Preliminary Risk Assessment	Based on the former land uses at the site the potential for contamination to be present at the site is considered to be low. The receptors of concern are human health, surface water and groundwater. The possible consequences on the plausible receptors are estimated to be a maximum rating of MEDIUM and the probability of the identified risks occurring is considered to be LOW, which is considered suitable as long as the adoption of suitable construction practices is implemented.
Scope of Phase 2 Site Investigation	The scope of ground investigation works carried out at the site by GroundSolve comprised: • 4 Window Sampling boreholes to a maximum depth of 4.00mbgl;
Findings of the Phase 2 Ground Investigation	The ground conditions at the site (from ground level, down) comprise: • Topsoil –dark brown slightly sandy gravelly silt • Made Ground – dark brown slightly sandy gravelly silt with red brick. • Sandstone Gravel – generally comprising slightly clayey sandy fine to coarse gravel. • Clay – comprising sandy clay Depth of clay is highly variable across the whole site. Groundwater was encountered at 2.34m has been monitored at depths of between 1.96m bgl and 2.44m bgl. Three gas monitoring visits have been undertaken and indicate that methane concentrations are <0.1% v/v, the highest carbon dioxide concentration (steady state) was 0.0% v/v, oxygen concentrations were between 15.1% v/v and 16.20% v/v and gas emission rates were between < 0.0 and < 0.1 l/hr.
Phase 2 Conclusions – Geoenvironmental	**Human Health:** • Elevated pervasive contamination of lead is present, which is not suitable for gardens; • Localised hotspot of hydrocarbons present within exploratory hole WS01, at 2.65m depth bgl. No significant risk to proposed development, however a watching brief is required during the construction. **Plant growth:** No unacceptable risks. **Controlled Waters:** No unacceptable risks. **Ground Gases (Human Health / Property):** • Ful radon protective measures are required as indicated by the current guidance. • Low risk from ground gases. CS1/Green conditions apply and no mitigation is necessary. **Water Supply Pipework:** Due to the depth and locality of the isolated hydrocarbon concentrations in the rear of the property, its unlikely that barrier pipe will be necessary.

Outline Contamination Remediation Strategy	A preferred remedial strategy for the site will have to be developed in consultation with the design team and the regulatory authorities. Liaison should be continued during implementation and subsequent verification. The following approach is suggested. • The writing and approval of a Remediation Method Statement; • Removal of Made Ground and topsoil, or installation of a simple cover system in gardens areas where material has been identified as unsuitable.
Reuse of Site-won Materials	Topsoil (where present) and made ground (where present) on site is not chemically suitable for use in garden or soft landscaped areas. Spoil resulting from excavations may be suitable for reuse as engineered fill (subject to additional testing and specification) or disposed off-site. of an earthworks specification. A CL:AIRE Materials Management Plan may be required to allow re-use of soils.
Foundations	Traditional strip foundations are likely suitable, with a minimum foundation depth of 1.10m, and an allowable bearing capacity of 150kN/m^2
Floor Slabs	Suspended ground floors are recommended. Ground floor slabs should be designed to incorporate any required gas mitigation measures.
Buried Concrete	It is recommended that ACEC Class AC-1s be adopted for the design of all buried concrete equating to a designated concrete class DS-1.
Further Work	The following further works will be required: • Discussions with regulatory bodies and the NHBC regarding the conclusions of this report; • Detailed design of foundations; • Installation of an Environmental Cover System. • Installation of 'full' Radon Protection Measures. • Validation of the remedial works; and • Preparation of a contamination verification report.

This summary forms part of a Tier 2 Risk Assessment (Ground Condition) report prepared by GroundSolve Ltd and contains an overview of the key findings and conclusions. The summary should not be treated as an independent document.

1 INTRODUCTION

GroundSolve Ltd (GSL) was commissioned by Kate Jarvis "the Client" to undertake a Phase 2 Site Investigation and Contaminated Land Risk Assessment for a property known as Dolwar, Coedpoeth, Wrexham referred to as the "Site". This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Part IIA of the Environment Protection Act, 1990;
- BS5930:2015 +A1:2020: "Code of practice for site investigations";
- BS10175: 2011 +A2:2017 "Investigation of Potentially Contaminated Sites - Code of Practice";
- The Building Regulations 2010. Part C (HM Government 2013);
- Environment Agency: Land Contamination Risk Management (LCRM), Version 3, October 2020;
- Environment Agency (2017) "The Environment Agency's Approach to Groundwater Protection" November 2018 Version 1.2.

1.1 Proposed Development

The proposed development of the site is understood to comprise:

- Demolition of the existing residential house.
- the removal from site or the treatment of any contaminated material encountered during groundworks;
- the construction of a detached residential building including access roads, parking areas and service provision.

The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed residential end use. If there is a subsequent change in the proposed land the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

The proposed development comprises the construction of a detached residential dwelling, with hard standing parking in the front of the property, retainment of an existing brick building in the north of the site, with soft standing landscaped area to the rear of the property. See **Figure 1.**



Figure 1: Extract from proposed development plan.

1.2 Objectives

The purpose of the report is to provide an assessment of the site using published information and information on conditions at the site in relation to the proposed residential development.

The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed end use. If there is a subsequent change in the proposed land, the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

This document is a working document and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on the conditions encountered. This version of this document is to be issued to regulators for approval (Wrexham County Council).

1.3 Previous Investigations

A Phase 1 Desk Study Preliminary Risk Assessment (PRA) was undertaken by GroundSolve Ltd (GSL) and this report should be read in conjunction with this work.

1.4 Limitations

This report has been prepared for the sole use of Miss Kate Jarvis. No other third party may rely upon or reproduce the contents of this report without the written approval of GroundSolve Ltd. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk.

Marked locations showing the positioning of Foul Sewer and drainage onsite in the form of yellow stakes reduced the ability to investigate ground conditions in this area. The existing property protrudes onto the proposed development outline and as such no intrusive positions were undertaken within the existing dwelling footprint.

2 SITE DETAILS AND DESCRIPTION

Table 2.1: Current Site Overview.

Site name	Dolwar, Coedpoeth
Site address	Dolwar, Park Road, Coedpoeth, Wrexham, LL11 3TD
National Grid Reference (NGR)	328344 350957
Approximate Site area	0.11ha
Site shape	Irregular  Figure 2: Existing Site Layout
Current land use on the Site	Residential

A site visit was undertaken on 05/02/2024. The locations of various features are detailed on Drawing No. GSL3035_Drawing_1_Existing_Site. Photographs of the site are presented in **Appendix A.**

Table 2.2: Summary of Description of the Site and its Environs

Current Use:	Disused residential dwelling
Access	Via asphalt roadway direct from Park Road.
Existing Buildings & Structures	Two existing buildings are present onsite, the existing dwelling and a small, detached brick building used for storage and as a garage. This is believed to not be part of the demolition works.
Site Surface	Partly asphalt/ concrete slabs or unmade up area for parking. Some grassed areas. Some pooling water in localised depressions.
Vegetation	Generally long field grass with mature & semi-mature trees noted on site boundaries, with some scrub.
Storage Tanks	Below Ground Tanks: No evidence/none suspected. Above Ground Tanks: None present.
Services	Foul sewer and drainage were known to be located within the rear and were marked out before GSLs arrival with yellow fence stakes. Gas and electric is known to enter the front of the property, with a low voltage cable running southerly down the side alley toward the neighbouring properties on the western boundary.
Asbestos	No potential Asbestos Containing Materials (ACMs) noted in the buildings or on the ground surface. However, a refurbishment / demolition asbestos survey will be required Prior to demolition
Waste Disposal	Based on the history of the Site and the anticipated potential contaminants of concern, it is considered unlikely that hazardous waste soil materials may be present beneath the majority of the Site. However, this will be subject to confirmatory investigation, sampling, laboratory analysis and waste classification in accordance with the Guidance on the Classification and Assessment of Waste (WM3).
Surrounding Area	Residential bounding all site exteriors, including Park Road to the east
Local / Background Knowledge	The site was formerly farmland, before development into a residential dwelling.

3 PREVIOUS INVESTIGATIONS

A summary of the findings from previous reports is given in **Table 3.1** below:

Table 3.1: Summary of Previous Investigations.

Site History	The site remained open agricultural land until circa 1912 whereby residential development was undertaken on the site, resulting in the existing dwelling today.
Geological Setting	No made ground or infilled land was identified within an influencing distance to the site. No superficial geology has been identified as present onsite. Published data suggests bedrock geology comprises Sandstone (Cefn Rock).
Mining	The site is within an area of historical workings, and as such a coal mining consultant's report was reviewed as part of the Phase 1 PRA. It was established, alongside historical coal maps, that no coal seams were present under the site, and as such risk associated with historical workings was low
Hydrogeology	The bedrock onsite is classified as a Secondary A aquifer. The nearest groundwater abstraction points are > 1000m of the site. The site does not lay within a source protection zone.
Waste	No evidence of significant contamination. Natural materials should be classified as non-hazardous by definition, onsite reuse possible however limited scope due to nature of development.
Contamination Sources	No significant onsite source Electricity transformer 7m east of the site

4 FIELDWORK

4.1 Introduction

The fieldwork was carried out on 14/02/2024. GroundSolve personnel were present to supervise all work, describe the ground encountered, and take samples. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- BS5930:2015 + A1:2020 "Code of Practice for Site Investigations;"
- BS10175:2011 + A2:2017 "Investigation of Potentially Contaminated Sites – Code of Practice."

The investigation included:

- 4No. Windowless Sample boreholes to a maximum depth of 3.30mBGL (WS01 to WS04),
- Sampling for chemical and geotechnical testing of soils,
- Description of the ground encountered in accordance with BS5930:2015 + A1:2020, Code of Practice for Site Investigations.

4.2 Dynamic (Window) Sample Boreholes

4no. windowless sampling boreholes were completed using a tracked windowless sample rig. The exploratory hole logs are presented in **Appendix B**

4.3 Samples and Sample Containers

Soil samples for chemical analysis each comprised a pair of samples, a plastic tub for metals and inorganics and an amber glass jar for organics.

Soil samples were stored in cool boxes with ice packs and dispatched directly to the testing laboratory, for all phases of the investigation.

Samples for physical testing comprised of Atterberg Testing and Particle Size Distribution (PSD) tests and were dispatched to The Testing Laboratory (TTL), a UKAS accredited laboratory.

5 LABORATORY TESTING

5.1 Chemical Laboratory Testing

Chemical samples were submitted to a UKAS accredited laboratory in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

The selection of samples for laboratory testing and analytes to be determined were made based on the preliminary CSM and relevant observations during the investigations. The sample selection rationale is as follows:

- To gain a good coverage across the Site of the various material types and strata encountered.
- To investigate the specific locations of previous potentially contaminative land uses as identified within the Phase 1 Desk Study and subsequent CSM (i.e. the area of Site utilised as a construction yard in recent years);
- To fully characterise the potential made ground materials within the identified higher-risk areas.

The selected soil samples were tested for a range of typical contamination indicators including specific tests for contaminants suspected as being present from the desk study, CSM, and observations made on-site. Tests were also performed which were used to support the modelling of contaminant transport and impacts (e.g. TOC) and for waste classification purposes.

Each of the soil samples were analysed for the 'total' concentration of a suite of potential contaminants, with one sample being analysed solely for total organic carbon content.

The results of the laboratory analysis are presented in **Appendix C**. The various suites of analysis for the soil are presented in **Table 5.1** below:

Table 5.1: Suites of Analysis for Environmental Soil Samples

Determinant	Soil Suite 1	Soil Suite 3	WAC (2 Stage)
Number of Samples	2	5	1
Index Tests			
Asbestos Screen / Quantification	✓	✓	-
pH	✓	✓	✓
Metals			
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn (all totals)	✓	✓	-
Inorganics			
Acid Soluble Sulphate	✓	✓	-
Cyanide - Total	✓	✓	-
Sulphate (2:1 extract on soil samples)	✓	-	-
Organics			
Phenols - Total (monohydric)	✓	-	-
Total Organic Carbon (TOC)	✓	-	✓
PAH (Speciated USEPA 16)		✓	-
Speciated TPH (C5-C35)	✓	-	-
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	✓	-	-

5.2 Physical Laboratory Testing

Samples were submitted to Professional Soils Laboratory (PSL) who are UKAS accredited in accordance with ISO17025. The following geotechnical testing was undertaken with the results of this testing presented in are presented in **Appendix D**. The various suites of analysis for the soil are presented in **Table 5.2**:

Table 5.2: Summary of Physical Testing

Determinant	Samples Used in Testing
Index Tests	
Atterberg	**2**
Moisture Content	**2**
PSD (Particle Size Distribution	**3**

6 GROUND CONDITIONS

6.1 General

The site investigations have allowed the site-specific ground conditions to be described and this information was used to provide an improved conceptual ground model. The geology encountered during the site investigations was generally consistent with existing publicly available information online on the British Geological Survey (BGS) GeoIndex (onshore) viewer. A summary of the general strata encountered across the site is provided in the following sub sections.

6.2 Ground Surface / Topsoil

The existing structure on site, to be demolished, exists within the proposed building footprint, and as such 2no. locations were drilled within the existing patio area, and a further 2no. locations were drilled within the existing soft standing area to the rear. Topsoil was encountered within WS04 and WS02 generally consisting of soft brown sandy gravelly silt.

6.3 Anthropogenic Materials

Made ground was encountered within WS01 and WS03 to depths of between 0.40m to 0.74mbgl, likely associated with the raising of site levels as a result of the patio area construction, comprising of soft dark brown sandy gravelly silt with red brick gravels.

6.4 Natural Deposits

Underlying the Made Ground (WS01 & WS03) and topsoil (WS02 & WS04) Dense sandstone gravel was encountered, recorded throughout the site and proven to a depth of 2.65m bgl. Underlying the sand was a very stiff brown very sandy clay, recorded as shallow as 1.70m bgl and proven to a depth of 3.30m bgl. These deposits have been interpreted as completed to highly weathered bedrock.

Soil classification tests were carried out on the gravel which revealed samples to comprise of >65% gravel sized clasts, correlating with observations made within the ground investigation. All results are presented in **Appendix D**.

6.5 Groundwater

During the ground investigation, perched groundwater was encountered within WS01 at a depth of 2.35m bgl, which showed olfactory and visual evidence of contamination. During the 3no. monitoring visits conducted, groundwater in this location was recorded as absent on two visits and at a depth of 2.44m bgl on the last visit.

Groundwater was not encountered during the fieldwork within the other three boreholes. However, water was recorded during the monitoring visits at depths varying between 1.96m bgl and 2.20m bgl. These depths indicate that the groundwater is perched above the clay stratum.

6.6 Surface Water

No surface water was encountered during the site walkover or ground investigation, with no onsite surface water features noted in the vicinity of the site.

7 GENERIC QUANTITATIVE RISK ASSESSMENT

7.1 Assessment for the Protection of Human Health

The results of the soil analyses are presented below, where they have been compared to suitable generic assessment criteria (GACs), in order to allow a generic quantitative risk assessment (GQRA) to be carried out for the site and the proposed development.

