



Phase II Interpretative Ground Assessment

At

Oldham Road Woodbine Street,
Rochdale

Client: Arcon

Reference: 31163-SUT-ZZ-00-RP-G-702-0001

Date: July 2022

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SUTCLIFFE INVESTIGATIONS

Phase II Interpretative Ground Assessment

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Foreword (Geotechnical and Environmental Assessment)

This report has been prepared for the sole internal use and reliance of the Client named on page 1. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Sutcliffe Investigation; such authorisation not to be unreasonably withheld. If any unauthorised third party comes into possession of this report, they rely on it at their risk and the authors owe them no duty of care and skill.

The report presents observations and factual data obtained during our site investigation and provides an assessment of Geotechnical and environmental issues with respect to information provided by the Client regarding the proposed development. Further advice should be sought from Sutcliffe Investigation prior to significant revision of the development proposals. Primary aims of this exploratory phase of investigation were to identify salient geotechnical and environmental issues affecting the site to enable the client to obtain budget costs for the necessary site preparatory and remedial works.

The report should be read in its entirety, including all associated drawings and appendices. Sutcliffe Investigation cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context.

The findings and opinions conveyed in this report (including review of any third-party reports) are based on information obtained from a variety of sources as detailed within this report, and which Sutcliffe Investigation believes are reliable. All reasonable care and skill have been applied in examining the information obtained. Nevertheless, Sutcliffe Investigation cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

The report represents the findings and opinions of experienced Geotechnical and environmental consultants. Sutcliffe Investigations does not provide legal advice and the advice of lawyers may also be required.

Intrusive investigation can only investigate shallow ground beneath a small proportion of the total site area. It is possible therefore that the intrusive investigation undertaken by Sutcliffe Investigation, whilst fully appropriate, may not have encountered all significant subsurface conditions. Any opinions expressed as to the possible configuration of strata between, or below exploratory holes are for guidance only and no responsibility is accepted as to its accuracy.

It should be borne in mind that the timescale over which the investigation was undertaken might not allow the establishment of equilibrium groundwater levels. Particularly relevant in this context is that groundwater levels are susceptible to seasonal and other variations and may be higher during the wetter periods than those encountered during this commission.

Where the report refers to the potential presence of invasive weeds such as Japanese Knotweed, or the presence of asbestos containing materials, it should be noted that the observations are for information only and should be verified by a suitably qualified expert.

This report assumes that ground levels will not change significantly from those existing at present. If this is not to be the case, then some modification to this report may be required.

It should be noted that the banning of the co-disposal of hazardous and non-hazardous waste was introduced in 2011, as a result of the implementation within the UK of the Landfill Directive. This will considerably affect the current practices and procedures for the handling and disposal of wastes, in particular hazardous wastes. In addition, it will be a requirement for all wastes to be pre-treated and to comply with certain waste acceptance procedures prior to sending wastes to landfill. The full potential effects of these important changes are not known at this stage, but it is perceived that disposal costs will rise, particularly for hazardous wastes, and waste pre-treatment may, in some cases, become an 'additional' redevelopment cost with regard to the remediation of contaminated sites.

Should this report recommend materials could be excavated and removed off-site for landfill disposal, then it should be noted that the costs, timescales and implications of the pending changes to waste management legislation could not be predicted at this stage. Sutcliffe Investigation will not be responsible for changing practices, etc that may affect the viability of necessary remedial actions or of the implications of potential alternative treatment techniques.

Sutcliffe Investigation reserves the right to amend their conclusions and recommendations in the light of further information that may become available. General notes and limitations relevant to all Sutcliffe Investigations are described in the Foreword and should be read in conjunction with this report.

Executive Summary

INTRODUCTION	Sutcliffe Investigations was instructed by Eastlands Homes (the “client”) to undertake a Phase II ground assessment for the site Known as Oldham Road Woodbine Street, Rochdale. The site is centred on National Grid Reference (NGR) 390370, 412330. This report assesses the ground based geotechnical and environmental risks, constraints and liabilities associated with the proposed development of the site. This is required in support of the discharge of contaminated land planning conditions assigned to the site and to allow the design of economic foundation solutions.
SITE DESCRIPTION	The site is square in shape and can be accessed via Oldham Road to the west of the site and Woodbine Street to the south of the site. The site is a relatively flat grass area with a low wooden fence that marks the site's western and southern boundaries. Also of note is an electricity pole located in the south western corner of the site. The site is currently undeveloped.
DEVELOPMENT PROPOSAL	The proposed development for the site is for an apartment which includes 18No. one bed flats and 4No. two bed flats along with associated car parking facilities and soft landscaping areas. The proposed development is presented as Drawing No: WS-BTP-00-SP-DR-A-3576 produced by BTP Architects.
PRELIMINARY CONCEPTUAL MODEL	The earliest available historical map (1851) indicated that a factory was noted in the eastern and southern sections of the site. No change was evident on site until, between 1956 and 1960, a part of the factory in the central eastern section of the site had been removed. Between 1977 and 1979 the rest of the factory was removed from the site. By 1999 a building was noted on site but by 2016 this had been removed. The site remained relatively unchanged until present day, with no significant features apparent. With the exception of made ground potentially being present on site, no significant identifiable sources of environmental concern were identified. The potential for significant contamination to have arisen at the site as a result of the current and former usage on site is considered to be low. However, the possibility of contamination albeit likely to be localised cannot be discounted.
PREVIOUS WORKS	Sutcliffe have completed a Phase I Preliminary Risk Assessment (PRA). (Report Reference: 31163-SUT-ZZ-00-RP-G-701-0002), a synopsis of which is provided in Section 2 of this report. No other previous studies are known to have been undertaken to Sutcliffe's knowledge.
SITE INVESTIGATION	Field works were undertaken on 28th April, 1st May & 3rd May 2022 and consisted of:  1No. Cable Percussion Borehole (BH101)  3No. Window Sample Holes (WS101, WS102 & WS103)  Contamination samples from various depth in the Made Ground.  Leachate samples.  Gas monitoring wells.  Monitoring of ground gas / ground water with installed locations.
GROUND CONDITIONS	Made Ground: Made Ground was encountered in all the exploratory holes across the site and was noted to a maximum depth of 3.00m bgl in BH101. Made Ground generally consisted of topsoil, brown to dark brown, occasionally clayey SAND with fine to coarse brick, concrete, sandstone and metal fragments as well as rare sandstone cobbles. Light grey SAND and graded granular limestone hardcore was recorded in WS103. Natural Ground: Natural ground was encountered in all exploratory holes and generally consisted of medium dense, orange brown to dark brown occasionally clayey occasionally gravelly SAND. Medium dense dark brown slightly peaty SAND is noted in WS101 and medium dense becoming dense, orange brown SAND is noted in BH101. Brown, very sandy slightly gravelly CLAY with some clayey silt pockets is noted in SA102.
GROUNDWATER	Multiple groundwater strikes were recorded between 3.00 – 5.00 during the site investigation. Groundwater was observed to be standing at 1.98 – 1.99m bgl in WS102 during the monitoring investigation. Notwithstanding, this is a preliminary assessment based on 2No. monitoring visit(s) and will be reviewed on the completion of the monitoring program (6No. visits) within the final report.

SOIL INFILTRATION	Soakaway Testing was undertaken during the site investigation, SA101 and SA102, both of which failed.
ENVIRONMENTAL RISK ASSESSMENT	Long Term Human Health No elevated levels of contamination were recorded in any of the samples taken from site when assessed against the 6.0% S.O.M. Residential without Plant Uptake values. As such, risk to the long-term human health of site users is considered negligible. Consequently, no site remediation is required. Controlled Waters Risk Assessment The exceedances of DWS and EQS in WS101 (including high concentration of Lead) are not considered significant due to the lack of groundwater observed in the monitoring programme and the nearby surface water course (Rochdale Canal) is not in continuity with groundwater. The exceedances of DWS and EQS in WS102 are not considered significant due to the level of contamination observed and the lack of nearby surface water courses that could be in continuity with ground water beneath the site.
ASBESTOS	Asbestos containing materials (ACM) were not observed within samples screened.
GROUND GAS RISK ASSESSMENT	Based on the results of the gas monitoring, the site is currently classified as Characteristic Situation 1 – Very Low Risk and require no protective measures to be installed. Notwithstanding, this is a preliminary assessment based on 2No. monitoring visit(s) and will be reviewed on the completion of the monitoring program (6No. visits) within the final report.
RADON	The site is not in a Radon Affected Area, as less than 1% of properties are above the Action Level. No radon protective measures are necessary.
GEOTECHNICAL ASSESSMENT	General It is understood that consideration is being given to the development of apartments with associated infrastructure and soft landscaping areas. Due to the ground conditions encountered it would be Sutcliffe's recommendation that a piled foundation solution is adopted, with piles being taken to a suitable depth in natural strata for bearing. Final pile design will be undertaken by a specialist piling contractor. Limited groundwater ingress was recorded during site investigation works and subsequent monitoring. Sub-surface concrete that is only in contact with Made Ground can be Design Sulphate Class DS-1, with an ACEC Classification of AC-1s. Ground Floor Construction Based upon the amount of Made Ground noted on site it is not recommended that a ground-bearing slab is utilised on site. Sutcliffe Investigations therefore propose a suspended P.C Unit ground floor be adopted. Geotechnical Uncertainty The site has been subject to previous development and therefore, the potential for relic foundations and obstructions cannot be discounted.
RECOMMENDATIONS	The following actions are recommended:  Design SMMP – management of material on and off site.  Good hygiene practices should be employed during construction work, in addition, the findings of this investigation should be included within the contractors H&S file and an assessment of risks associated with short term human health completed. No consumption of food or smoking should occur without prior hand washing. If dust is encountered, dust masks should be worn, and dust suppression employed.

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1 Introduction

1.1 Terms of Reference

Sutcliffe Investigations was instructed by Arcon (*the “client”*) to undertake a Phase II ground assessment for the site at Oldham Road Woodbine Street, Rochdale.

A plan detailing the sites existing site layout is presented as *Drawing Ref: 300321CP-01*.

This report assesses the ground based geotechnical and environmental risks, constraints and liabilities associated with the proposed development of the site. This is required in support of the discharge of contaminated land planning conditions assigned to the site and to allow the design of economic foundation solutions.

1.2 Development Proposal & Legislative Context

Development Proposal

The proposed development for the site is for an apartment which includes 18No. one bed flats and 4No. two bed flats along with associated car parking facilities and soft landscaping areas. The proposed development is presented as Drawing No: WS-BTP-00-SP-DR-A-3576 produced by BTP Architects.

Legislative Context

The presence of contaminants which may pose a risk to human health, or the environment is a material planning consideration. For planning it should be considered whether the site is suitable for its new use, and the responsibility for securing a safe development (including cumulative effects of pollution on health, and the potential sensitivity of the proposed development to adverse effects from pollution,) rests with the developer and/or landowner. Planning is concerned with the site's proposed use not its current use, where the amount of contamination is expected to be low relative to the level of risk. This is the opposite to Part 2A which considers high levels (significant harm) and the current use of the site.

Section 57 of the Environment Act 1995 adds Part 2A (ss.78A-18YC) to the Environmental Protection Act 1990 and contains the legislative framework for identifying and dealing with contaminated land. Where development is undertaken on land which may be affected by contamination, the National Planning Policy Framework, paragraph 120 to 122 considers pollution and remediation. This links the contaminated land regime within the development process.

For there to be an environmental liability associated with the site there must be a perceived source (a contaminant), a receptor (humans, living organisms or property) and a pathway between them. The potential presence of all of these aspects would result in a complete contaminant linkage.

In accordance with environmental legislation and the associated guidelines, assuming the site is to be redeveloped as housing, it should be noted that any redevelopment of the site could actually create new pathways that could increase the liabilities associated with the

site. In addition, the basis of the intrusive ground assessment is to refine the preliminary conceptual model.

1.3 Site Location and Setting

The site is located at Oldham Road and Woodbine Street, Rochdale, OL16 5JB at National Grid Reference (NGR) 390370, 412330, within a predominantly residential area with local amenities also noted in the area.

A location plans and aerial photograph of the site are shown as *Figure 1 & 2*.