The Category 4 Screening Levels (C4SLs) published by DEFRA (2014) have been adopted in the first instance, which have been published for six substances to date. Where a C4SL is unavailable, the "Suitable 4 Use Levels" (S4ULs) published by LQM/CIEH (2015) have been adopted.

These criteria have been derived using the CLEA model for a range of standard end-use scenarios and a range of soil organic matter (SOM) contents. It should be noted that the C4SL values are derived on the basis of a "low level of toxicological concern", while the S4UL values are based on a "tolerable" or "minimal" level of risk. As such, the S4ULs describe a lower level of risk than the C4SLs, and are equivalent to the former Soil Guideline Values (SGVs, published by the Environment Agency) and the previous editions of the LQM/CIEH GAC values.

The GQRA is based on a soil with a Soil Organic Matter of 2.5%, for a residential with home grown produce end use.

A full summary of the chemical test results is presented in **Appendix C**.

7.2 Restrictions

The existing building is still present on site and the underground services are still in operation, therefore there was some restrictions with the locations of the investigation locations. In addition, there are differences in site levels with steps in between, which again restricted movement and locations on site.

7.3 Results

Metals

The results from the metal analysis have recorded high Lead concentrations with 4 exceedances of the applicable GACs. The four exceedances for lead are as follows: from WS01 at 0.40m, WS02 at 0.10m, WS03 at 0.60m, and WS04 at 0.40m. The two samples from WS02 and WS04 are located within the topsoil within the garden and are likely representative of the topsoil in the rest of the plot.

Table 7.1: Metals Suite

Metals	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Arsenic	7.2	30.4	14.03	7	37	C4SL	0
Cadmium	<0.5	5.2	1.54	7	22	C4SL	0
Chromium	17.7	131	37.94	7	910	S4UL	0
Chromium, Hexavalent	-	-	-	0	21	C4SL	0
Copper	21.8	382	90.43	7	2400	S4UL	0
Lead	29.3	**486**	241.46	7	**200**	**C4SL**	**4**
Mercury	<0.5	1.1	0.59	7	1.2	S4UL	0
Nickel	22	124	42.66	7	130	S4UL	0
Phenol - Monohydric	-	-	-	0	120	S4UL	0
Selenium	<1.0	1.1	1.01	7	250	S4UL	0
Zinc	84.8	914	288.83	7	3700	S4UL	0

GroundSolve conclude that the risk from metal concentrations to the proposed development is considered high, and further action will be required.

PAHs

All samples selected for analysis have generally recorded low PAHs.

Table 7.2: Polyaromatic Hydrocarbons

Polyaromatic Hydrocarbons (PAH)	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Acenaphthene	<0.5	<0.5	0.5	7	2.3	S4UL	0
Acenaphthylene	<0.5	<0.5	0.5	7	170	S4UL	0
Anthracene	<0.5	<0.5	0.5	7	2400	S4UL	0
Benzo(a)anthracene	<0.5	<0.5	0.5	7	7.2	S4UL	0
Benzo(a)pyrene	<0.5	<0.5	0.5	7	5	C4SL	0
Benzo(b)fluoranthene	<0.5	<0.5	0.5	7	2.6	S4UL	0
Benzo(g,h,i)perylene	<0.5	<0.5	0.5	7	320	S4UL	0
Benzo(k)fluoranthene	<0.5	<0.5	0.5	7	77	S4UL	0
Chrysene	<0.5	<0.5	0.5	7	15	S4UL	0
Dibenzo(a,h)anthracene	<0.5	<0.5	0.5	7	0.24	S4UL	0
Fluoranthene	<0.5	<0.5	0.5	7	280	S4UL	0
Fluorene	<0.5	<0.5	0.5	7	170	S4UL	0
Indeno(1,2,3-c,d)pyrene	<0.5	<0.5	0.5	7	27	S4UL	0
Naphthalene	<0.5	<0.5	0.5	7	2.3	S4UL	0
Phenanthrene	<0.5	<0.5	0.5	7	95	S4UL	0
Pyrene	<0.5	<0.5	0.5	7	620	S4UL	0

Petroleum Hydrocarbons (PHC)

WS01 encountered material with a slight hydrocarbon impacted material was noted in during the fieldwork between 2.35m and 2.65m within the sandstone gravel. No hydrocarbon impacted material was encountered above this stratum or from any of the remaining boreholes.

Five samples were selected for TPH testing. One of the samples was taken from WS01 at 2.65m, which noted a hydrocarbon odour.

Table 7.3: Petroleum Hydrocarbons

Petroleum Hydrocarbons	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Aliphatic C5-C6	<0.01	<0.01	0.01	5	42	S4UL	0
Aliphatic C6-C8	<0.01	<0.01	0.01	5	100	S4UL	0
Aliphatic C8-C10	<1.0	19	4.6	5	27	S4UL	0
Aliphatic C10-C12	<1.0	85	17.8	5	130	S4UL	0
Aliphatic C12-C16	<1.0	539	108.84	5	1100	S4UL	0
Aliphatic C16-EC35	<1.0	894	182.66	5	65000	S4UL	0
Aliphatic C35-C40	<1.0	2.9	1.64	5	65000	S4UL	0
Aromatic C5-C7	<0.01	<0.01	0.01	5	70	S4UL	0
Aromatic C7-C8	<0.01	<0.01	0.01	5	130	S4UL	0
Aromatic C8-C10	<1.0	17.6	4.32	5	34	S4UL	0
Aromatic C10-C12	<1.0	77.2	16.24	5	74	S4UL	1
Aromatic C12-C16	<1.0	536	108.24	5	140	S4UL	1
Aromatic >C16-C21	<1.0	642	129.86	5	260	S4UL	1
Aromatic >C21-C35	<1.0	278	58.4	5	1100	S4UL	0
Aromatic >C35-EC40	<1.0	<1	1	5	1100	S4UL	0

The speciated Total Petroleum Hydrocarbons (TPH) results have shown slightly elevated concentrations between TPH Aromatic C10-C21 from WS01 at 2.65m. Additional investigation around WS01 was limited due to underground services in the area. WS02 is located down slope of WS01 and did not encounter hydrocarbon impacted material.

The origin of the hydrocarbon impacted material is unknown, however due to the locate is likely to be from offsite. The speciated TPH results indicate that the majority hydrocarbons are between C12 to C21. The source may therefore be a heating oil tank from the adjacent site.

A monitoring well was installed within WS01, WS02 and WS03. Groundwater was either absent or recorded close to the base of each monitoring well. There wasn't enough water to sample from WS01. Gas monitoring including VOC were carried out from all three boreholes. The results of the monitoring have shown VOC readings were all below the detection limit (0.1ppm).

The fieldwork, chemical results and monitoring indicate that the risk from hydrocarbons to the proposed development is considered low, however a watching brief should be carried out during the construction phase. A procedure will be in place if significant contamination is encountered during the construction (Appendix H).

Asbestos

Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g., asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our site staff for the presence of bulk ACMs. During the fieldwork no suspected ACMs were not identified.

Laboratory assessments were carried out in order to confirm the site assessment that ACMs were absent, and no asbestos was detected in any of the samples retrieved from site.

7.4 Assessment for the Protection of Controlled Waters

The results from the fieldwork and monitoring indicates that only perched groundwater was encountered. The ground conditions have shown that the site is underlain by thin Made Ground deposits over slightly clayey sandy gravel interbedded with clay bands which is considered completed weathered bedrock. Groundwater is likely to be at a significant depth within the competent sandstone bedrock.

WS01 has encountered mild hydrocarbon impacted material within the weathered bedrock. The fieldwork has shown that the source is likely to be offsite and localised. The impacted material is not likely to be in conductivity with groundwater at depth within the competent sandstone bedrock.

The total concentrations detected within soil samples are predominantly relatively marginal in human health terms and do not indicate particularly high concentrations which would be indicative of a significant source of groundwater contamination, which has been assessed as background levels resulting from natural mineralisation and mining in the area.

GroundSolve believes that the site does not pose a significant risk to Controlled Water because:

- Proposed development would not change existing site conditions, with any residential development a continuation of existing conditions.
- Current nonmetal contamination on site was limited to one isolated area (WS01) at depths >2.00m bgl and correlates to perched groundwater encountered during the ground investigation. Further monitoring

found no more contaminated water and PID readings confirmed an absence of vapours.

- Very stiff clay deposits have been encountered within the weathered sandstone, therefore vertical and lateral migration will be limited.
- No licensed potable abstractions are within 1000m.
- The nearest surface water feature is 190m SW of the site (Afon Clywedog)
- Hydrocarbon impacted material was not found in boreholes located proximal to WS01.

7.5 Permanent Ground Gases

The phase 1 desk study has recorded the presence of a sandstone quarry within 250m of the site. There is no evidence that the quarry was infilled. Part of the old quarry has been redeveloped with residential properties. There are no other credible ground gas sources close to the site.

The site investigation has encountered have clayey sandstone gravel and very stiff clay which is interpreted as weathered bedrock. No significant organic material was encountered during the fieldworks. Hydrocarbon impacted soils were encountered in WS01 between 2.35m to 2.65m.

Measured Gas Concentrations

Three rounds of gas monitoring have been carried out by GroundSolve in the 3no. gas monitoring wells. The highest flow rates, methane, and carbon dioxide concentrations to date, together with the lowest oxygen levels (i.e., a combination of the worst-case temporal conditions recorded) from the monitoring visits are summarised in the table below:

Table 7.4: Summary of Ground Gas Monitoring

Borehole	Response Zone (mbgl)	No. of monitoring occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Water Level (mbgl)	Atmospheric pressure readings (mb)
WS01	0.65 – 2.65	3	0.00	0.00	0.20	15.30	2.44	954
WS02	0.70 – 2.70	3	0.00	0.00	0.10	15.40	2.06	954
WS03	1.00 – 3.00	3	0.00	0.00	0.10	15.10	1.96	954

* limit of detection on gas monitor

Ground Gas Assessment

Full data from the monitoring visits undertaken to date can be found within **Appendix E** with background information relating to the origin and production of landfill and ground gases presented in **Appendix F**, together with current

guidance on the assessment of ground gases. In accordance with this approach and the above measured ground gas levels, it is considered that the worst-case temporal conditions (pressure below 1000mb) have been measured during the monitoring period. The gas flow rates measured across the whole of the site at all of the monitoring visits was less than the instrument detection limit of 0.1 l/hr. From Table 8.5 of CIRIA C665 the worst-case Characteristic Situation for the site are as follows:

Table 7.5 Characteristic Gas Situations

Borehole Number	Steady State Flow	CH4			CO2		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
WS01	0.1	0.1	0.001	GS1	0.2	0.001	GS1
WS02	0.1	0.1	0.001	GS1	0.1	0.002	GS1
WS03	0.1	0.1	0.001	GS1	0.1	0.001	GS1

No methane concentrations have been recorded. The fieldwork and ground gas concentrations are indicating low gas risk and GS1 conditions, which would require no remedial measures.

The Site is located within an area where the radon risk is high, with an estimated 10-30% of properties affected by radon; therefore, full radon protective measures are required.

7.6 Risks to Human Health (Construction Phase)

During the construction works there will be a risk from dust to on-site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Method statement for site activities including control of dust generation;
- Having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- The method statement shall have a contingency plan which should be implemented if the presence of significantly elevated levels of lead is suspected in groundworks; and
- Only permitting smoking or eating on site in appropriate pre-designated areas.

Given the presence of heavy metals (principally lead) together with the proximity of residential receptors in the environs of the site and construction workers, control of fugitive dust will be a priority. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance, and that the following measures will be introduced to assist with control of dust generation during the groundworks phase of the works:

- Access roads and any stockpiles created during groundworks should be regularly damped down with water;
- Vehicles used to transport materials/wastes and aggregates should be enclosed or tarpaulined;
- Vehicle movements and speed should be kept to a minimum within the site ;
- Dust generating equipment (e.g., mobile crushing and screening equipment) should be located to minimise potential nuisance impacts to receptors as far as practicable; and
- Minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.

7.7 Conceptual Site Model

The proposed development comprises a detached dwelling.

The conceptual site model has been updated since the Phase 1 Preliminary Risk Assessment, as the findings of the Phase 2 site investigation revealed the following general downward succession:

- Site surface: topsoil;
- Made Ground (below existing hard standing and patio areas);
- Sandstone gravels: Encountered in all areas, comprising a layer of dense to medium dense to very dense light brown slightly clayey sandy gravel
- Very stiff brown sandy clay (WS02-WS04)

The potential contamination at the site has been assessed using the contaminant-pathway-receptor linkage approach. Following the site investigation, the plausible contaminant sources have been updated or confirmed as likely offsite sources.

The results of site investigation and laboratory analysis generally record high concentrations of long chain aromatic hydrocarbons at 2.65m bgl within WS01, as well as elevated lead concentrations across the site.

GroundSolve conclude that the risk from elevated soil lead concentrations to the proposed development is considered high and will require additional remediation due to the following factors:

- Although the source of the lead is likely to be natural occurring background levels and the soils in the surrounding areas are likely to have similar concentrations, this does not eliminate the risk to human health.
- Lead concentrations on the site are elevated in some instances by 2x the guidance value (200mg/kg).

A clean cover system, 600 mm in thickness, shall be installed in all garden and soft-landscaped areas, typically 450mm subsoil and 150mm topsoil. Where patios or decking is present, a 600mm thick capping layer will still apply, however some of the thickness may comprise the patio and any underlying imported stone/gravel structural make-up used in the patio construction.

The council will require that all imported clean cover soils are suitable, and that there is appropriate sampling and testing of this soil, and a verification report is produced. Reference should be made to the Welsh Land Contamination Working Group (WLGA) document - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems'.

For the garden and soft landscaped areas :

- Cover systems, 600 mm in thickness, are to extend across the whole garden area, regardless of the proposed surface cover (this includes any decking and any areas of artificial lawn).
- Clean cover in garden and soft landscaping area to comprise a minimum thickness of 150 mm of topsoil over a 450 mm thick subsoil.
- No soils are to be imported to site until information on their source, the results of any soil analysis, and an assessment of their suitability for use. This is to ensure that soils used as part of the proposed development are suitable for use, and contaminated soil is not brought on and used within developments.

The Site is located within an area where the radon risk is high, with an estimated 10-30% of properties affected by radon; therefore, full radon protective measures are required.

Whilst unexpected contamination is not anticipated, the proposed development could encounter previously unrecorded hotspots of contaminants. These will be assessed and mitigated in accordance with current good practice.