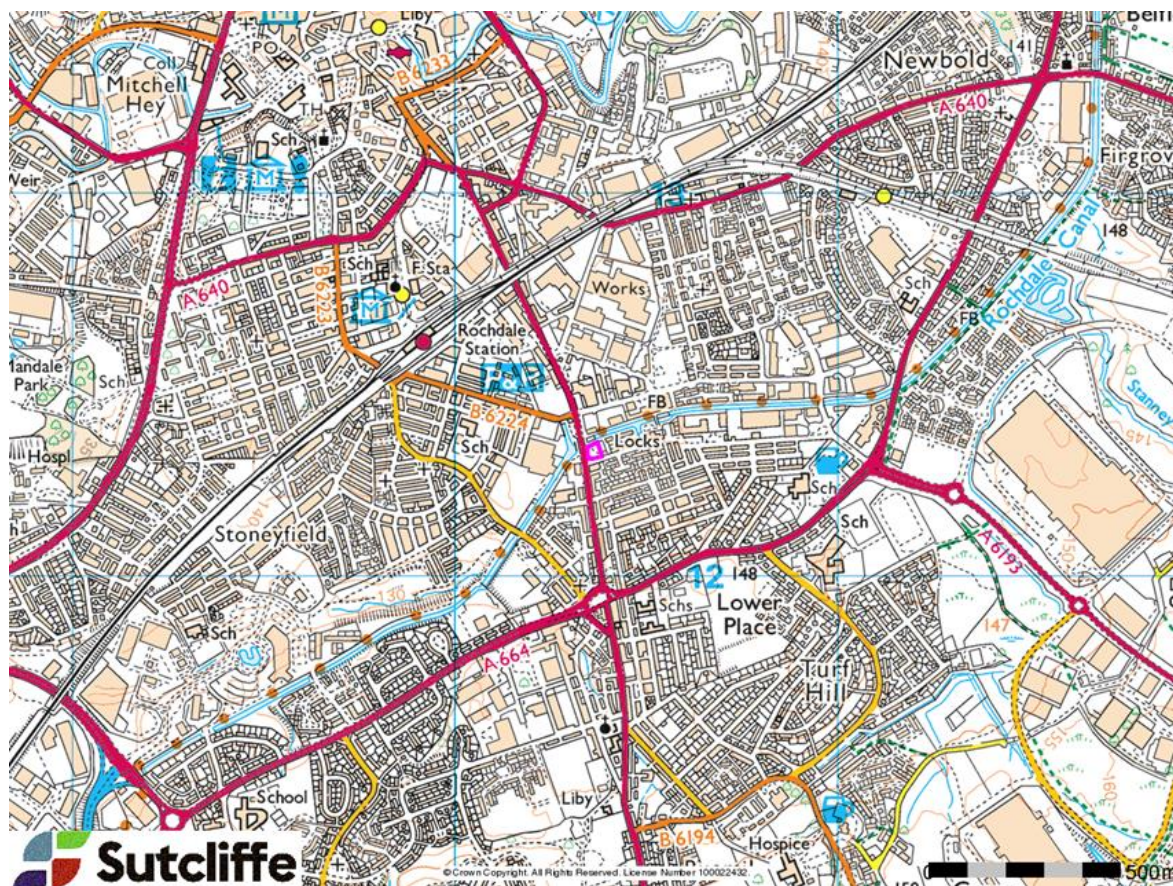


Figure 1: General Location of Site

1.4 Site Description and Layout

The site is square in shape and can be accessed via Oldham Road to the west of the site and Woodbine Street to the south of the site. The site is a relatively flat grass area with a low wooden fence that marks the site's western and southern boundaries. Also of note is an electricity pole located in the south western corner of the site. The site is currently undeveloped.



Figure 2: Aerial Photograph of the Site

1.5 Previous Studies

Sutcliffe have completed a Phase I Preliminary Risk Assessment (PRA). (*Report Reference: 31163-SUT-ZZ-00-RP-G-701-0002*), a synopsis of which is provided in Section 2 of this report. No other previous studies are known to have been undertaken to Sutcliffe's knowledge.

1.6 Objectives & Scope of Assessment

The aim of the intrusive ground investigation is to identify potential geotechnical & environmental liabilities and constraints, associated with the development of the site area in support of the following:

- ✚ A planning application and the discharge of contaminated land conditions where reasonably practicable that may have been assigned to the site and to include the design of a remediation scheme, if required as part of the National Planning Policy Framework (NPPF).

-
-  To assess the likelihood of reuse of materials that are site won or disposal options for surplus material.
 -  The preliminary design of detailed and economic foundations options inclusive of all information and specifications relating to foundation types, the location of underlying rock, (if encountered), preparation of ground, concrete grades, reuse of materials for both the proposed building, and the existing foundations.

2 Preliminary Conceptual Risk Assessment

2.1 Introduction

The Phase I PRA completed by Sutcliffe is summarised below. This report should be read in conjunction with Report Ref.: *Phase I Preliminary Risk Assessment, Woodbine Street, Rochdale, Ref: 31163-SUT-ZZ-00-RP-G-701-0002*.

2.2 Site History

On-site

The earliest available historical map (1851) indicated that a factory was noted in the eastern and southern sections of the site. No change was evident on site until, between 1956 and 1960, a part of the factory in the central eastern section of the site had been removed. Between 1977 and 1979 the rest of the factory was removed from the site. By 1999 a building was noted on site but by 2016 this had been removed.

The site remained relatively unchanged until present day, with no significant features apparent.

Off-site

The earliest historical map dated 1851 indicated that the surrounding area of the site consisted of Rochdale Canal noted immediately north of the site along with factories noted 20m north, east and south of the site. Undeveloped field land was noted 54m west, 116m south east and 122m north east of the site. Residential properties were noted 95m north, 113m south and 204m south west of the site. A sand pit was noted approximately 284m north west of the site and a gravel pit was noted 366m west of the site. Sudden Brook was noted approximately 400m south west of the site and the Lancashire & Yorkshire Railway Line was noted 466m north west of the site.

With the exception of progressive development commercial/residential/industrial), from between 1890 and 1893 and onwards, no significant identifiable changes were apparent in the immediate and wider surroundings.

Historical Contamination Potential

With the exception of made ground potentially being present on site, no significant identifiable sources of environmental concern were identified. The potential for significant contamination to have arisen at the site as a result of the current and former usage on site is considered to be low. However, the possibility of contamination albeit likely to be localised cannot be discounted.

Significant thicknesses of Made Ground are not anticipated on-site. While widespread contamination is not anticipated, discrete areas of localised contamination may be present. Potential contaminants associated with such activities may comprise a wide range of metals, hydrocarbons, oils, acids, alkalis and asbestos.

No significant off-site sources that would represent a risk to the site have been identified in the immediate surrounds

2.3 Geotechnical Constraints

Coal Mining

The site is within a coal mining area, however no further action is required to assess the risks associated with coal mining assets.

Geology

No records of artificial ground have been identified within the development site boundary. No action is required with respect to foundation design.

There are two records of artificial ground within 500m of the site the nearest of which is 27m south west of the site and is noted as Infilled Ground.

Two faults are noted within 500m of the site, the nearest is noted 404m south west of the site.

Historical Land Use

The site has been subject to previous development and therefore, the potential for relic foundations and obstructions cannot be discounted.

2.4 Potential Contaminant Linkages

Sources

Based on the information from the desk study, historical maps, published information, and a site walkover a summary of potential contaminant sources is provided in *Table 2.1*.

Table 2.1: Potential Source(s) of Contamination

Ref.	Potential Sources	Potential Contaminants
S1 (On-site)	Demolished buildings	All metals, fuel, hydrocarbons and oils and localised ground gas.
S2 (Off-site)	None	N/a

Pathways

Exposure pathways are the potential routes and mechanisms by which potential on-site sources could be linked to the identified potential receptors and thereby expose them to potential harm.

The following potential exposure pathways have been identified at the site:

Table 2.2: Pathways

Ref.	Pathway	Description
P1	Direct contact with potential contaminants.	Dermal absorption, ingestion and inhalation of contaminants via direct contact. Construction workers may come into contact during the site works; however, this will be for a short time and therefore limited exposure will occur. PPE can be used and worn as a precaution to reduce the risk.
P2	Ingestion of potential contaminants.	
P3	Inhalation of potential contaminants.	
P4	Leaching and migration of contaminants.	Leaching of possible contaminants could migrate into the underlying Secondary A Aquifers via shallow groundwater. On-site drainage is also at risk from shallow contamination if present.
P5	Vertical and lateral migration of ground gases / vapours.	There is the potential for contaminants to be present on the site, which could generate ground gas & vapours on site.

Receptors

Based on the site's environmental setting and the proposed future end-use of the area following redevelopment, the following potential receptors have been identified:

Table 2.3: Receptors

Ref.	Receptor	Description
R1	Current & future site users	Site users; personnel, general workers and maintenance workers,
R2	Construction Workers	Contractors working on the development of the site. Construction workers, maintenance workers or other personnel who may be directly exposed to contaminated materials in the course of their activities).
R3	Controlled Waters	Secondary A Aquifers and on-site drainage.
R4	Adjacent Site Users	Adjacent site users. Third-party land (i.e., the possibility of contamination migrating off-site onto third party land via contaminated groundwater, surface water run-off).
R5	Infrastructure / Buried services	Proposed buildings and buried services

NOTE: ground workers (i.e., If the site was redeveloped, any associated activities may bring site personnel and construction workers into contact with potentially contaminative materials, however, it is considered that the risks to workers will be short term and could be controlled by safe working procedures.

2.5 Risk Evaluation

An evaluation of the risk that each contaminant linkage poses to the project (as identified in the *Section 2*) has been undertaken, in general accordance with CIRIA guidance document C552, 2001 (as detailed in *Appendix B*) and in *Tables 2.4, 2.5 and 2.6* below.

The evaluation and resultant actions identified are based on available information presented within the Phase I PRA (*Report reference: GRO-20215-1793*)

Table 2.4: Classification of consequence

Classification	Definition
Severe	Acute risks to human health, catastrophic damage to buildings/property, major pollution of controlled waters.
Medium	Chronic risk to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures.
Mild	Pollution of non-sensitive waters, minor damage to buildings or structures.
Minor	Requirement for protective equipment during site works to mitigate health effects, damage to non-sensitive ecosystems or species.

Table 2.5: Classification of Probability

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage, and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 2.6: Risk Assessment Matrix

Consequence				Probability
Severe	Medium	Mild	Minor	
Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk	
High Risk	Moderate Risk	Moderate / Low Risk	Low Risk	
Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk	
Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk	
Low Risk	Very Low Risk	Very Low Risk	Very Low Risk	Negligible Likelihood

Each potential contaminant linkage is identified in *Table 2.7* below.

The evaluation and the resultant actions identified are based on the available information presented within this report. A visual representation of the Preliminary CSM is presented as *Figure 3*.

During the development there is a potential for short term human health risk to construction workers. These should be assessed and anticipated by the contractor under CDM Regulations 2015.

Table 2.7: Preliminary Risk Evaluation of Potential Contaminant Linkages

Preliminary Conceptual Site Model									
1. Hazard Identification		2. Hazard Assessment				3. Risk Estimation		4. Risk Evaluation	5. Managing the Risk
Contaminant Source		Pathway		Receptor		Consequence of risk being realised	Probability of risk being realised	Classification	Action required
S	Potentially contaminated soil on Site	P1	Dermal contact	R1/2	Site users	Medium	Low	Moderate / Low	It is possible that harm could arise to a designated receptor from an identified hazard. Investigation is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
		P2	Ingestion of soil / soil dust	R1/2	Site users	Medium	Low	Moderate / Low	
		P3	Inhalation of vapours / soil gas	R1/2	Site users	Severe	Unlikely	Moderate / Low	
		P4	Leaching and migration of contaminants	R3/5	Secondary A Aquifers	Medium	Low	Moderate / Low	
		P5	Lateral migration of soil gas / vapours	R1	Site users	Severe	Unlikely	Moderate / Low	
				R4	Property	Severe	Unlikely	Moderate / Low	

3 Ground Investigation

3.1 Design Rationale

The aim and design of the ground assessment is to satisfy planning conditions assigned to the site by reference to the National Planning Policy Framework (NPPF). This will identify elevated concentrations of determinands with the aim of assessing long term human health risks to site users and groundwater resources. In addition, the works have been designed to allow the design of economic foundation solutions for the proposed new builds.

3.2 Fieldwork

Field works were undertaken on 28th April, 1st May and 3rd May 2022 by PM Sampling, VC Drilling, Hurts and Layer Surveys, specialist ground investigation contractors and comprised:

-  1No. Cable Percussion Borehole (BH101)
-  3No. Window Sample Holes (WS101, WS102 & WS103)
-  Contamination samples from various depth in the Made Ground.
-  Leachate samples.
-  Gas monitoring wells.
-  Monitoring of ground gas / ground water with installed locations.

All works were supervised by a suitably qualified Sutcliffe engineer. The investigation was carried out in general accordance with the following standards:

-  BS10175:2011+A2:2017 Investigation of Potentially Contaminated Sites – Code of Practice.
-  R&D Technical Report P5-066/TR Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, 2001 (Environment Agency).
-  BS 5930:2015 Code of practice for site investigations; and,
-  BS EN ISO 22475-1:2006 Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution.

Site Investigation logs collated as part of the ground investigation completed by Sutcliffe are presented in *Appendix C*.

3.3 Health & Safety

Service plans for the development site have been obtained and are included as part of the Phase I PRA. Copies of these plans are maintained on site by the Sutcliffe engineer who is also responsible for clearing the areas to be investigated by use of a Cable Avoidance Tool (CAT) and signal generator (Genny).

3.4 Sampling Strategy

Due to the history of the site, with limited development having occurred, a non-targeted sampling strategy was used to obtain a site wide representation of the site and the potential contamination issues.

The site area is $1,161\text{m}^2 \div 6 \text{ sample positions} = 193.5\text{m}^2 \div 0.8 = 241.88$

$\sqrt{241.88\text{m}^2} = \text{a } 15.55\text{m grid.}$

Therefore, this gives an 80% probability of finding a circular area of interest of 241.88m^2 .

There are things to target on site sometimes Pits/ponds for gas, HC storage tanks etc

A summary of exploratory hole detailing rationale is shown in *Table 3.1* below.

Table 3.1: Summary of Site Activities

Ref. No.	Location Rationale	Method	Completed Depth (mbgl)	Installation Details	Testing & Sampling details
BH101	General Site Coverage (HH)	Cable Percussion	15.45	No installation	SPTs and environmental samples
WS101	General Site Coverage (GG, HH, CW)	Window Sampler	6.45	Standpipe installed to 3.00m bgl	SPTs and environmental samples
WS102	General Site Coverage (GG, HH, CW)	Window Sampler	4.45	Standpipe installed to 2.00m bgl	SPTs, CPTs and environmental samples
WS103	General Site Coverage (GG, HH)	Window Sampler	6.45	Standpipe installed to 4.00m bgl	SPTs and environmental samples
SA101	BRE 365 'Soakaway'	Machine Excavator	2.10	No installation	N/A
SA102	BRE 365 'Soakaway'	Machine Excavator	2.00	No installation	N/A

GG – Ground Gas / CW – Controlled Water / HH – Human Health

A plan detailing the position of sampling locations on an existing layout of the site is presented as *Drawing Ref: 31163-SUT-ZZ-00-DR-G-720-0001*.

3.5 Chemical Laboratory Testing

Selected soil samples (Made Ground) were collected at various depths and horizons and submitted for chemical analysis, details of which are presented in *Table 3.2*.

Table 3.2: Summary of Soils Analysis (Total & Leachate Concentrations)

Suite Reference	Analysis Suite
Soils Suite	Metals suite, speciated (16) polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons according to the Total Petroleum Hydrocarbon Working Group (TPHCWG), asbestos screen, total cyanide, phenols and soil organic matter.
Leachate	Metals suite, speciated (16) PAHs.

All samples were analysed by MCERTS accredited soil analysis laboratory Envirolab under UKAS accredited methods. All samples have been taken in accordance with current British Standards.

Envirolab are appropriately accredited for the works required and are an approved supplier under the Sutcliffe's Quality Management System.

Analytical test certificates are presented in *Appendix D*.

TPH Speciated aromatic and aliphatic bands with BTEX analysis have been carried out in line with the TPHCWG. The toxicity and migration risk associated with a TPH is dependent on the specific aliphatic aromatic carbon banding.

Of particular concern are the low molecular weight compounds, which are highly mobile and show a greater level of toxicity than the higher molecular weight compounds. Therefore, a low TPH consisting of low molecular weight aliphatic and aromatic carbon banding compounds may present more of a risk than a high TPH consisting of heavy weight aliphatic and aromatic carbon banding compounds.