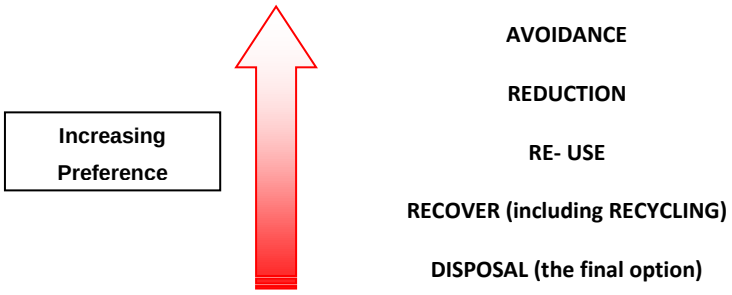
Hazard Identification				Hazard Assessment			
Link	**Contaminant**	**Pathway**	**Receptor**	**Probability**	**Consequence**	**Risk**	**Hazard Assessment**
1	Contaminated soil/groundwater Potential for Made Ground associated with existing structures. Metals, PAHs, ACMs	Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	A- Humans using the site during construction.	Likely	Mild	Moderate / Low	Made ground identified with elevated heavy metals. **Recommendation:** Construction workers should employ appropriate PPE and standard site safety measures during construction.
2		Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	B- Humans using the site after development completion. No change of use.	Likely	Medium	Moderate	Made ground identified with elevated heavy metals. **Recommendation:** Where soft landscaping proposed a cover layer may be required to break the pollutant linkage. Where hardstanding is present no further remedial works will be required.
3		Via service pipes	B- Humans using the site after construction. F- Building structures.	Likely	Mild	Moderate / Low	No hydrocarbon contamination present at pipeline depth (0.75-1.35mbgl). **Recommendation:** Should water pipes be installed a Risk Assessment should be undertaken. It is unlikely that barrier pipe will be required.
4	TPHs	Dermal contact, ingestion, and inhalation.	A - Humans using the site during construction.	Low	Mild	Low	Hydrocarbon contamination encountered in perched water at depth. No contamination encountered in the surrounding area, potentially from an offsite source. **Recommendation**: Watching brief required during construction phase.

Hazard Identification				Hazard Assessment			
Link	**Contaminant**	**Pathway**	**Receptor**	**Probability**	**Consequence**	**Risk**	**Hazard Assessment**
5		Migration of contaminated groundwater (vertical/lateral).	B - Humans using the site after development completion. No change of use.	Low	Medium	Moderate / Low	Hydrocarbon contamination encountered in perched water at depth. Clay present preventing migration. No hydrocarbon vapours detected during monitoring. **Recommendation**: Watching brief required during construction phase.
6	Potential hazardous gases from onsite made ground and potential offsite infilled features.	Migration and accumulation of hazardous ground gasses and vapours (vertical/lateral) leading to asphyxiation (carbon dioxide) and explosion (methane, hydrocarbons).	A & B - Humans using the site during construction and after development completion.	Unlikely	Severe	Moderate / Low	No putrescible made ground encountered during site investigation works. Gas monitoring shows no flow and no elevated levels of ground gas. **Recommendation**: No further works required.
7	Radon	Migration and accumulation of hazardous ground gasses and vapours (vertical/lateral) leading to asphyxiation (carbon dioxide) and explosion (methane, hydrocarbons).	B - Humans using the site after development completion.	Likely	Severe	**High**	Radon risk is 10-30% of estimated properties affected. **Recommendation:** Full Radon protection required in the new build property.
8	Aggressive ground conditions	Direct contact with infrastructure.	F - Building structures	Unlikely	Medium	Low	No elevated levels of Sulphate or low pH encountered in any of the soil samples taken. **Recommendation:** Sulphate resistant concrete is not required onsite. DS-1 AC-1s acceptable.

8 WASTE ASSESSMENT

8.1 Waste Hierarchy

In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



8.2 Waste Characterisation and Classification

If there is a portion of excess soil this will then have to be sent to a suitable landfill site. A two-phase approach is required comprising:

- Waste Characterisation; and
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that the materials encountered during the investigation can be classified as non hazardous.

Waste Classification

In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. Limited WAC testing was carried out as part of this investigation, with 1no. sample within the made ground in WS01 at 0.40m bgl being tested.

If quantities of material are to be removed from site, further WAC testing will have to be carried out to confirm the landfill waste classification and if any pre-treatment is required. This is best carried out once all material to be disposed of is stockpiled, and volumes can be accurately assessed. It should be noted that natural clay can be classified as Inert Waste 17 05 04: Soil and stones only (excluding topsoil, peat, soil and stones).

Testing Frequency

There are also set requirements for the required sampling and testing frequencies for materials being sent for disposal at landfills. The required testing frequencies for each different waste type are summarised in **Table 8.1** below.

Table 8.1: Laboratory Sampling Testing Frequencies

Testing Level	Quantity of Waste	Number of Samples	
		Homogeneous	Heterogeneous & New Wastes
Level 1 Characterisation (Description, Total Concentrations & Leaching)	<100T	2	5
	<500T	3	8
	<1000T	5	14
	10,000 T	11	22
	Per additional 10,000T	+5 pro rata	+10 pro rata
Level 2 Compliance For Regularly Generated Wastes (Total Concentrations & Leaching)		1 per defined waste sub-population per year	3 per defined waste sub-population per year
Level 3 Verification Delivery document & visual check		Visual – Each Load	Visual – Each Load
Chemical testing as per Level 2 suite		1 per year per waste stream	3 per year per waste stream

9 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

9.1 Fieldwork and Laboratory Data Review

The proposed development includes the construction of a detached dwelling.

The topography of the site slopes from south to north ranging from approximately 237.34mAOD in the west of site to approximately 241.34mAOD in the east toward the front of the drive.

The shallow ground conditions predominantly comprise dark brown slightly sandy gravelly silt, varying in thickness from 0.27m to 0.45m, and made ground comprising of reworked dark brown slightly sandy gravelly silt with red brick fragments.

The natural strata comprise of medium dense to very dense light brown sandy gravel and overlying stiff to very stiff brown mottled grey sandy clay.

The natural gravels should prove suitable for conventional spread foundations (pads/strips). The classification test results on the clay strata underlying the gravel are summarised below:

Table 9.1: Summary of Classification Testing

Hole	Depth (m)	Moisture Content (%)	% passing 425um sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Modified Plasticity Index	Plasticity	Volume Change Potential
WS02	2.95	11	67	31	24	7	5	Low	Low
WS04	2.50	19	93	36	23	13	12	Intermediate	Low
Minimum		***11***	***67***	***31***	***23***	***7***	***4.69***		
Average		***15.0***	***80.0***	***33.5***	***23.5***	***10.0***	***8.4***		
Maximum		***19***	***93***	***36***	***24***	***13***	***12.09***		

Testing indicates that the clays show no evidence of desiccation with moisture contents lower than the plastic limits, and a low volume change potential. Should foundations be laid in the natural clay strata, they may require deepening in line with NHBC Chapter 4.2 (2024) with regards to the zone of influence of vegetation.

SPT N-values were recorded throughout each borehole and are summarised in **Table 9.2** below for the material encountered.

Table 9.2: Summary of SPT N Values

Location	Depth (m bgl)	SPT N Values	Stratum	Estimated Allowable Bearing Capacity* (kN/m²)
WS01	1.00	25	Gravel	125
	2.00	50	Gravel	225
	2.60	50	Gravel	218
WS02	0.50	24	Gravel	133
	2.00	30	Clay	261
	2.70	50	Clay	419
WS03	0.60	36	Gravel	194
	2.00	30	Gravel	135
	3.00	50	Clay	414
WS04	1.00	32	Gravel	159
	2.00	32	Clay	279
	2.70	50	Clay	419

*Approximate ABC of a strip foundation using a Factor of Safety of 2.5.

9.2 Trees

A number of mature trees and bushes are located on or adjacent to the site boundaries. Foundations for the proposed development are likely to be constructed within the sandy gravel deposits therefore provisions associated with tree effects may be suspended as the granular strata is not moisture sensitive. If cohesive deposits are encountered at foundation depth, consideration for volume change potential clay should be given.

9.3 Foundation Recommendations

For the purpose of this assessment, it is assumed the site will not be subject to extensive reprofiling.

It should be noted that made ground is not a suitable founding strata.

It is anticipated that spread footings could be adopted for the foundations at this site but that the following factors should be taken into account for the design:

- the potential variability of the formation material across new building giving the potential for differential settlements

- take into account that the footings of the current building will be present and that the foundations for the new building will interact these;

It is recommended that for preliminary design purposes that a deep trench fill type strip footing 600mm wide at a depth of around 1.10m and a net allowable bearing capacity of 150kN/m^2 would be appropriate. Foundations may need to be deepened depending on ground conditions encountered. Should any soft spots or deeper than expected made ground be encountered, it is recommended that these are removed and infilled with a suitably compacted granular material.

When footings have been initially sized then full design of these should be carried out in accordance with BS EN 1997-1: 2004 +A1 2013: Eurocode 7 – Geotechnical Design – Part 1: General rules (including UK National Annex of November 2007) and BS8004:2015: Code of practice for foundations.

9.4 Ground Floor Slab Recommendations

It is recommended that suspended floors are adopted for the building due to the requirements of radon gas protection measures.

9.5 Groundwater Conditions

3no. rounds of groundwater monitoring have been carried out to date by GroundSolve in the monitoring well installations. Groundwater level varies between 1.96 – 2.44m bgl.

9.6 Reuse of Materials

The sandstone gravel deposits between 0.74m and 2.00m are considered suitable as structural fill material subject to placement and compaction with an approved earthworks specification. Material beyond 2.00m bgl, although unlikely to be excavated or removed. The made ground and topsoil onsite should not be reused for residential purposes, unless under hard standing areas, due to the elevated Lead concentrations across the site.

9.7 Groundwater & Excavations

It is not expected that groundwater will be encountered in any excavations at this site, unless excavated to depths >1.90m bgl. It is anticipated that any groundwater in excavations can be controlled by sump pumping. If inflows are relatively localised, this may cause softening of the ground if excavations extend into the clay, and require localised excavation support in order to prevent instability of the sides of excavations.

Excavations through the soils to a depth of about 2.30m may be unstable as a result of non-cohesive properties of granular material, and it should be expected that these will gradually collapse into excavations, leading to instability of the sides of excavations. All excavations should be carried out in accordance with CIRIA Report 97 "Trenching Practice" and BS6031: 2009: Code of Practice for Earthworks. Further guidance on this aspect of site works is given in the British Standards for "Workmanship on Building Sites", BS 8000, Parts 1 and 14, and in the Construction Industry Training Board's Site Safety Note 10.

Excavation depths should generally be readily achieved using conventional hydraulic plant (e.g. wheeled JCB or similar) although larger plant will have higher excavation rates.

9.8 Buried Concrete and Pipework

The results of laboratory pH and sulphate content indicate that ACEC Class AC-1s conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore, special precautions are not required at the site for the design of concrete in terms of the durability and structural performance.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Remediation and Validation Recommendations

Elevated levels of lead have been noted in the topsoil across the site. As such some remediation is recommended to address this and sever the pollutant linkage.

The site is also within an area of elevated Radon. Radon protection measures will be required within any new build property.

GSL should stress that no remediation, enabling works or designing works should take place until Regulatory approval has been obtained.

The relevant contractors should be briefed that during development works at the site should any unusual ground conditions and / or visual or olfactory evidence of contamination (including asbestos containing material) be encountered at the site, GSL and the Local Authority should be informed, and further assessment of the material may be required.

10.2 Capping Layer

It is recommended that, in garden and soft landscaping areas, all impacted soils are removed, either to 0.60mbgl or to clean natural strata. The levels can then be built back up with a suitably validated clean topsoil to provide an environmental cover system.

It is recommended that these works are validated by a suitable third party to ensure that the correct depth of a suitable material has been emplaced in line with guidance laid out by the Welsh Land Contamination Working Group (WLGA/CLILC).

10.3 Radon Protection

The BRE document BR211 (2007) has example of ‘full’ protection designs and include:

- Suspended concrete floor with void, cavity tray and radon gas membrane; or
- Suspended beam and block with vented void using a periscopic vent and radon gas membrane; or
- Cast in-situ concrete floor with cavity tray and radon gas membrane.

GSL advise that final foundation details should be provided to the Local Authority for review.

10.4 Gas Monitoring

Based on the findings to date of the gas monitoring that has been undertaken, it is not considered that there is a significant risk to the proposed development from ground gas and as such further monitoring is not required. Three visits have been undertaken and no elevated levels of Carbon Dioxide or Methane have been identified and no flow has been noted despite monitoring during worst case temporal conditions (below 1000mb).

10.5 Validation of Subsoil / Topsoil

Chemical validation of any imported soils to be used on site in soft landscaping areas should be undertaken. Imported soils should be accompanied by a certificate of analysis and source details.

A summary of the required imported material sampling requirements is presented in **Table 10-1**. Ideally, the material should be sampled at source to prevent double handling if soil fails, with confirmatory sampling undertaken on importation to site. However, where this is not possible then material imported should be segregated based on source and soil type. Validation samples should be taken prior to placement in gardens to ensure suitability for use.

Table 10.1: Imported Material Sampling Requirements

Material Type	Source	Suite of Analysis	Sampling Rate*
Topsoil	Greenfield	Standard metals/metalloids, PAH (16 USEPA speciation), asbestos, pH and Soil Organic Matter (SOM) (or calculated from Total Organic Carbon (TOC)).	4 samples per 250m^3 (Minimum 4 samples per source)
	Brownfield / Unknown	Standard metals/metalloids, PAH (16 USEPA speciation), TPH (CGW banded) asbestos, pH and SOM/TOC.	

Sampling rates as per WLGA/CLILC guidance.

Any soil with visual or olfactory evidence of hydrocarbons should be rejected.

In addition, it should be ensured that the matrix of the topsoil is suitable as a growing medium and no undesirable material is present (in line with BS3882). GSL advise this information is provided by the supplier before material is imported onto site.

Imported material to be used in gardens will be compared against Residential with home produce criteria (as used in the contamination risk assessment in Section 7).

10.6 Site Completion Report

It is recommended that any remediation carried out on the site is validated by a third party and suitable documentary evidence provided in a Site Completion Report, such as photographs, consignment documents and analytical results. This should include as a minimum:

- Details of the demolition of the current building within a Pre-Demolition and Major Refurbishment Asbestos Survey.
- Provision of any waste transfer documents.
- Verification testing of any imported soil for soft landscaping areas.
- Details of any unexpected contamination identified onsite, suitably risk assessed and / or validated.

The Site Completion Report will assist the Local Authority in the discharge of any future relevant planning condition and will also be of use to solicitors acting on behalf of any prospective conveyancer who may have concerns over the former use of the site.

10.7 Regulatory Liaison

Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g., local authority environmental health officer, Environment Agency etc) to obtain Planning Permission prior to commencement of the works and should be agreed with the NHBC or similar, or with the local authority building control officer prior to commencement of the works. Where remediation works are required, a verification report should be submitted to the relevant authorities for approval in accordance with relevant Planning Conditions.

10.8 Health and Safety

As outlined within the HSE publication “Successful Health and Safety Management – HSG65” this report should inform your development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.

In accordance with the Construction Design and Management (CDM) Regulations 2015, Groundsolve has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report, GroundSolve has discharged and completed all contractual and legal requirements for these positions, and we have no further involvement with the project.

11 REFERENCES

BRE BR211 (2015). Radon: Guidance on Protective Measures for New Dwellings. IHS BRE Press, Bracknell.

BRE SD1 (2005). Concrete in Aggressive Ground. Special Digest 1 (revised edition). IHS BRE Press, Bracknell.

BRE 414 (2001) Protective measures for housing on gas-contaminated land. BRE.

BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites - Code of Practice. British Standards Institution, London.

BS5930:2015+A12020 Code of practice for ground investigations BSI

BS8485 2015 Code of Practice for the design of protective measures for methane and carbon dioxide ground gases in new buildings. British Standards

BS8576-2013 Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs). BSI,

CIRIA Rep R 132 (1996) A Guide for Safe Working on Contaminated Sites. Report 132, CIRIA, London.