Based on the TPHCWG the aromatic band C5 – C7 is considered to consist only of Benzene and the aromatic band C7 – C8 of Toluene. Therefore, the more specific BTEX analysis has been used for risk assessment rather than the aromatic bands.

3.6 Drainage

It is recommended that the client / developer contact United Utilities with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

3.7 Water Supply

Please note the testing suite carried out for this site is for human health purposes and may not cover the suite of contaminants required by United Utilities for pipe selection and therefore further testing may be required.

3.8 Services

It is recommended that the client / developer contact the relevant service provided to ascertain the requirements for power reinforcement and / or relocation / diversion of existing services.

4 Ground Model

4.1 General

The following section describes the ground conditions encountered during the intrusive ground assessment completed by Sutcliffe.

4.2 Made Ground

A summary of the strata depths and thicknesses for Made Ground is detailed in Table 4.1 and Table 4.2 below.

Table 4.1: Ground Conditions Encountered (Made Ground)

Strata	Depths encountered (mbgl)		Thickness (m)		
	Min	Max	Min	Max	Average
MADE GROUND	0.00	3.00	0.10	2.80	0.64

Table 4.2: Ground Conditions Encountered (Made Ground – Detailed)

Strata	Depths encountered (mbgl)		Thickness (m)		
	Min	Max	Min	Max	Average
Grass over black, fine to medium grained SAND with much root material (TOPSOIL)	0.0	0.2	0.1	0.2	0.15
Brown to dark brown, occasionally clayey SAND with fine to coarse brick, sandstone and metal fragments as well as half and whole bricks	0.10	1.60	0.70	1.50	1.10
Light grey, fine to coarse grained SAND and graded granular limestone hardcore ¹	1.60	1.90	0.30	0.30	0.30
Dark brown, fine to medium grained SAND with fine to coarse brick and concrete fragments and sandstone cobbles.	0.10	3.00	0.40	2.80	1.60

¹ Only encountered at one location – WS103.

4.3 Natural Ground

A summary of the strata depths and thicknesses for natural ground is detailed in Table 4.3 and 4.4 below.

Table 4.3: Ground Conditions Encountered (Natural – General)

Strata	Depths encountered (mbgl)		Thickness (m)		
	Min	Max	Min	Max	Average
CLAY ¹	0.90	2.00**	1.10	1.10**	1.10**
SAND	0.20	15.45**	0.20	6.45**	1.87**

¹ Only encountered at one location – SA102.

** Final Depth of Strata not proven, average thickness on identified ground.

Table 4.4: Ground Conditions Encountered (Natural – Detailed)

Strata	Depths encountered (mbgl)		Thickness (m)		
	Min	Max	Min	Max	Average
Medium dense, orange brown to dark grey, fine to medium grained SAND	1.90	9.00	0.50	6.00	1.90
Medium dense becoming dense, orange brown, fine to coarse grained SAND ¹	9.00	15.45**	6.45**	6.45**	6.45**
Medium dense, light brown, gravelly fine to medium grained SAND. Gravel is fine to medium, subangular to subrounded and of sandstone ²	0.50	2.00	1.50	1.50	1.50
Medium dense, dark brown, slightly peaty fine to medium grained SAND ³	3.10	3.50	0.40	0.40	0.40
Medium dense, dark brown occasionally light brown, clayey fine to medium grained SAND	1.20	4.45**	0.20	1.85**	0.88**
Brown, slightly clayey fine to medium grained SAND with occasional clay pockets ⁴	0.20	2.10**	1.90**	1.90**	1.90**
Brown, very sandy, slightly gravelly CLAY with some clayey silt pockets. Sand is fine to medium. Gravel is fine, subangular and of sandstone ⁵	0.90	2.00**	1.10	1.10**	1.10**

¹ Only encountered at one location – BH101.² Only encountered at one location – WS101.³ Only encountered at one location – WS101.⁴ Only encountered at one location – SA101.⁵ Only encountered at one location – SA102.

** Final Depth of Strata not proven, average thickness on identified ground.

4.4 Standard Penetration Tests (SPT)

The standard penetration test (SPT) is used to provide geotechnical engineering properties for foundation design purposes. The results can be used to determine the relative density, bearing capacity, and settlement of granular soil. The results can also be used to correlate the approximate strength of cohesive soil.

The SPT results are detailed in Table 4.5 and Figure 4 hereunder.

Table 4.5: SPT Results

Strata	No. of Tests	Range	Average
MADE GROUND	3	14 – 28	21.7
SAND	26	4 – 32	17.4

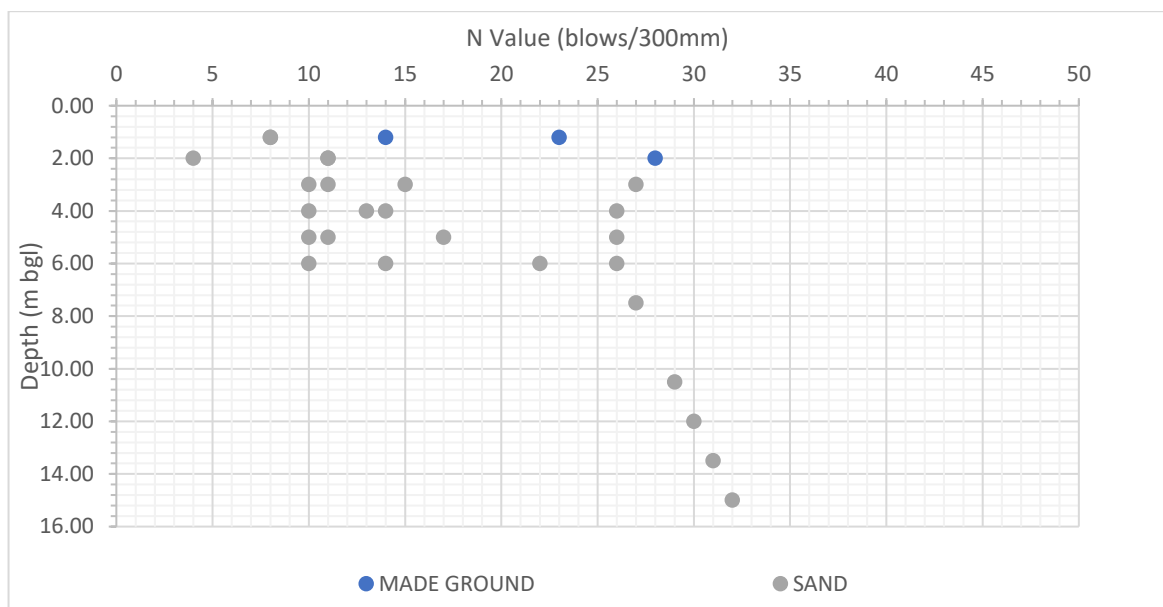


Figure 4: SPT Results

4.5 Field Evidence of Contaminated Soils

Made Ground was noted within every investigation location conducted except for SA101. Within the Made Ground, an additional contamination indicator was also noted:

Table 4.6: Field Evidence of Contaminated Soils

Ref. No.	Depth (mbgl)	Contamination Indicator
WS102	2.60 – 3.00	Distinct Hydrocarbon Odour

Apart from the above instance, no other visual or olfactory contamination indicators were noted during the Site Investigation

4.6 Groundwater

Multiple groundwater strikes were recorded during the site investigation, as noted in *Table 4.7* below:

Table 4.7: Groundwater Observations

Ref. No.	Depth (mbgl)	Comment
BH101	5.00	No rise
WS101	5.00	No rise
WS102	3.00	No rise
WS103	4.00	No rise

5 Geotechnical Laboratory Testing and Assessment

5.1 General

In total 4No. samples were recovered from site for the purpose of geotechnical laboratory testing. A breakdown of the testing scheduled is set out in *Table 5.1* below.