CIRIA C552 (2001) Contaminated land risk assessment. A guide to good practice (report no. C552).

CIRIA C665 (2007) Assessing the risks posed by hazardous gases to buildings CIRIA, London

CIRIA C681 (2009) Unexploded ordnance (UXO) A guide for the construction industry (C681)

CIRIA C785 (2019) Unexploded ordnance (UXO) risk management guide for land-based projects (C785)

CIRIA C758D (2019) Abandoned mine workings manual (C758D)

Contaminated Land: Applications in Real Environments (CL:AIRE) (2011) Definition of Waste Code of Practice (version 2).

Department of Environment Food and Rural Affairs (DEFRA) (2012) Environmental Protection Act 1990:Part 2A Contaminated Land Statutory Guidance (report no. PB13735).

Environment Agency (2000) Technical Aspects of Site Investigation. Report P5-065/TR, Environment Agency, Bristol.

Environment Agency (2002) Guidance on Monitoring Landfill Leachate, Groundwater and Surface Water. Report LFTGN02, Environment Agency, Bristol.

Environment Agency (2007) Evaluation of Models for Predicting Plant Uptake of Chemicals from Soil. Report SC050021/SR, Environment Agency, Bristol.

Environment Agency (2015) Guidance on the Classification and Assessment of Waste Technical Guidance WM3 (1st edition).European Union (1998) Drinking Water Directive (Council Directive 98/83/EC).

Land Contamination Risk Management (LCRM) Environment Agency October 2020 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm .

LQM/CIEH Ltd (2015) S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.

SoBRA (2017) Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater – Version 1.0.

The Water Framework Directive, (Standards and Classification) Directions (England and Wales).

World Health Organisation (2017) Guidelines for Drinking Water Quality (4th edition).

Britain From Above - https://britainfromabove.org.uk/en/image/WPW060399

http://www.warstateandsociety.com/Bombing-Britain

https://www.epa.gov/pfas/basic-information-pfas

UK Maps of Radon, http://www.ukradon.org/information/ukmaps

Health and Safety Executive (2015) Construction (Design and Management) Regulations.

Coal Authority Interactive Map Viewer, http://mapapps2.bgs.ac.uk/coalauthority/home.html

BGS Geology of Britain Viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html

12 DEFINITIONS

AOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GQRA	Generic Quantitative Risk Assessment
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
ppm	Parts per million
ppmv	Parts per million by volume
SAC	Special Area of Conservation
SPZ	Source Protection Zone (see **Error! Reference source not found.**)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest

DRAWINGS

A3



Key

Window Sample Location

A	Original Drawing	06/04/2024
Revision	Description	Date

GroundSolve Ltd
Consulting Geotechnical Engineers

Unit 1, Charter Court
Well House Barns
Chester Road Bretton
Flintshire CH4 0DH

Tel: 01244 661361
Fax: 01244 661289

Job Title

Dolwar, Coedpoeth

Drawing Title

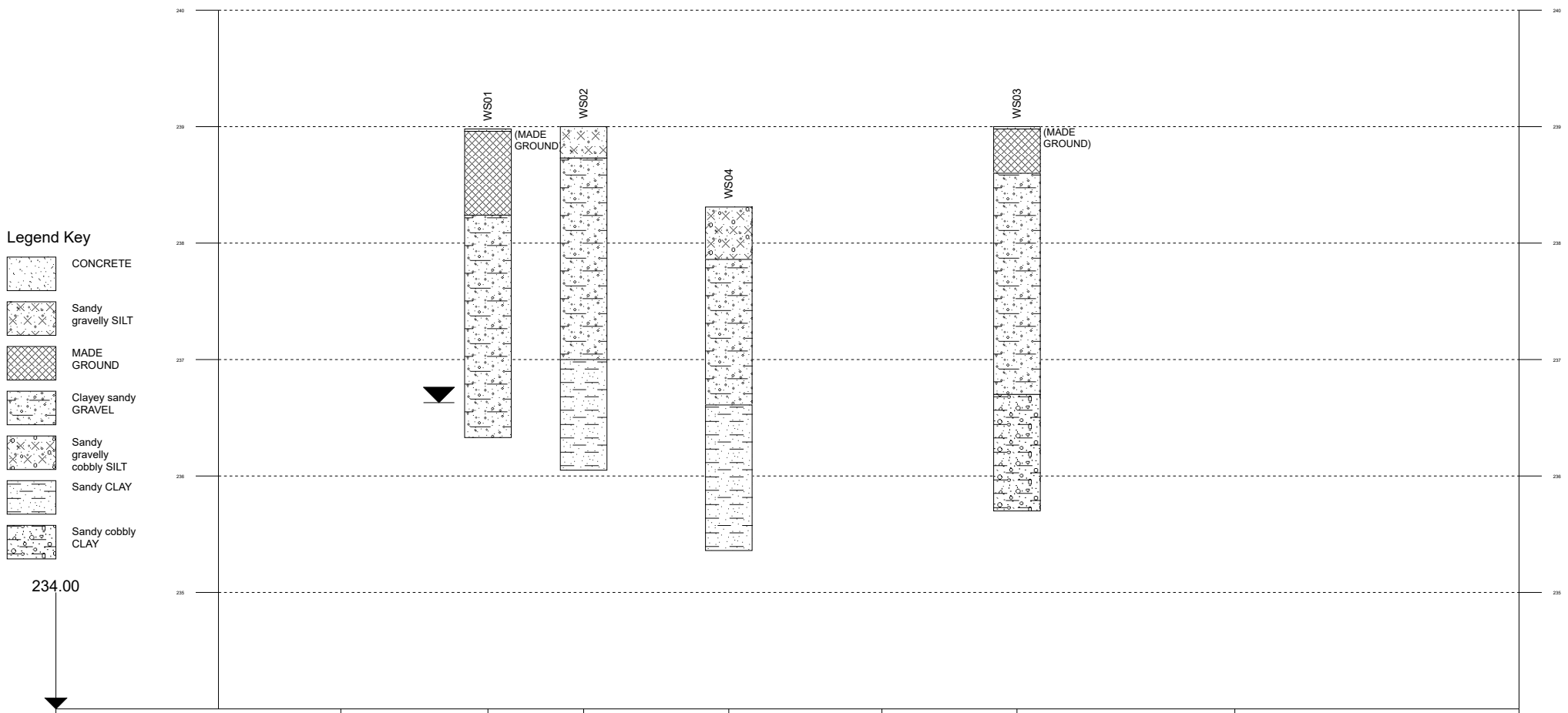
Existing Site Layout
Intusive Location Plan

Drawing Scale	Drawn By	Approved By
1:200 @A3	AR	SF

Drawing Status	Date of Issue
Information	06/03/2024

Drawing No	Revision
3035-DR-001	A

Project Id: 3035	Title: Section Line
Project Title: Dolwar, Coedpoeth	Vertical Scale: 1:50
Location: Wrexham	Horizontal Scale: 1:200
Client: Miss Kate Jarvis	Engineer:



Chainage (m)	0.00	5.05	8.33	13.32	18.57	23.21	30.69
Elevation (mAOD)		238.98	239.00	238.31		239.00	
Offset (m)		0.38	1.87	2.29		3.61	

APPENDIX A – SITE PHOTOGRAPHS

SITE PHOTOGRAPHS





Photo 1



Photo 2



Photo 3



Photo 4



Photo 5



Photo 6



Photo 7



Photo 8

APPENDIX B – EXPLORATORY HOLE RECORDS

GroundSolve Ltd	Windowless Sample Record	WS01

Project Name: Dolwar, Coedpoeth	Client: Miss Kate Jarvis	Date: 14/02/2024
Location: Wrexham	Contractor: GroundSolve LTD	Co-ords: E328342.00 N350953.00
Project No. : 3035	Crew Name: Macklin Geotech	Drilling Equipment: Competitor Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS01	WS	238.98m AoD	AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.02	238.96		Concrete slab
		0.40	ES					Stiff dark brown slightly sandy gravelly SILT. Gravels are subangular to subrounded fine to coarse sandstone and occasional red brick, concrete and rare bituminous gravels. (MADE GROUND)
					0.74	238.24		Medium dense to very dense light brown slightly clayey sandy fine to coarse sub angular GRAVEL of sandstone with low sandstone cobbles content. (Completely weathered SANDSTONE)
		1.00	B					
		1.00	D					
		1.00	ES					
		1.00	SPT	N=25 (8,7/7,6,6,6)				
		1.45	D					
		2.00	SPT	N=50 (13,11/13,13,19,5)				*From 2.00m becomes very dense.*
	▼							*From 2.35m oily sheen with mild odour noted*
		2.45	D					
		2.60	SPT	50 (25 for 27mm/50 for 22mm)				
		2.65	ES		2.65	236.33		End of Borehole at 2.650m

1 2 3 4 5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
2.65	102										

Remarks

Groundwater strike at 2.35m bgl. Stable.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH


GroundSolve Ltd
Consulting Geotechnical Engineers
PROJECT NAME
DOLWAR COED POETH
DATE
14/2/24
PROJECT NO.
3035
CLIENT
BOREHOLE NO.
WS01
BOX NO.
DEPTH FROM
1.20
M
TO
M

WS01

GroundSolve Ltd	Windowless Sample Record	WS02

Project Name: Dolwar, Coedpoeth	Client: Miss Kate Jarvis	Date: 14/02/2024
Location: Wrexham	Contractor: GroundSolve LTD	Co-ords: E328339.00 N350955.00
Project No. : 3035	Crew Name: Macklin Geotech	Drilling Equipment: Competitor Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS02	WS	239.00m AoD	AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10	ES					Soft dark brown slightly sandy gravelly SILT. Gravels are subangular to subrounded fine to coarse sandstone.
					0.27	238.73		
		0.50	ES					Medium dense to dense light brown slightly clayey sandy fine to coarse sub angular GRAVEL of sandstone with low sandstone cobble content. (Completely weathered SANDSTONE)
		0.50	SPT	N=24 (5,5/5,7,7,5)				
		0.95	D					
		2.00	SPT	N=30 (6,7/7,7,8,8)	2.00	237.00		Very stiff brown mottled grey very sandy CLAY. (Completely weathered MUDSTONE)
		2.45	D					
		2.70	ES					
		2.70	SPT	50 (12,13/50 for 30mm)				
		2.95	D		2.95	236.05		End of Borehole at 2.950m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
2.95	102										

Remarks

Dry and stable.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 1 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
PROJECT NAME
DOLWAR COED POETH
DATE
14/2/24
PROJECT NO.
3035
CLIENT
BOREHOLE NO.
WS02
BOX NO.
DEPTH FROM
1.00
TO
2.70

WS02

GroundSolve Ltd	Windowless Sample Record	WS03

Project Name: Dolwar, Coedpoeth	Client: Miss Kate Jarvis	Date: 14/02/2024
Location: Wrexham	Contractor: GroundSolve LTD	Co-ords: E328341.00 N350964.00
Project No. : 3035	Crew Name: Macklin Geotech	Drilling Equipment: Competitor Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS03	WS	239.00m AoD	AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.02	238.98		Concrete slab
		0.20	ES					Soft dark brown slightly sandy gravelly SILT. Gravels are subangular to subrounded fine to coarse sandstone, occasional red brick and red bituminous material.
					0.40	238.60		(MADE GROUND)
		0.60	ES					Dense light brown slightly clayey sandy fine to coarse sub angular GRAVEL with moderate sandstone cobble content. (Completely weathered SANDSTONE)
		0.60	SPT	N=36 (3,3/36 for 290mm)				
		1.00	B					
		1.00	D					
		1.45	D					
		2.00	SPT	N=30 (10,10/8,8,7,7)				
		2.20	ES					
					2.30	236.70		Very stiff brown mottled grey very sandy CLAY with low sandstone cobble content. (Completely weathered MUDSTONE)
		2.45	D					
		2.50	D					
		3.00	SPT	N=50 (8,8/50 for 285mm)				
		3.30	D		3.30	235.70		End of Borehole at 3.300m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
3.30	102										

Remarks

Dry and stable.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH


GroundSolve Ltd
Consulting Geotechnical Engineers
Unit 7 Well House Barns
Chester Road
Bretton, CH4 0DH
01244 661361
www.groundsolve.com
enquiries@groundsolve.com
DOLWAR COED POETH
14/2/24
PROJECT NO.
3035
CLIENT
BOREHOLE NO.
WS03
BOX NO.
DEPTH FROM
1.20
TO
2.00

WS03

GroundSolve Ltd	Windowless Sample Record	WS04

Project Name: Dolwar, Coedpoeth	Client: Miss Kate Jarvis	Date: 14/02/2024
Location: Wrexham	Contractor: GroundSolve LTD	Co-ords: E328336.00 N350959.00
Project No. : 3035	Crew Name: Macklin Geotech	Drilling Equipment: Competitor Dart

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS04	WS	238.31m AoD	AR	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.40	ES		0.45	237.86		Soft dark brown slightly sandy gravelly SILT with low sandstone cobble content. Gravels are subangular to subrounded fine to coarse sandstone
		0.50	D					Dense light brown slightly clayey sandy fine to coarse sub angular GRAVEL with low sandstone cobble content. (Completely weathered SANDSTONE)
		1.00	B					
		1.00	D					
		1.00	SPT	N=32 (9,9/8,8,8,8)				
		1.45	D					
		1.70	ES		1.70	236.61		Very stiff brown mottled grey very sandy CLAY. (Completely weathered MUDSTONE)
		2.00	SPT	N=32 (6,7/7,7,9,9)				
		2.45	D					
		2.50	D					
		2.70	SPT	50 (25 for 75mm/50 for 24mm)				
		2.95	D		2.95	235.36		End of Borehole at 2.950m

1 2 3 4 5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
2.95	102										

Remarks

Dry and stable.

GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
CH4 0DH

APPENDIX C – CHEMICAL TEST RESULTS

Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone: (01424) 718618

cs@elab-uk.co.uk
info@elab-uk.co.uk

Certificate of Analysis

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number:	24-52388
Issue:	1
Date of Issue:	23/02/2024
Contact:	Alex Ridge
Customer Details:	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton FlintshireCH4 0DH
Quotation No:	Q24-04319
Order No:	Not Supplied
Customer Reference:	3035
Date Received:	16/02/2024
Date Approved:	23/02/2024
Details:	Dolwar, Coedpoeth
Approved by:	

Ben Rees, Customer Services Assistant

Sample Summary

Report No.: 24-52388, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
353056	WS01 0.40	14/02/2024	16/02/2024	Silty loam	
353057	WS01 1.00	14/02/2024	16/02/2024		
353058	WS01 2.65	14/02/2024	16/02/2024	Sandy loam	
353059	WS02 0.10	14/02/2024	16/02/2024	Silty loam	
353060	WS02 0.50	14/02/2024	16/02/2024		
353061	WS02 2.70	14/02/2024	16/02/2024	Sandy silty loam	
353062	WS03 0.20	14/02/2024	16/02/2024		
353063	WS03 0.60	14/02/2024	16/02/2024	Silty clayey loam	
353064	WS03 2.20	14/02/2024	16/02/2024	Sandy loam	
353065	WS04 0.40	14/02/2024	16/02/2024	Silty loam	
353066	WS04 1.70	14/02/2024	16/02/2024		

Results Summary

Report No.: 24-52388, issue number 1

				ELAB Reference	353056	353058	353059	353061	353063	353064	353065
				Customer Reference							
				Sample ID							
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Location	WS01	WS01	WS02	WS02	WS03	WS03	WS04
				Sample Depth (m)	0.40	2.65	0.10	2.70	0.60	2.20	0.40
				Sampling Date	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024
Determinand	**Codes**	**Units**	**LOD**								
Soil sample preparation parameters											
Moisture Content	N	%	0.1		22.4	14.2	26.4	12.9	16.2	11.7	18.6
Stones Content	N	%	0.1		14.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Material removed	N	%	0.1		14.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Description of Inert material removed	N		0		Stones	None	None	None	None	None	None
Metals											
Arsenic	M	mg/kg	1		30.4	8.3	17.0	10.7	9.3	7.2	15.3
Cadmium	M	mg/kg	0.5		5.2	< 0.5	1.7	0.5	1.3	0.5	1.1
Chromium	M	mg/kg	5		131	25.5	19.1	26.9	19.4	26.0	17.7
Copper	M	mg/kg	5		382	40.0	97.5	37.4	21.8	21.8	32.5
Lead	M	mg/kg	5		442	29.3	486	116	222	58.9	336
Mercury	M	mg/kg	0.5		1.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nickel	M	mg/kg	5		124	34.0	26.9	31.3	22.0	31.1	29.3
Selenium	M	mg/kg	1		1.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc	M	mg/kg	5		914	84.8	252	122	300	149	200
Anions											
Water Soluble Sulphate	M	g/l	0.02		0.06	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02
Inorganics											
Total Cyanide	M	mg/kg	1		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02		0.10	< 0.02	n/t	< 0.02	< 0.02	< 0.02	n/t
Miscellaneous											
Acid Neutralisation Capacity	N	mol/kg	0.1		< 0.1	n/t	n/t	n/t	n/t	n/t	n/t
Loss on Ignition	M	%	0.01		10.6	n/t	n/t	n/t	n/t	n/t	n/t
pH	M	pH units	0.1		8.3	8.0	7.1	7.3	7.9	7.8	7.0
Soil Organic Matter	U	%	0.1		4.6	0.9	5.6	2.3	1.5	0.7	3.3
Total Organic Carbon	N	%	0.01		12	1.1	11	3.0	0.66	0.50	3.8

Tests marked N are not UKAS accredited.
The Environmental Laboratory Ltd. Reg. No. 3882193

Results Summary

Report No.: 24-52388, issue number 1

			ELAB Reference	353056	353058	353059	353061	353063	353064	353065
			Customer Reference							
			Sample ID							
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	WS01	WS01	WS02	WS02	WS03	WS03	WS04
			Sample Depth (m)	0.40	2.65	0.10	2.70	0.60	2.20	0.40
			Sampling Date	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024
Determinand	**Codes**	**Units**	**LOD**							
Organics										
>C8-C10 BCB (EH_1D_Total)	N	mg/kg	1	< 1.0	15.6	n/t	< 1.0	< 1.0	< 1.0	n/t
>C10-C12 BCB (EH_1D_Total)	N	mg/kg	1	< 1.0	81.5	n/t	< 1.0	< 1.0	< 1.0	n/t
>C12-C16 BCB (EH_1D_Total)	N	mg/kg	1	< 1.0	653	n/t	1.5	< 1.0	< 1.0	n/t
>C16-C21 BCB (EH_1D_Total)	N	mg/kg	1	< 1.0	940	n/t	3.9	< 1.0	< 1.0	n/t
Diesel Range Organics (>C8-C21) (EH_1D_Total)	N	mg/kg	1	< 1	1690	n/t	5	< 1	< 1	n/t
Phenols										
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons										
Naphthalene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)anthracene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b)fluoranthene	N	mg/kg	0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1,2,3-cd)pyrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dibenzo(a,h)anthracene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo[g,h,i]perylene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Coronene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH(16)	N	mg/kg	2	3.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	2.4
Total (of 17) PAHs	N	mg/kg	2	3	n/t	n/t	n/t	n/t	n/t	n/t

Results Summary

Report No.: 24-52388, issue number 1

				ELAB Reference	353056	353058	353059	353061	353063	353064	353065
				Customer Reference							
				Sample ID							
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Location	WS01	WS01	WS02	WS02	WS03	WS03	WS04
				Sample Depth (m)	0.40	2.65	0.10	2.70	0.60	2.20	0.40
				Sampling Date	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024	14/02/2024
Determinand	**Codes**	**Units**	**LOD**								
BTEX											
Benzene	M	ug/kg	10	< 10.0	< 10.0	n/t	< 10.0	< 10.0	< 10.0	n/t
Toluene	M	ug/kg	10	< 10.0	< 10.0	n/t	< 10.0	< 10.0	< 10.0	n/t
Ethylbenzene	M	ug/kg	10	< 10.0	< 10.0	n/t	< 10.0	< 10.0	< 10.0	n/t
Xylenes	M	ug/kg	10	< 10.0	< 10.0	n/t	< 10.0	< 10.0	< 10.0	n/t
MTBE	U	ug/kg	10	< 10.0	< 10.0	n/t	< 10.0	< 10.0	< 10.0	n/t
Total BTEX	M	mg/kg	0.01	< 0.01	n/t	n/t	n/t	n/t	n/t	n/t
TPH CWG											
>C5-C6 Aliphatic (HS_1D_MS_AL)	N	mg/kg	0.01	< 0.01	< 0.01	n/t	< 0.01	< 0.01	< 0.01	n/t
>C6-C8 Aliphatic (HS_1D_MS_AL)	N	mg/kg	0.01	< 0.01	< 0.01	n/t	< 0.01	< 0.01	< 0.01	n/t
>C8-C10 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	< 1.0	19.0	n/t	< 1.0	< 1.0	< 1.0	n/t
>C10-C12 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	< 1.0	85.0	n/t	< 1.0	< 1.0	< 1.0	n/t
>C12-C16 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	< 1.0	539	n/t	2.2	< 1.0	< 1.0	n/t
>C16-C21 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	< 1.0	631	n/t	4.7	< 1.0	< 1.0	n/t
>C16-C35 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	2.3	894	n/t	15.0	< 1.0	< 1.0	n/t
>C21-C35 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	2.3	264	n/t	10.4	< 1.0	< 1.0	n/t
>C35-C40 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	2.9	2.3	n/t	< 1.0	< 1.0	< 1.0	n/t
Total (>C5-C40) Aliphatic (HS_1D_MS+EH_CU_1D_AL)	N	mg/kg	1	5.2	1540	n/t	17.3	< 1.0	< 1.0	n/t
>C5-C7 Aromatic (HS_1D_MS_AR)	N	mg/kg	0.01	< 0.01	< 0.01	n/t	< 0.01	< 0.01	< 0.01	n/t
>C7-C8 Aromatic (HS_1D_MS_AR)	N	mg/kg	0.01	< 0.01	< 0.01	n/t	< 0.01	< 0.01	< 0.01	n/t
>C8-C10 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	< 1.0	17.6	n/t	< 1.0	< 1.0	< 1.0	n/t
>C10-C12 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	< 1.0	77.2	n/t	< 1.0	< 1.0	< 1.0	n/t
>C12-C16 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	< 1.0	536	n/t	2.2	< 1.0	< 1.0	n/t
>C16-C21 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	< 1.0	642	n/t	4.3	< 1.0	< 1.0	n/t
>C21-C35 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	< 1.0	278	n/t	11.0	< 1.0	< 1.0	n/t
>C35-C40 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	< 1.0	< 1.0	n/t	< 1.0	< 1.0	< 1.0	n/t
Total (>C5-C40) Aromatic (HS_1D_MS+EH_CU_1D_AR)	N	mg/kg	1	< 1.0	1550	n/t	17.4	< 1.0	< 1.0	n/t
Total (>C5-C40) Ali/Aro (HS_1D_MS+EH_CU_1D_Total)	N	mg/kg	1	5.2	3090	n/t	34.7	< 1.0	< 1.0	n/t
Total Petroleum Hydrocarbons											
Mineral Oil w Florisil (EH_CU_1D_Total)	N	mg/kg	5	< 5	1850	n/t	11	< 5	< 5	n/t
PCB (ICES 7 congeners)											
Total PCBs (7 congeners)	N	mg/kg	0.03	< 0.03	n/t	n/t	n/t	n/t	n/t	n/t

Tests marked N are not UKAS accredited.

Results Summary

Report No.: 24-52388, issue number 1

WAC Analysis								
Elab Ref:	353056					**Landfill Waste Acceptance Criteria Limits***		
Sample Date:	14/02/2024					**Inert Waste Landfill**	**Stable Non-reactive Hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID:	WS01							
Depth (m):	0.4							
Site:	Dolwar, Coedpoeth							
Determinand		**Code**	**Units**					
Total Organic Carbon		N	%		12.00	3	5	6
Loss on Ignition		M	%		10.6	--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		N	mg/kg		< 0.03	1	--	--
TPH Total WAC (EH_CU_1D_Total)		N	mg/kg		< 5	500	--	--
Total (of 17) PAHs		N	mg/kg		3.0	100	--	--
pH		M			8.3	--	>6	--
Acid Neutralisation Capacity		N	mol/kg		< 0.1	--	To evaluate	To evaluate
Eluate Analysis			**2:1**	**8:1**	**10:1**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
			mg/l	**mg/l**	**mg/kg**			
Arsenic		N	< 0.005	< 0.005	< 0.05	0.5	2	25
Barium		N	0.020	0.008	0.10	20	100	300
Cadmium		N	< 0.001	< 0.001	< 0.01	0.04	1	5
Chromium		N	< 0.005	< 0.005	< 0.05	0.5	10	70
Copper		N	< 0.005	< 0.005	< 0.05	2	50	100
Mercury		N	< 0.005	< 0.005	< 0.01	0.01	0.2	2
Molybdenum		N	0.008	< 0.005	< 0.05	0.5	10	30
Nickel		N	0.023	< 0.001	< 0.05	0.4	10	40
Lead		N	0.002	< 0.001	< 0.05	0.5	10	50
Antimony		N	< 0.005	< 0.005	< 0.05	0.06	0.7	5
Selenium		N	< 0.005	< 0.005	< 0.05	0.1	0.5	7
Zinc		N	0.005	< 0.005	< 0.05	4	50	200
Chloride		N	2.000	1.000	< 50	800	15000	25000
Fluoride		N	< 1	< 1	< 10	10	150	500
Sulphate		N	15.000	3.000	44.90	1000	20000	50000
Total Dissolved Solids		N	123.000	48.000	568.00	4000	60000	100000
Phenol Index		N	< 0.01	< 0.01	< 0.10	1	-	-
Dissolved Organic Carbon		N	15.800	4.930	62.00	500	800	1000
Leach Test Information								
Eluent Volume (ml)		N	198	1370				
pH		N	7.6	7.6				
Conductivity (uS/cm)		N	184	72				
Temperature (°C)		N	18	17				
Solid Information								
Dry mass of test portion (g)			174					
Moisture (%)			30.9					

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards on Sea, East Sussex, TN38 9BY
Tel: +44 (0)1424 718618, Email: info@elab-uk.co.uk, Web: www.elab-uk.co.uk

Results Summary

Report No.: 24-52388, issue number 1

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

In accordance with procedures, a 1kg soil sample should be analysed. For amounts less than this caution should be used when analysing the data as sample size is smaller than the recommended amount, therefore samples could be deemed as not being representative of the materials present on site.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)	F/mm2 (I)
353056	0.40	WS01	Brown Soil, Stones, Clinker, Organics	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353058	2.65	WS01	Brown Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353059	0.10	WS02	Brown Soil, Stones, Clinker, Brick, China	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353061	2.70	WS02	Brown Soil, Stones, Clinker, Organics	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353063	0.60	WS03	Brown Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353064	2.20	WS03	Brown Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353065	0.40	WS04	Brown Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t

Method Summary

Report No.: 24-52388, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Acid Soluble Sulphate	U	Air dried sample	22/02/2024	115	Ion Chromatography
Aqua regia extractable metals	M	Air dried sample	19/02/2024	300	ICPMS
Phenols in solids	N	As submitted sample	19/02/2024	121	HPLC
PAH (GC-FID)	N	As submitted sample	19/02/2024	133	GC-FID
Water soluble anions	M	Air dried sample	19/02/2024	172	Ion Chromatography
Low range Aliphatic hydrocarbons soil	N	As submitted sample	21/02/2024	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	21/02/2024	181	GC-MS
Total cyanide	M	As submitted sample	20/02/2024	204	Colorimetry
Aliphatic hydrocarbons in soil	N	As submitted sample	21/02/2024	214	GC-FID
Aliphatic/Aromatic hydrocarbons in soil	N	As submitted sample	21/02/2024	214	GC-FID
Aromatic hydrocarbons in soil	N	As submitted sample	21/02/2024	214	GC-FID
Basic carbon banding in soil	N	As submitted sample	19/02/2024	218	GC-FID
Diesel range organics in soil	N	As submitted sample	20/02/2024	257	GC-FID
Asbestos identification	U	Air dried sample	21/02/2024	281	Microscopy
Soil organic matter	U	Air dried sample	19/02/2024	BS1377:P3	Titrimetry
TPH with Florisil clean up solids	N	As submitted sample	19/02/2024	GCL117	GC-FID
Leachate					
Arsenic	N		22/02/2024	301	ICPMS
Cadmium	N		22/02/2024	301	ICPMS
Chromium	N		22/02/2024	301	ICPMS
Lead	N		22/02/2024	301	ICPMS
Nickel	N		22/02/2024	301	ICPMS
Copper	N		22/02/2024	301	ICPMS
Zinc	N		22/02/2024	301	ICPMS
Mercury	N		22/02/2024	301	ICPMS
Selenium	N		22/02/2024	301	ICPMS
Antimony	N		22/02/2024	301	ICPMS
Barium	N		22/02/2024	301	ICPMS
Molybdenum	N		22/02/2024	301	ICPMS
pH Value	N		22/02/2024	113	Electrometric
Electrical Conductivity	N		22/02/2024	136	Probe
Dissolved Organic Carbon	N		22/02/2024	102	TOC analyser
Chloride	N		22/02/2024	270	Ion Chromatography
Fluoride	N		22/02/2024	270	Ion Chromatography
Sulphate	N		22/02/2024	270	Ion Chromatography
Total Dissolved Solids	N		22/02/2024	144	Gravimetric
Phenol index	N		22/02/2024	121	HPLC
WAC Solids analysis	N				
pH	M	Air dried sample	19/02/2024	113	Electrometric
Total Organic Carbon	N	Air dried sample	20/02/2024	210	IR
Loss on Ignition	M	Air dried sample	19/02/2024	129	Gravimetric
Acid Neutralisation Capacity	N	Air dried sample	19/02/2024	NEN 737	Electrometric
Total BTEX	M	As submitted sample	21/02/2024	181	GCMS
Mineral Oil (EH_CU_1D_Total)	N	As submitted sample	19/02/2024	117	GCFID
Total PCBs (7 congeners)	N	Air dried sample	20/02/2024	120	GCMS
Total (of 17) PAHs	N	As submitted sample	20/02/2024	133	GCFID

Tests marked N are not UKAS accredited

Report Information

Report No.: 24-52388, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"
LOD	LOD refers to limit of detection, except in the case of pH soils and pH waters where it means limit of discrimination.
	Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.
	ELAB are unable to provide an interpretation or opinion on the content of this report.
	The results relate only to the sample received.
	PCB congener results may include any coeluting PCBs
	Uncertainty of measurement for the determinands tested are available upon request
	Unless otherwise stated, sample information has been provided by the client. This may affect the validity of the results.

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

TPH Classification - HWOL Acronym System

HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
2D	GC-GC - Double coil gas chromatography
#1	EH_Total but with humics mathematically subtracted
#2	EH_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry

End of Report

Job No: 3035
Site Location : Dolwar, Coedpoeth
Residential with gardens (1% SOM)

GroundSolve Ltd

Metals & Non-Metals	WS01 0.40	WS01 2.65	WS02 0.10	WS02 2.70	WS03 0.60	WS03 2.20	WS04 0.40	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Arsenic	30.4	8.3	17	10.7	9.3	7.2	15.3	7.2	30.4	14.03	7	37	C4SL	0
Cadmium	5.2	<0.5	1.7	0.5	1.3	0.5	1.1	<0.5	5.2	1.54	7	22	C4SL	0
Chromium	131	25.5	19.1	26.9	19.4	26	17.7	17.7	131	37.94	7	910	S4UL	0
Copper	382	40	97.5	37.4	21.8	21.8	32.5	21.8	382	90.43	7	2400	S4UL	0
Lead	442	29.3	486	116	222	58.9	336	29.3	486	241.46	7	200	C4SL	**4**
Mercury	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1	0.59	7	1.2	S4UL	0
Nickel	124	34	26.9	31.3	22	31.1	29.3	22	124	42.66	7	130	S4UL	0
Phenol - Monohydric	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	7	120	S4UL	0
Selenium	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	1.01	7	250	S4UL	0
Zinc	914	84.8	252	122	300	149	200	84.8	914	288.83	7	3700	S4UL	0

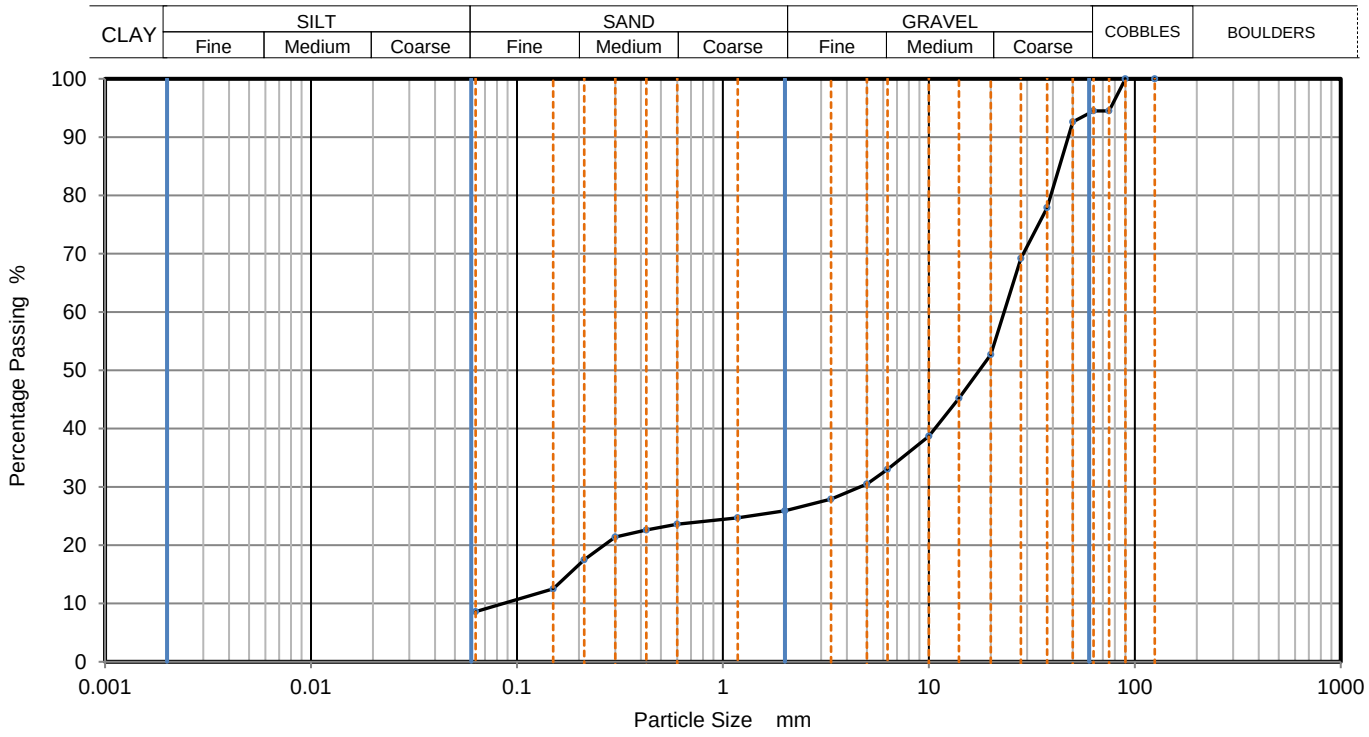
Petroleum Hydrocarbons	WS01 0.40	WS01 2.65	WS02 0.10	WS02 2.70	WS03 0.60	WS03 2.20	WS04 0.40	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Benzene	<10.0	<10.0	-	<10.0	<10.0	<10.0	-	<10.0	<10	10	5	0.87	C4SL	0
Toluene	<10.0	<10.0	-	<10.0	<10.0	<10.0	-	<10.0	<10	10	5	130	S4UL	0
Ethylbenzene	<10.0	<10.0	-	<10.0	<10.0	<10.0	-	<10.0	<10	10	5	47	S4UL	0
xylenes	<10.0	<10.0	-	<10.0	<10.0	<10.0	-	<10.0	<10	10	5	56	S4UL	0
>C5-C6 Aliphatic--(HS_1D_MS_AL)--	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	0.01	5	42	S4UL	0
>C6-C8 Aliphatic--(HS_1D_MS_AL)--	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	0.01	5	100	S4UL	0
>C8-C10 Aliphatic--(EH_CU_1D_AL)--	<1.0	19	-	<1.0	<1.0	<1.0	-	<1.0	19	4.6	5	27	S4UL	0
>C10-C12 Aliphatic--(EH_CU_1D_AL)--	<1.0	85	-	<1.0	<1.0	<1.0	-	<1.0	85	17.8	5	130	S4UL	0
>C12-C16 Aliphatic--(EH_CU_1D_AL)--	<1.0	539	-	2.2	<1.0	<1.0	-	<1.0	539	108.84	5	1100	S4UL	0
>C16-C35 Aliphatic--(EH_CU_1D_AL)--	2.3	894	-	15	<1.0	<1.0	-	<1.0	894	182.66	5	65000	S4UL	0
>C35-C40 Aliphatic--(EH_CU_1D_AL)--	2.9	2.3	-	<1.0	<1.0	<1.0	-	<1.0	2.9	1.64	5	65000	S4UL	0
>C5-C7 Aromatic--(HS_1D_MS_AR)--	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	0.01	5	70	S4UL	0
>C7-C8 Aromatic--(HS_1D_MS_AR)--	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	0.01	5	130	S4UL	0
>C8-C10 Aromatic--(EH_CU_1D_AR)--	<1.0	17.6	-	<1.0	<1.0	<1.0	-	<1.0	17.6	4.32	5	34	S4UL	0
>C10-C12 Aromatic--(EH_CU_1D_AR)--	<1.0	77.2	-	<1.0	<1.0	<1.0	-	<1.0	77.2	16.24	5	74	S4UL	**1**
>C12-C16 Aromatic--(EH_CU_1D_AR)--	<1.0	536	-	2.2	<1.0	<1.0	-	<1.0	536	108.24	5	140	S4UL	**1**
>C16-C21 Aromatic--(EH_CU_1D_AR)--	<1.0	642	-	4.3	<1.0	<1.0	-	<1.0	642	129.86	5	260	S4UL	**1**
>C21-C35 Aromatic--(EH_CU_1D_AR)--	<1.0	278	-	11	<1.0	<1.0	-	<1.0	278	58.4	5	1100	S4UL	0
>C35-C40 Aromatic--(EH_CU_1D_AR)--	<1.0	<1.0	-	<1.0	<1.0	<1.0	-	<1.0	<1	1	5	1100	S4UL	0

Polyaromatic Hydrocarbons (PAH)	WS01 0.40	WS01 2.65	WS02 0.10	WS02 2.70	WS03 0.60	WS03 2.20	WS04 0.40	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Naphthalene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	2.3	S4UL	0
Acenaphthylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	170	S4UL	0
Anthracene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	2400	S4UL	0
Dibenzo(a,h)anthracene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	7.2	S4UL	0
Benzo(a)pyrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	5	C4SL	0
Benzo(b)fluoranthene	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	2.6	S4UL	0
Benzo[g,h,i]perylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	320	S4UL	0
Benzo(k)fluoranthene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	77	S4UL	0
Chrysene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	15	S4UL	0
Dibenzo(a,h)anthracene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	0.24	S4UL	0
Fluoranthene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	280	S4UL	0
Fluorene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	170	S4UL	0
Indeno(1,2,3-cd)pyrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	27	S4UL	0
Naphthalene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	2.3	S4UL	0
Phenanthrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	95	S4UL	0
Pyrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	7	620	S4UL	0

Other Contaminants / Testing	WS01 0.40	WS01 2.65	WS02 0.10	WS02 2.70	WS03 0.60	WS03 2.20	WS04 0.40	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Soil Organic Matter	4.6	0.9	5.6	2.3	1.5	0.7	3.3	0.7	5.6	2.7	7	-	-	-
pH	8.3	8	7.1	7.3	7.9	7.8	7	7	8.3	7.63	7	-	-	-
Total Cyanide	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	1	7	-	-	-
Water Soluble Sulphate	0.06	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	0.06	0.03	7	-	-	-

APPENDIX D – PHYSICAL TEST RESULTS

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J263028
				Borehole/Pit No.	WS01
Project Name	Dolwar, Coedpoeth			Sample No.	
Soil Description	Brown slightly sandy clayey GRAVEL			Depth, m	1.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP2024022062



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	95		
63	95		
50	93		
37.5	78		
28	69		
20	53		
14	45		
10	39		
6.3	33		
5	31		
3.35	28		
2	26		
1.18	25		
0.6	24		
0.425	23		
0.3	21		
0.212	18		
0.15	13		
0.063	9		

Dry Mass of sample, g	9211

Sample Proportions	% dry mass
Very coarse	6
Gravel	69
Sand	17
Fines <0.063mm	9

Grading Analysis		
D100	mm	
D60	mm	23.2
D30	mm	4.61
D10	mm	0.0861
Uniformity Coefficient		270
Curvature Coefficient		11

Remarks

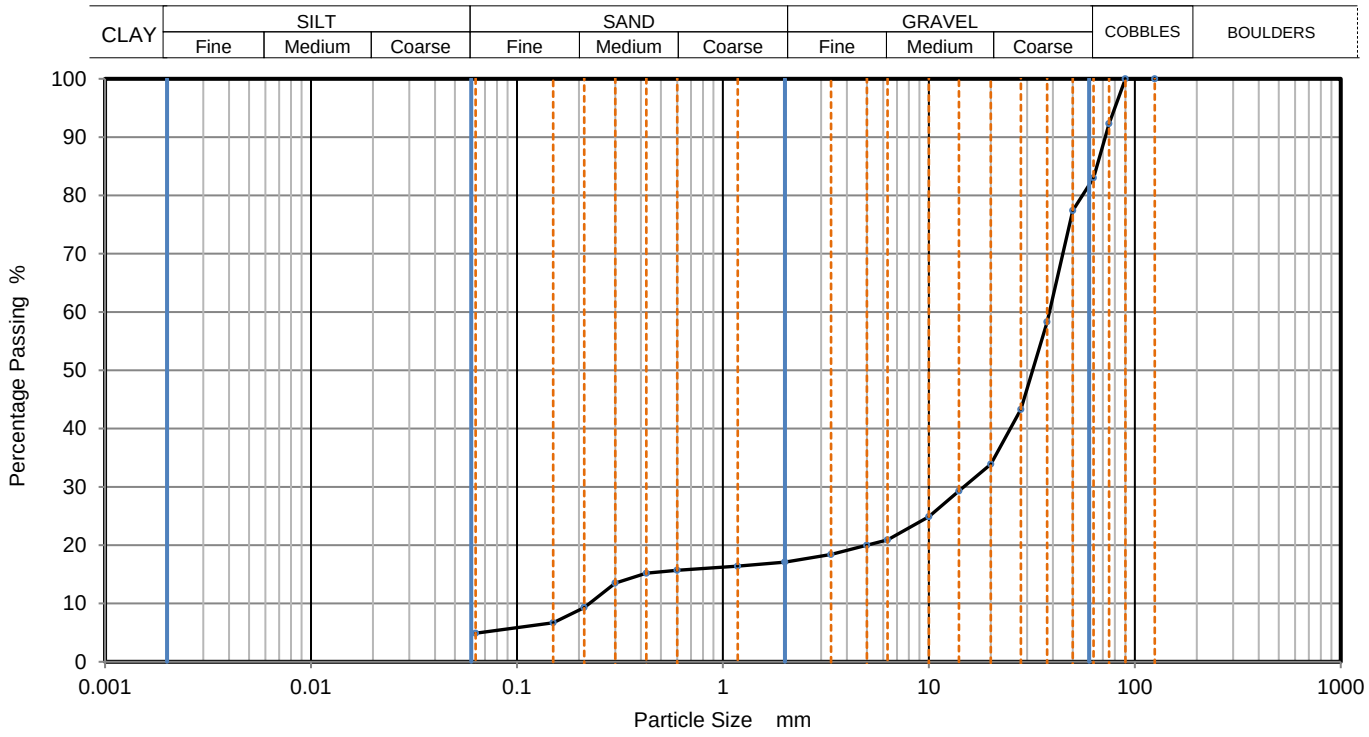
Preparation and testing in accordance with BS1377 unless noted below

Date Printed	05/03/2024

UKAS TESTING
7758

PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J263028
				Borehole/Pit No.	WS03
Project Name	Dolwar, Coedpoeth			Sample No.	
Soil Description	Brown slightly sandy clayey GRAVEL			Depth, m	1.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP2024022064



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	92		
63	83		
50	77		
37.5	58		
28	43		
20	34		
14	29		
10	25		
6.3	21		
5	20		
3.35	18		
2	17		
1.18	16		
0.6	16		
0.425	15		
0.3	14		
0.212	9		
0.15	7		
0.063	5		