Table 5.1: Geotechnical Testing

Ref. No.	Depth (m)	Particle Size Distribution	Other
BH101	5.00	✓	
WS101	1.00 – 2.00	✓	
WS102	1.00 – 2.00	✓	
WS103	1.00 – 2.00	✓	

5.2 Particle Size Distribution

PSD testing was scheduled on 4No. samples recovered from site. The result of this testing is outlined below in *Table 5.2*.

Table 5.2: PSD Test Results

Borehole Number	Depth From (m)	Depth To (m)	Sieve Percentage (%)		
			Gravel	Sand	Silt/Clay
BH101	5.00	5.00	30	68	2
WS101	1.00	2.00	20	66	14
WS102	1.00	2.00	9	70	21
WS103	1.00	2.00	1	98	1

The results of this testing are comparable with the observed ground conditions and indicate that the ground conditions are variable across the site.

5.3 Dynamic Cone Penetrometer

The Dynamic Cone Penetration Test provides a measure of a material's in-situ resistance to penetration. Test results can be correlated to California Bearing Ratios (CBR %).

A total of 3No. tests were carried out across the site. Results of the DCP tests are detailed in *Table 5.3* below.

Table 5.3: Dynamic Cone Penetrometer Results

Test	CBR Range (%)	Minimum CBR (%)
CBR1	8 – 145	8
CBR2	7 – 185	7

It is recommended that new external trafficked pavements be designed on a CBR of 7%.

5.4 Soil Infiltration

2No. infiltration test (TP104) was carried out on site.

The test results did not provide an infiltration rate due to the inefficiencies of the ground to infiltrate. Infiltration testing has been undertaken and failed; therefore, alternative drainage solutions will be required.

5.5 Stability

WS102 collapsed at a depth between 4.00-5.00m bgl and SA102 was noted to have started collapsing approximately 160mins after the pit was dug. Based on these observations and the amount of Made Ground noted on-site, shoring would likely be required if any groundworks are to be left open during site works.

5.6 Soluble Sulphate and pH

It is envisaged foundations will extend through the Made Ground and into the natural strata and samples taken from the Made Ground have been submitted for pH and water-soluble sulphate (2:1 soil/water extract) analysis.

The highest water-soluble sulphate concentration and the lowest pH value for the Made Ground is shown in *Table 5.3*.

Table 5.3: Soluble sulphate and pH classification

Soil Type	Lowest pH Values	Highest Soluble Sulphate Concentration (g/l)
Made Ground	6.65	0.02

Therefore, in accordance with Table C2 of BRE: Special Digest 1 2005, sub-surface concrete that is in contact with Made Ground should be Design Sulphate Class **DS-1**, with the ACEC classification of **AC-1s**.

A complete set of geotechnical laboratory certificates are presented in *Appendix F*.

5.7 Foundation Recommendations

General

It is understood that consideration is being given to the development of apartments with associated infrastructure and soft landscaping areas.

Due to the ground conditions encountered it would be Sutcliffe's recommendation that a piled foundation solution is adopted due to the amount of Made Ground that has been identified on site. Final pile design will be undertaken by a specialist piling contractor.

Limited groundwater ingress was recorded during site investigation works and subsequent monitoring.

Sub-surface concrete that is only in contact with Made Ground can be Design Sulphate Class DS-1, with an ACEC Classification of AC-1s.

Ground Floor Construction

Based upon the amount of Made Ground noted on site it is not recommended that a ground-bearing slab is utilised on site. Sutcliffe Investigations therefore propose a suspended P.C Unit ground floor be adopted.

Designated Concrete Mixes

The following designated mix in accordance with BRE Special Digest SD1 and BS 8500: Part1: 2015 will be suitable for use on this site.

Table 5.4: Designated Concrete Mixes

Application	DS-1 Conditions (Made Ground and Natural) ACEC Class AC-1s
Unreinforced strip / trench fill footings	GEN1
Reinforced strip / trench fill footing (mesh reinforcement)	RC30
Reinforced strip / trench fill footings (rebar etc)	RC30
Unreinforced concrete floor slabs	GEN2
In situ reinforced concrete floor slabs	RC30

**Note: Although RC 30 is in line with BS8500, Sutcliffe Investigation recommend the use of RC35 for concrete used in structurally sensitive works, to provide greater certainty of compliance with strength verification tests. Tolerable mixes dispatched by a batching plant are +/- 10%, and delays on site can also result in deterioration of the concrete.*

5.8 Geotechnical Uncertainty

The site has been subject to previous development and therefore, the potential for relic foundations and obstructions cannot be discounted.

6 Long Term Human Health Risk Assessment

6.1 Methodology

Based on the Preliminary Risk Assessment and Ground Model for this site, a Generic Quantitative Risk Assessment for human health has been undertaken in accordance with LCRM and SR (SC050021 series) (DEFRA) guidance as well as CL:AIRE Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (2020) and comprises the following:

-  Selection of appropriate generic screening values for human health assessment.
-  Creation of relevant datasets from which to undertake the assessment.
-  Assessment of contamination distribution and comparison of site data to screening values using relevant statistical tests (in accordance with CIEH guidance).
-  Assessment of risks to receptors.
-  Determination of requirements for further investigation or remediation.

6.2 Selection of Soil Screening Values

Soil screening values appropriate for a *Residential without Plant Uptake* were selected.

6.3 Creation of Relevant Datasets

As part of the desk study assessment and Preliminary Conceptual Model, Made Ground was identified as the principal potential source identified for contamination in the risk evaluation (*Section 2.0*). Consequently, the sampling strategy targeted Made Ground encountered on site.

6.4 Identification of Contaminants of Concern

The results of the soil analysis from the investigation are shown in *Appendix D*. These results were then compared against the relevant GACs for 6.0% soil organic matter (S.O.M.). The average percentage S.O.M. was 5.7% for 4No. samples.

Elevated levels of contamination were recorded in all samples taken from site when assessed against the 6.0% S.O.M. *Residential without Plant Uptake* values.

Table 6.1: Chemical Analysis Results for Made Ground Stratum

Contaminant	Threshold Value (mg/kg)	Location	Depth (m bgl)	Recorded Concentration (mg/kg)
Lead	310	WS101	0.10-0.50	332
benzo(b)fluoranthene	4	WS102	0.10-0.50	5.57
Benzo(a)pyrene	3.2	WS105	0.10-0.50	5.23
Dibenzo(ah)anthracene	0.32	WS105	0.10-0.50	0.53

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6.5 Assessment

The soil analytical data has been assessed following CL:AIRE guidance, LCRM and NHBC R&D Publication 66 2008 “*Guidance for the Safe Development of Housing on Land Affected by Contamination*”.

The purpose of human health risk assessment for planning is to decide whether the land is suitable for the proposed end use and does not pose a risk to human health.

Statistical analysis in accordance with CL:AIRE publication *Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (2020)* was used to assist in answering the key question raised above.