Dry Mass of sample, g	6995

Sample Proportions	% dry mass
Very coarse	17
Gravel	66
Sand	12
Fines <0.063mm	5

Grading Analysis		
D100	mm	
D60	mm	38.5
D30	mm	14.8
D10	mm	0.225
Uniformity Coefficient		170
Curvature Coefficient		25

Remarks

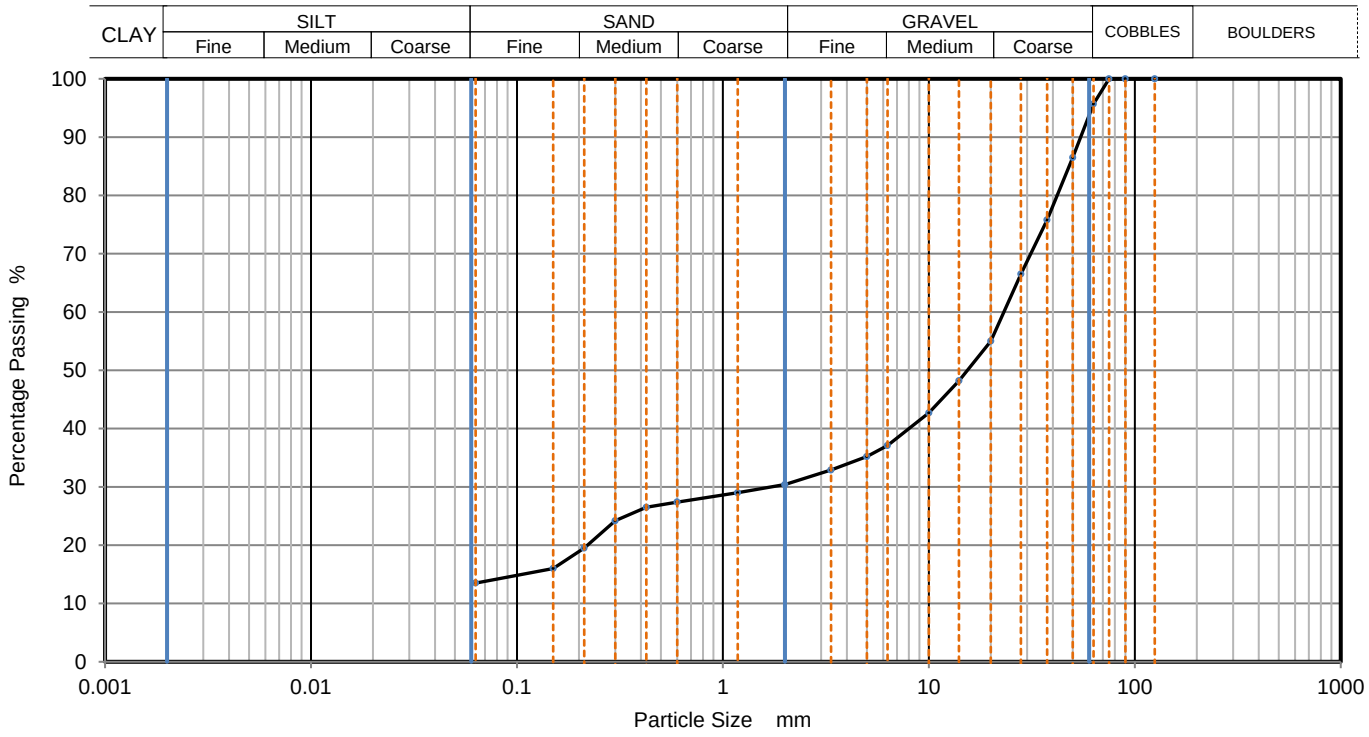
Preparation and testing in accordance with BS1377 unless noted below

Date Printed	05/03/2024

UKAS TESTING
7758

PSD

GQF-008-55 Issue 01 - Oct 22	**PARTICLE SIZE DISTRIBUTION**			Job Ref	J263028
				Borehole/Pit No.	WS04
Project Name	Dolwar, Coedpoeth			Sample No.	
Soil Description	Brown slightly sandy clayey GRAVEL			Depth, m	1.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	TTLP2024022066



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	96		
50	87		
37.5	76		
28	67		
20	55		
14	48		
10	43		
6.3	37		
5	35		
3.35	33		
2	30		
1.18	29		
0.6	27		
0.425	27		
0.3	24		
0.212	20		
0.15	16		
0.063	14		

Dry Mass of sample, g	5643

Sample Proportions	% dry mass
Very coarse	4
Gravel	65
Sand	17
Fines <0.063mm	14

Grading Analysis		
D100	mm	
D60	mm	23.2
D30	mm	1.7
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Date Printed	05/03/2024

UKAS TESTING
7758

PSD

GQF-008-48
Issue 01 - Oct 22

Summary of Classification Test Results

Project No.
J263028

Project Name
Dolwar, Coedpoeth

Hole No.	Sample				Soil Description	Density bulk Mg/m^3	Density dry Mg/m^3	*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m^3	Remarks
	Ref	Top	Base	Type										
WS02		2.95		D	Brown slightly sandy slightly gravelly CLAY			11	67	31	24	7		
WS04		2.50		D	Brown mottled grey slightly sandy slightly gravelly CLAY			19	93	36	23	13		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Date Printed: 05/03/2024

Key

Density test
Linear measurement unless :
wd - water displacement
wi - immersion in water

Liquid Limit
4pt cone unless :
cas - Casagrande method
1pt - single point test

Particle density
sp - small pyknometer
gj - gas jar

7758

INDEX

APPENDIX E – SUMMARY OF GAS AND GROUNDWATER MONITORING

No: 3035

GROUNDWATER AND GROUND GAS MONITORING

GroundSolve Ltd
Consulting Geotechnical Engineers

Site: Coedpoeth

Location	Date	Monitored by	Well Details		Groundwater	Gas												Weather
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure (mb)	Flow - Peak (l/h)	Flow - Steady (l/h)	CH_4 (% v/v)	GSV CH_4 (l/hr)	CO_2 (% v/v)	GSV CO_2 (l/hr)	O_2 (% v/v)	CO (ppm)	H2S (ppm)	VOC	Conditions
WS101	23/02/24	AB	50	2.61	Dry	954	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	16.1	0	0	0	Overcast and dry
	01/03/24	AR	50	2.61	Dry	976	Falling	0.01	0.1	0.1	0.1	0.0001	0.2	0.0002	15.3	0	0	0	Overcast and dry
	08/03/24	AR	50	2.61	2.44	978	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	15.3	0	0	0	Overcast and dry
WS102	23/02/24	AB	50	2.52	2.10	954	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	16.2	0	0	0	Overcast and dry
	01/03/24	AR	50	2.51	2.06	977	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	15.4	0	0	0	Overcast and dry
	08/03/24	AR	50	2.59	2.12	978	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	15.4	0	0	0	Overcast and dry
WS103	23/02/24	AB	50	2.60	2.20	954	Falling	0.01	0.0	0.1	0.1	0.0001	0.1	0.0001	16.2	0	0	0	Overcast and dry
	01/03/24	AR	50	2.60	2.15	976	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	15.6	0	0	0	Overcast and dry
	08/03/24	AR	50	2.69	1.96	978	Falling	0.01	0.0	0.1	0.1	0.0001	0.1	0.0001	15.1	0	0	0	Overcast and dry

NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

GSV (l/HR) = $\frac{[\text{gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$

APPENDIX F – CURRENT GUIDANCE FOR GROUND GAS RISK ASSESSMENT

Current Guidance for Ground Gas Risk Assessment

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment for permanent ground gases (e.g., methane and carbon dioxide), the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern: methane and carbon dioxide and does not apply to other ground gases (e.g., radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table G1 below:

Table G1. Potential Sources of Ground Gases

Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically, 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically, 90% CH_4, but 1 to 27% C_2-C_4 alkanes, May also contain other trace gases e.g., CO, helium and CO_2 (from degradation of CH_4 in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g., silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. Can degrade to produce methane / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	Various types. Most common is "fire damp" with high methane, produced by the desorption of gas trapped in coal. "Black damp" (Stythe gas) with high carbon dioxide and denser than air. "White damp" is high in carbon monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural Shallow Ground Gas	Various types - high carbon dioxide formed by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g., carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

This Appendix concentrates on the assessment of risk from methane and carbon dioxide. This Appendix does not provide guidance for the assessment of risk when other gases are present due to 'Other Sources' from the above table (particularly organic compounds such as BTEX and VOC's or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources;
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc);
3. Properties of gases present including:
    a. Chemical composition;
    b. Physical properties;
    c. Ratios of components e.g., methane : carbon dioxide.
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc.

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are the more likely candidates.

Hazards Associated with Presence of Ground Gases

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached, and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long-Term Occupational Exposure Limit (LTOEL, 8-hour period) and the Short-Term Occupational Exposure Limit (STOEL, 15-minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

Figure G2 is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:

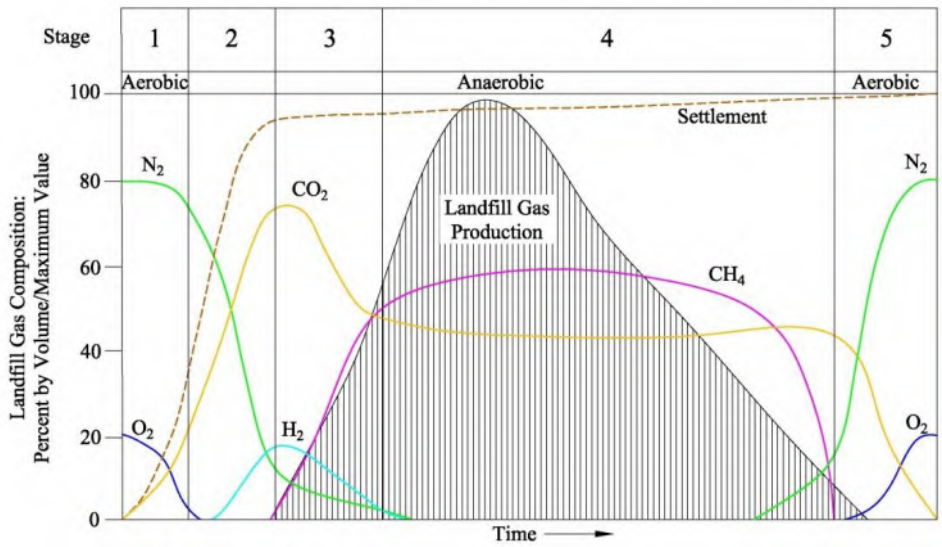


Figure G2. Idealised Representation of Landfill Gas Generation.

The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event (as marked on Figure G2), as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;

- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing 'face' for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g., rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over-riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Guidance Documents

Currently in the UK, there are no statutory threshold limits for hazardous gases in the ground as site specific variables mean that standard threshold values cannot be applied. The published guidance relating to development of sites where methane and carbon dioxide are present has been produced in response to building projects on or close to landfill sites, as both gases are principal constituents of landfill gas. Much of the historic guidance that has been produced on gas risk assessment focused on landfill sites and as a result there has previously been a lack of clarity when relating the process to gas conditions on non-landfill sites.

Statutory guidance regarding methane in the ground has previously taken a limiting concentration of 1.0 % by volume methane (equal to 20% of the lower explosive limit of methane in air) above which necessary actions will be appropriate. For carbon dioxide the limiting recommended trigger was 1.5 % by volume (the Long-Term Exposure Limit for carbon dioxide). Above these concentrations the Building Regulations Approved Document C (1992) stated that consideration should be given to whether actions may be appropriate, whilst more specific solutions would be likely to be necessary at concentrations greater than 5% by volume of carbon dioxide (Building Regulations Approved Document C, 1992). However, the latest fully revised version of Approved Document C (DoE, 2004) no longer endorses this approach and instead requires the use of a risk-based approach in interpreting the findings of a gas monitoring survey. Further, the latest EA documentation on landfill gas (LFTGN 03, 2004) continues to sanction the use of a risk-based approach through a structured approach to the assessment of ground gases and links with the risk assessment process outlined within CLR 11 for soil contaminants.

With the above in mind, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to *"Guidance on the Management of Landfill Gas"* (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) *"Assessing Risks Posed by Hazardous Ground Gases for Buildings."***

  This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:

  - **All development types except low rise housing with gardens and for Low Rise Buildings without a 150mm void** (Situation A) (Table 8.5 CIRIA C665)

  and;

  - **Low rise housing with gardens with a 150mm ventilated sub-floor void** (Situation B) (Table 8.7 CIRIA C665)
    (See below for further explanation of the methods of characterisation)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) *"Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present."***

  This document presents the "Traffic Lights System" detailed below and is relevant only for low rise properties (e.g., bungalows and town houses) that have a ventilated sub-floor void (i.e., Situation B as described in CIRIA C665).

- **Wilson and Card (CIEH, expected 2011) *"Ground Gas Handbook for Designers and Regulators"***

  This document is expected to provide practical guidance on ground gas assessments and the design and evaluation of protection measures.

- **British Standard (BS 8485+A1, January 2019)** ***"Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings"***

  This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. The Standard provides a framework in line with CLR11 allowing designers to judge the adequacy of ground gas and related site investigation data. The document provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions mitigating against the presence of ground gas on a development site.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation. These documents also stress the importance that the assessor should be confident that the ground gas monitoring results are representative of the likely worse case ground gas regime on a site and that the data collected from the site is sufficient. With this in mind, CIRIA C665 sets out ideal monitoring periods as below.

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)

		Generation Potential of Source				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Sensitivity of Development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24

Notes

1. First number is the number of readings and the second is the minimum period in months (e.g., 6/2 – six sets of readings over two months).

2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

3. High sensitivity end use on high or very high hazard site will not normally be acceptable unless the source is treated to reduce gassing potential.

Before the latest guidance, good practice for site characterisation had been based upon the method proposed by Wilson and Card (1999). CIRIA C665 (2007) effectively supersedes Wilson and Card (1999) and includes a modified version of the Wilson and Card method (Tables 8.5, 8.6 and Box 8.1). Gas concentrations and flow rates for either methane and/or carbon dioxide measured at a site to 'Characteristic Situations.' Appropriate protection measures are selected from Table 8.6 (if using modified Wilson & Card method) and from Box 8.4 from CIRIA C665 (if using the NHBC traffic lights method). Throughout the risk assessment process, strong regard must be given to the nature of the gassing source, the flow rates and the estimated surface emissions. Note that certain protection measures are stated in CIRIA Report 149 that are now considered wholly inappropriate to certain developments and consequently should not be used without modification. Throughout the process, it is important to remember that these tables are not

intended to be used as a definitive design tool and have been prepared to show the typical scope of measures for gas control.

Both the NHBC (2007) and CIRIA (2007) guidance documents and BS 8485+A1 (2019) propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$$

These GSVs are then compared to generic 'Traffic Lights' contained within the NHBC guidance, which present typical maximum gas concentrations and limiting GSV's, for 'Situation B Development' (Low rise housing with gardens).

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light	Methane [1]		Carbon Dioxide [2]	
	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)
Green	1	0.13	5	0.78
Amber 1	5	0.63	10	1.6
Amber 2	20	1.60	30	3.10
Red				

Notes:

1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Box 8.4 of CIRIA C665 Gas protection measures for low-rise housing development based upon allocated NHBC Traffic light (Boyle and Witherington, 2007)	
Traffic Light Classification	**Protection Measures Required**
Green	Negligible gas regime identified, and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist Contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

For a 'Situation A Development' (All development except low rise housing with gardens), the GSV value is used to derive the appropriate Characteristic Situation from Table 8.5 of CIRIA C665 (below):

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification					
Characteristic Situation (CIRIA R149)	**Comparable Partners in Technology gas Regime (see Box 8.2)**	**Risk Classification**	**Gas Screening Value (CH_4 or CO_2) (l/hr)[1]**	**Additional Factors**	**Typical Source of Generation**
1	A	Very low risk	<0.07	Typically, methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3	Natural soil, high peat/organic content. "Typical" made ground
3	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

It was intended in CIRIA C665 that the characteristic situation allocated to the development from the table above would then be used in Table 8.6 of CIRIA C665 in order to determine the level of gas protection the development requires. However, BS8485:2015 superseded this document and a different set of mitigation standards were put forward.

The recommended minimum gas protection score (points) be selected based on the building type (Table 3 which defines four building types) and the ground gas Characteristic Situation as detailed in Table 4 of BS8485:2015+A1:2019 (see below).

The first step in the decision-making process is to obtain the level of gas protection necessary in the range 0 to 7.5 from Table 4. Then a combination of structural barriers (Table 5) ventilation protection measures (Table 6) and/or gas resistant membranes (Table 8)should be chosen to meet that requirement. The level of gas protection necessary should take into account the characteristic gas situation and a number of other factors. The whole decision-making process should be made transparent, where all parties can see the approach being taken, can understand the various steps and decisions made and be confident that a risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the gas Characteristic Situation is 4 or more (and for NHBC Red situations according to CIRIA C665), the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 4 alone is not sufficient.

BS8485:2015+A1:2019 Table 3 Building Types				
	Type A	**Type B**	**Type C**	**Type D**
Ownership	Private	Private or commercial/ public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

BS8485:2015+A1:2019 Table 4 Gas Protection Score by CS and Type of Building				
CS	Required Gas Protection			
	High risk	Medium risk	Low risk	
	Type A	Type B	Type C	Type D
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 (A)	5.5(A)	4.5	3.5
5	(B)	6A)	5.5	4.5
6	(B)	(B)	(B)	6
a) Residential building should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g., high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g., in institutional and/or fully serviced contractual situations.				
b) The gas hazard is too high for this empirical method to be used to define the gas protection measures				
NOTE 3 The NHBC has published guidance for use on residential developments, which utilise an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilising beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilising this system would therefore need to refer to NHBC to assess compliance for specific recommendations [see 8485:2015 for further on this note]				
NOTE4 The method of selecting the combination of these types of protection is given in section 7.2 of BS8485:2015. Once type of measures has been decided, the detailed design and specification of the measures should be undertaken (section 7.3)				

Section 7.2 defines the order of selecting protective measures. The first choice is provided by structural barriers as defined in Table 5.

BS8485+A1:2019 Table 5 Gas protection scores for structural barriers		
PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
Floor and substructure design		
Floor slabs Block and beam floor slab	0	*General – score conditional that breaches of slab are sealed*
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5	
Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement)	1 or 1.5	*To achieve 1.5, raft or suspended slab to be well reinforced to prevent cracking and minimal penetrations*
Basement floor and walls to BS 8102:2009, Grade 2 waterproofing – See notes in BS8485:2015+A1:2019	2	
Basement floor and walls to BS 8102:2009, Grade 3 waterproofing - See notes in BS8485:2015+A1:2019	2.5	*Conditional that waterproofing is not based on geosynthetic clay liner*

Ventilation methods are detailed in Table 6, and points can only be gained from using one of the five types:

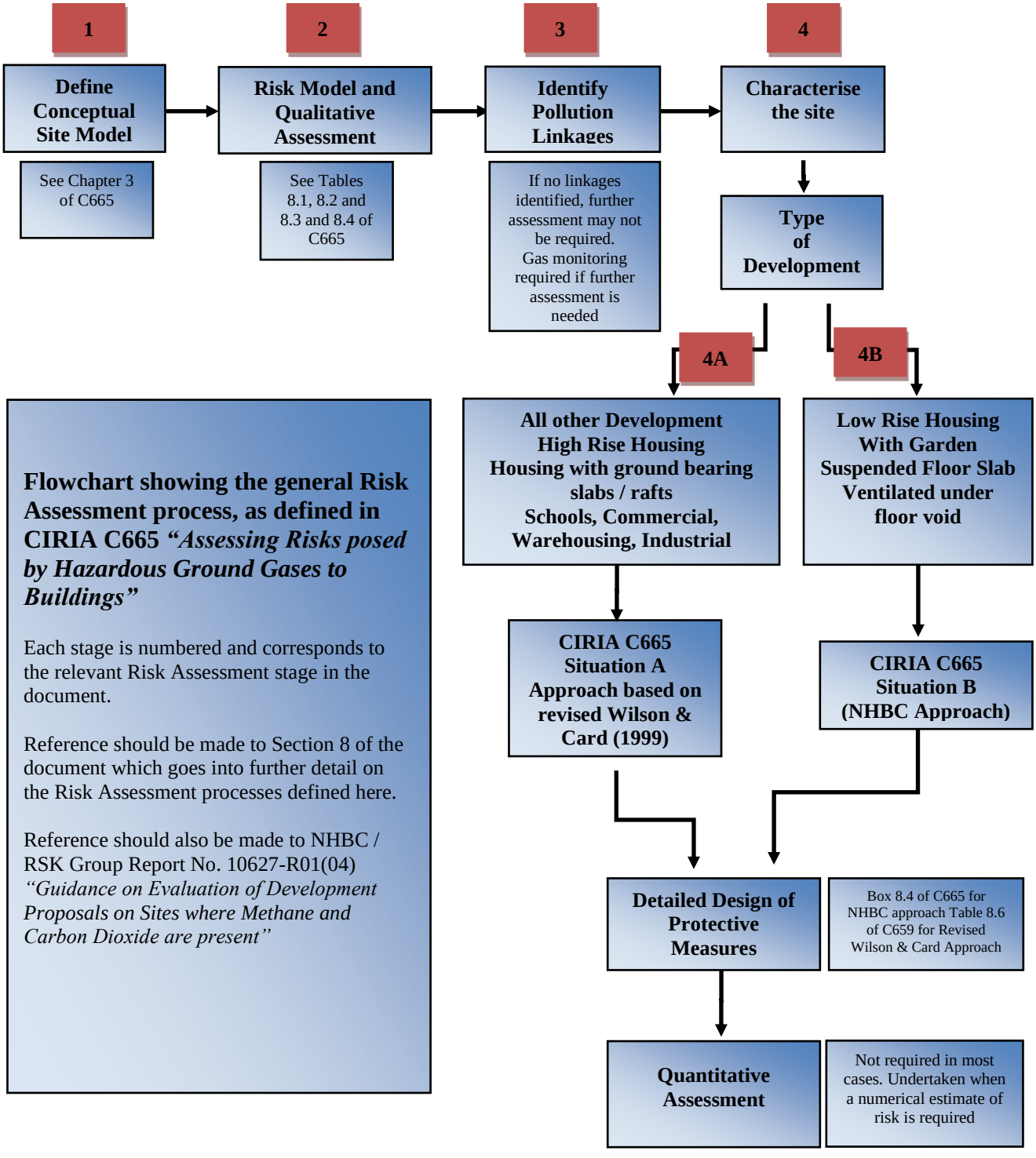
BS8485:2015+A1:2019 Table 6 Gas Protection Scores for Ventilation Protection Measures		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
a) Pressure relief pathway (usually formed by low fines gravel or with a thin geocomposite blanket with strips terminating in a gravel trench external to the building	0.5	*Whenever possible, a pressure pathway relief pathway (as a minimum) should be installed in all gas protection measures systems.* *If a layer has a low permeability and/or is not terminating in a venting trench (or similar), then the score is zero.*
b) Passive sub floor dispersal layer Very good performance Good performance Media used to provide the dispersal layer are: • Clear void • Polystyrene void forming blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	 2.5 1.5	*Performance criteria shown in Fig B.6 and B.7 of BS 8484:2015.[See Annex B]*
c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	*This system relies on continued serviceability of the pumps; therefore, alarm and response systems should be in place. [See Annex B].*
d) Active positive pressurisation by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	*This system relies on continued operation of the pumps; therefore, alarm and response systems should be in place. [See Annex B].*
e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or under croft)	4	*Assumes car park is vented , designed to Building Regulations 2000, Approved Document F.*

Membrane methods are detailed in Table 7.

BS8485:2015+A1:2019 Table 7 Gas protection score for gas resistant membrane		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method) • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (e.g., settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (e.g., penetration from steel fibres in fibre reinforced concrete, dropping tools etc); and to withstand in-service stresses (e.g., settlement if placed below a floor slab) • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735	2	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.* *If a membrane is installed that does not meet the criteria, then the score is zero.*
See notes in BS8485:2015+A1:2019 regarding membrane requirements		

For a site which is impacted by migratory gases from an off source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

Following the choice of protection measures, detailed design should be entered into [Section 8 of BS 8485:2015+A1:2019].



Flowchart showing the general Risk Assessment process, as defined in CIRIA C665 *"Assessing Risks posed by Hazardous Ground Gases to Buildings"*

Each stage is numbered and corresponds to the relevant Risk Assessment stage in the document.

Reference should be made to Section 8 of the document which goes into further detail on the Risk Assessment processes defined here.

Reference should also be made to NHBC / RSK Group Report No. 10627-R01(04) *"Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are present"*

APPENDIX G – GUIDANCE FOR CLASSIFICATION OF SOIL FOR OFF SITE DISPOSAL AT A LANDFILL SITE

GroundSolve Ltd

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as "suitable for use" on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g., separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g., separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to 'dilute it' and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two-tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three-tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six-figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g., by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g., corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance 'Understanding the Landfill Directive' version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓
17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB's are hazardous			✓

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g., 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency's "Technical Guidance *WM3* Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste" (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally, some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of sites do not incur landfill tax which in the 2018/19 tax year is £2.80 for inactive waste (inert and some types of non-hazardous waste) and £88.95/Tonne for active waste (some types of non-hazardous waste and hazardous waste. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three-stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g., a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g., there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous, but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be is included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g., sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g., total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g., lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present

in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst-case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g., add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

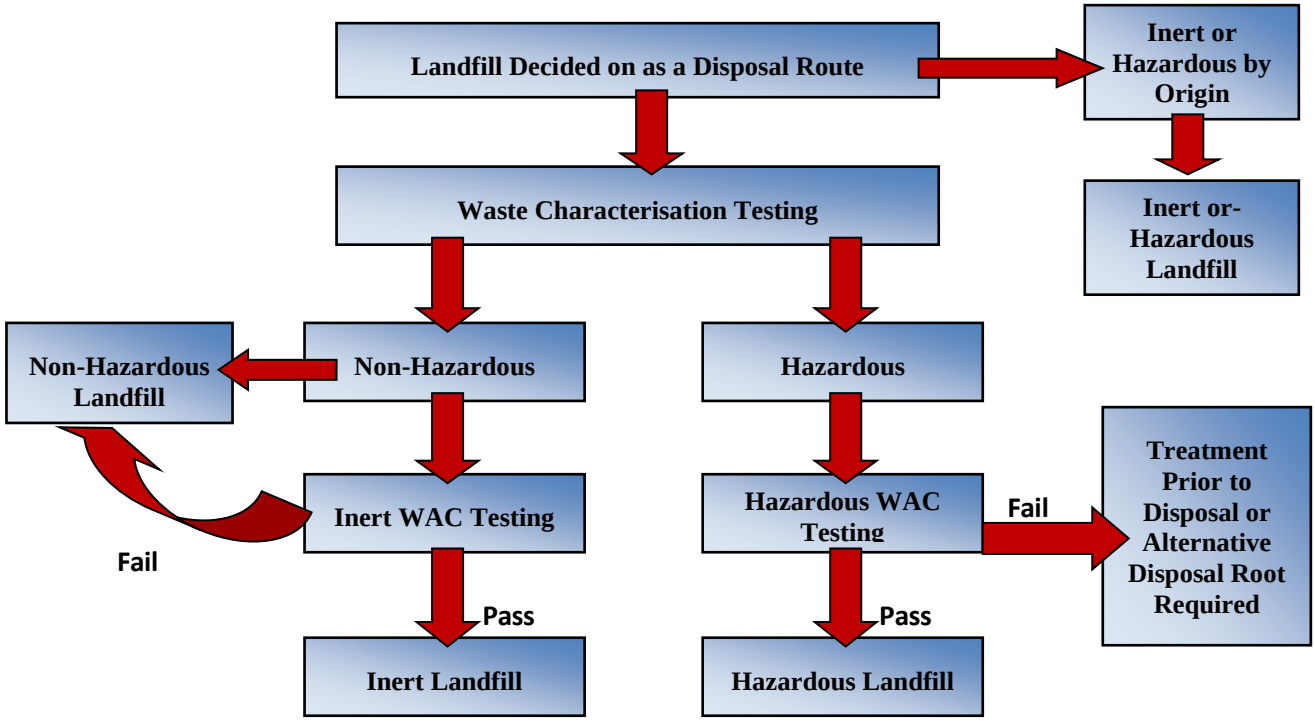
If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively, WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g., by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



Landfill Tax

It should be noted that HM Revenue and Customs (HMRC) classify wastes for tax purposes using a different scheme to the threefold landfill EU Landfill Directive scheme (i.e., the hazardous, non-hazardous and inert). HMRC have a two-fold system for landfill tax. The Standard Landfill Tax is currently £88.95/T and applies to all wastes unless they qualify for the reduced rate of landfill tax of £2.80/T. The wastes that qualify for the reduced rate of Landfill Tax are set out in The Landfill Tax (Qualifying Material) Order 2011 with supplementary information on the interpretation of these regulations in HMRS "Notice LFT1 – A General Guide to Landfill Tax" (May 2012) and HMRC Briefing Notes 15/12 and 18/12.

APPENDIX H – UNFORESEEN GROUND CONTAMINATION

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any “brownfield” site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination, and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected, contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of clayey Alluvium, or on 2000-gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept, and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:

- re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
- treatment of material on site to meet compliance targets so it can be reused; or

- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. Verification Report will be produced for the work.

Asbestos

Asbestos cement products and asbestos fibres have not been encountered in the soils at the site but based on the age of the Made Ground material containing asbestos could be expected to be encountered. If non-notifiable asbestos (e.g., chrysotile asbestos cement board) is encountered in excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore, it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on-site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on-site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE; and,
- Dust and fibre monitoring.

Potential mitigation measures that would be required include:

- Ensuring works are carried out by suitably trained and experienced personnel with working with asbestos;
- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and,
- Compliance monitoring.

Unexpected Tanks

The site was a former petrol station, however no additional underground tanks are anticipated to be present on site. However, as with any development, there remains a low risk that tanks are present on-site. Should an underground tank be encountered, operations should cease in the area. Additionally, there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic recorded will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.