Utilising the 2-way confidence interval method, the likelihood of whether the true mean is less than the critical concentration can be calculated and aid with decision making in terms of further investigation or remediation.

This assessment will be using an 85% confidence interval to state that:

*There is an **85%** chance that the true mean concentration level of the contaminant in this sampling zone lies between **x** and **y** mg/kg.*

A 99% confidence interval will be used to state that:

*There is a **99%** chance that the true mean concentration level of the contaminant in this sampling zone will not lie outside **x** and **y** mg/kg.*

Results of the Statistical analysis is presented in *Appendix D*.

6.6 Statistical Analysis

Lead

There was 1No. exceedance of the Lead screening value from samples analysed at WS101. The critical concentration of this contaminant is **310.00mg/kg.**

Statistical Analysis of samples screened for the contaminant indicate that:

 There is an **85%** chance that the true mean concentration level of the contaminant in this sampling zone lies between **57.35-301.15mg/kg.**

 There is a **99%** chance that the true mean concentration level of the contaminant in this sampling zone will not lie outside **0.00-549.26mg/kg.**

Based on the results of the statistical analysis, Sutcliffe are not confident that the true mean concentration of the site lies below the critical concentration.

Benzo(b)fluoranthene

There was 1No. exceedance of the Benzo(b)fluoranthene screening value from samples analysed at WS102. The critical concentration of this contaminant is **4.00mg/kg.**

Statistical Analysis of samples screened for the contaminant indicate that:

-  There is an **85%** chance that the true mean concentration level of the contaminant in this sampling zone lies between **0.47-4.57mg/kg**.
-  There is a **99%** chance that the true mean concentration level of the contaminant in this sampling zone will not lie outside **0.00-8.74mg/kg**.

Based on the results of the statistical analysis, Sutcliffe are not confident that the true mean concentration of the site lies below the critical concentration.

Benzo(a)pyrene

There was 1No. exceedance of the Benzo(a)pyrene screening value from samples analysed at WS102. The critical concentration of this contaminant is **3.20mg/kg**.

Statistical Analysis of samples screened for the contaminant indicate that:

-  There is an **85%** chance that the true mean concentration level of the contaminant in this sampling zone lies between **0.41-4.25mg/kg**.
-  There is a **99%** chance that the true mean concentration level of the contaminant in this sampling zone will not lie outside **0.00-8.17mg/kg**.

Based on the results of the statistical analysis, Sutcliffe are not confident that the true mean concentration of the site lies below the critical concentration.

Dibenzo(ah)anthracene

There was 1No. exceedance of the Dibenzo(ah)anthracene screening value from samples analysed at WS102. The critical concentration of this contaminant is **0.32mg/kg**.

Statistical Analysis of samples screened for the contaminant indicate that:

-  There is an **85%** chance that the true mean concentration level of the contaminant in this sampling zone lies between **0.10-0.45mg/kg**.
-  There is a **99%** chance that the true mean concentration level of the contaminant in this sampling zone will not lie outside **0.00-0.82mg/kg**.

Based on the results of the statistical analysis, Sutcliffe are not confident that the true mean concentration lies below the critical concentration.

6.7 Discussion

The statistical analysis for all exceeded contaminants indicates that there is a high probability that the true mean concentrations are above the critical concentration indicating a risk to human health.

6.8 Asbestos

Asbestos containing materials (ACM) were not observed within samples screened.

6.9 Conclusions

Based on the results of the statistical analysis, the site is considered likely to pose a risk to long term human health.

Notwithstanding, considering the proposed development and the location of the zones of exceeded contaminants (i.e. WS101 and WS102) positioned under proposed hardstanding, there is no pathway for the exceeded contaminants to affect relevant receptors hence the risk to long term human health is considered low.

7 Controlled Waters Risk Assessment

7.1 Methodology

Based on the Preliminary Risk Assessment and Ground Model for this site, a Level 1 Screening Assessment has been undertaken in general accordance with Environment Agency guidance Environment Agency Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, 2006.

The methodology comprises:

 Identification of potential contaminant linkages.

- Selection of appropriate generic screening values for controlled waters.
- Screening measured concentrations of leachate against the generic screening values available for UK Drinking Water Standards (UK DWS) and Environmental Quality Standards (EQS).

 Assessment of contaminant distribution and risk to receptors.

- Identification of contaminants of concern and relevant contaminant linkages.
- Identification of potential contaminants and contaminant linkages which are no longer of concern.

7.2 Identification of Potential Contaminant Linkages

Contaminant linkages have been identified in *Section 3.0* between the Made Ground and the underlying aquifer via infiltration and/or migration of dissolved phase contaminants.

7.3 Selection of Generic Screening Values

Screening values for Drinking Water Standards (DWS) have been used to assess leachability. DWS are relevant to potable receptors (Secondary A Aquifers).

Environmental Quality Standards (EQS) screening values have been used to assess risks to surface water resources.

7.4 Leachate Screening – UK DWS & EQS

Metals, TPHCWG and Speciated PAHs were assessed. Exceedances of relevant UK DWS and EQS screening criteria were encountered, details of which are identified in *Table 7.1 & 7.2*. It should be noted that several determinands have limits of detection greater than their respective screening values. Due to the level of uncertainty associated with such results, these exceedances are not considered significant and are excluded from the table below.

Table 7.1: Leachate Exceedances Summary - DWS

Determinant	DWS Threshold (µg/l)	Range of concentrations (µg/l)	Location	Depth (m bgl)	Recorded Concentration (µg/l)
Arsenic	10	<1 – 73	WS101	0.10 – 0.50	73
Lead	10	13 – 1610	WS101	0.10 – 0.50	1610
			WS102	0.10 – 0.50	13
Nickel	20	1 – 33	WS101	0.10 – 0.50	33

Table 7.2: Leachate Exceedances Summary - EQS

Determinant	EQS Threshold (µg/l)	Range of concentrations (µg/l)	Location	Depth (m bgl)	Recorded Concentration (µg/l)
Arsenic	50	<1 – 73	WS101	0.10 – 0.50	73
Copper	1	7 – 248	WS101	0.10 – 0.50	248
			WS102	0.10 – 0.50	7
Lead	14	13 – 1610	WS101	0.10 – 0.50	1610
Zinc	10.9	7 – 135	WS101	0.10 – 0.50	135

Leachate screening tables are presented in *Appendix G*. Analytical certificates are presented in *Appendix D*.

7.5 Contaminant Distributions and Risk to Receptors

Several determinands exceeded the DWS and EQS screening values. The risk to controlled waters (groundwater & surface waters) is considered likely as a result of the following:

-  The site is underlain by Glaciofluvial Deposits, a Secondary A Aquifer, which consists of permeable layers of sand and gravel. As such a pathway for leachate migration towards the bedrock is likely.
-  There is a high concentration of Lead identified in WS101 which will pose a significant risk to controlled waters.
-  The nearest surface water feature is noted only 8m north of the site and relates to Rochdale Canal, however it is unlikely the canal is in continuity with groundwater beneath the site given how canals are engineered.

7.6 Conclusion

The exceedances of DWS and EQS in WS101 (including high concentration of Lead) are not considered significant due to the lack of groundwater observed in the monitoring programme and the nearby surface water course (Rochdale Canal) is not in continuity with groundwater.

The exceedances of DWS and EQS in WS102 are not considered significant due to the level of contamination observed and the lack of nearby surface water courses that could be in continuity with ground water beneath the site.

8 Ground Gas & Groundwater Risk Assessment

8.1 CIRIA C665 Assessment

Gas monitoring wells were installed in 3No. exploratory hole locations (WS101, WS102 & WS103) as part of the ground investigation completed by Sutcliffe.

A full copy of all gas monitoring readings and water levels can be found in *Appendix E*.

8.2 Methodology

A ground gas risk assessment has been undertaken in general accordance with the British Standard BS8485:2015+A1:2019, "*Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings*".

The guidance is written specifically for use by designers of gas protection measures relating to the development of a site. Reference has also been made to the CIRIA document C665:2007: "*Assessing Risks Posed by Hazardous Ground Gases to Buildings*" and to the Health and Safety Executive document EH40/2005 "*Workplace Exposure Limits*".

Our assessment comprises the following:

-  Review of results.
-  Calculation of Hazardous Gas Flow Rate for Methane (CH₄) and Carbon Dioxide (CO₂).
-  Assessment of risks from ground gas.
-  Development options.

8.3 Review of Field Data

To date, two (2No.) out of six (6No.) rounds of gas and groundwater monitoring have been undertaken.

Gas monitoring was undertaken using a fully calibrated GFM gas monitor which measured concentrations of oxygen, carbon dioxide and methane as well as gas flow emission rates.

Monitoring of groundwater installations were undertaken using an electronic ATEX Dipmeter.

The findings are summarised below in *Table 8.1* and the results are presented in full in *Appendix E*. Calibration certificates are also presented in *Appendix E*.

Table 8.1: Summarised Ground Gas and Groundwater Monitoring Data

Location	MAX CH ₄ (%)	MAX CO ₂ (%)	MIN O ₂ (%)	MAX (ppm)	Atmospheric Pressure (mb)	MAX Flow Rate (l/hr)	Water Level (m bgl)
28/06/2022							
WS101	0.0	5.6	15.9	-	995	0.0	Dry
WS102	0.0	0.9	20.0	-	995	0.0	1.99
WS103	0.0	1.0	19.7	-	995	0.0	Dry
07/07/2022							
WS101	0.0	5.2	16.1	-	1013	0.0	Dry
WS102	0.0	2.1	18.0	-	1013	0.0	1.98
WS103	0.0	0.6	20.2	-	1013	0.0	Dry

8.4 Calculation of Hazardous Gas Flow Rate (HGFR)

A hazardous gas flow rate (HGFR) is derived, representative of the actual flow of gas from the borehole. This, combined with a consideration of other factors such as maximum concentration, is used to characterise the site. HGFRs for both methane and carbon dioxide based on steady state flow and concentration have been calculated as:

HGFR = maximum gas concentration on visit x measured borehole flow rate on visit.

Results of the calculation are presented in *Appendix E*.

Methane HGFR

The highest calculated HGFR per borehole for methane is presented below:

Table 8.2: Methane HGFR

Ref. No.	Flow (l/h)	CH ₄ (%)	HGFR CH ₄ (l/h)	Characteristic Situation (CS)
WS101	0.1 ¹	0.1 ²	0.0001	CS1
WS102	0.1 ¹	0.1 ²	0.0001	CS1
WS103	0.1 ¹	0.1 ²	0.0001	CS1

¹ Where maximum recorded flow is <0.1l/h, 0.1l/h has been used as recommended in CIRIA C665.

² Where maximum recorded concentration is <0.1%, 0.1% has been used as recommended in BS8485.

Carbon Dioxide HGFR

The highest calculated HGFR per borehole for carbon dioxide is presented below:

Table 8.2: Carbon Dioxide HGFR

Ref. No.	Flow (l/h)	CO ₂ (%)	HGFR CO ₂ (l/h)	Characteristic Situation (CS)
WS101	0.1 ¹	5.6	0.0056	CS1
WS102	0.1 ¹	2.1	0.0021	CS1
WS103	0.1 ¹	1.0	0.0010	CS1

¹ Where maximum recorded flow is <0.1l/h, 0.1l/h has been used as recommended in CIRIA C665.

8.5 Ground Gas Risk Assessment

In accordance with CIRIA C665 the ground gas monitoring results indicate that the site has a HGFR of 0.0001l/hr for methane and 0.0056l/hr for carbon dioxide.

This results in the site being classified as Characteristic Situation 1 – Very Low Risk and require no protective measures to be installed.

Notwithstanding, this is a preliminary assessment based on 2No. monitoring visit(s) and will be reviewed on the completion of the monitoring program (6No. visits) within the final report.

8.6 Radon

According to the Envirocheck Report, the site is not within a radon affected area, as <1% of homes are above the action level hence no radon protection measures are necessary.

8.7 Groundwater Protection Measures

Groundwater was observed to be standing at 1.98 – 1.99m bgl in WS102 during the monitoring investigation. No groundwater has been encountered in WS101 and WS103 during the 2No. monitoring visits.

Based on the Resting Groundwater Levels (RWLs) no discernible groundwater flow has been recorded.

There is no evidence at this stage of significant perched water either in the Made Ground or in the natural stratum encountered on site that would suggest special groundwater protection measures to the building foundations are required.

In light of these observations, contractors should allow for pumping to develop and maintain dry working conditions, in foundation and service trench excavations.

9 Land Contamination Risks and Remediation Requirements

9.1 Revised Conceptual Model

Based on the findings of the human health, the preliminary conceptual model has been revised as shown in *Figure 7*. The drawing shows all contaminant linkages from the preliminary conceptual model, identifying those which remain relevant.

9.2 Discounted Contaminant Linkages

Long Term Human Health

Notwithstanding, considering the proposed development and the location of the zones of exceeded contaminants (i.e., WS101 and WS102) positioned under proposed hardstanding, there is no pathway for the exceeded contaminants to affect relevant receptors hence the risk to long term human health is considered low.

9.3 Remaining Potential Contaminant Linkages

Ground Gas

Based on the results of the gas monitoring, the site is currently classified as Characteristic Situation 1 – Very Low Risk and require no protective measures to be installed.

Notwithstanding, this is a preliminary assessment based on 2No. monitoring visit(s) and will be reviewed on the completion of the monitoring program (6No. visits) within the final report.

Controlled Waters

The exceedances of DWS and EQS in WS101 (including high concentration of Lead) are not considered significant due to the lack of groundwater observed in the monitoring programme and the nearby surface water course (Rochdale Canal) is not in continuity with groundwater.

The exceedances of DWS and EQS in WS102 are not considered significant due to the levels of contamination observed and the lack of nearby surface water courses that could be in continuity with ground water beneath the site.

Table 9.1: Summary of Remaining Contaminant Linkages

1. Hazard Identification		2. Hazard Assessment				3. Risk Estimation		4. Risk Evaluation	5. Managing the Risk
Contaminant Source		Pathway		Receptor		Consequence	Probability	Classification	Action required
S1	Made Ground	P1	Dermal contact	R1/2	Site users	Medium	Negligible	Very low Risk	Based on the results of the chemical analysis, the site is considered likely to pose a risk to long term human health.
		P2	Ingestion of soil / soil dust	R1/2	Site users	Medium	Negligible	Very low Risk	
		P3	Inhalation of vapours / soil gas	R1/2	Site users	Severe	Negligible	Low Risk	Considering the proposed development and the location of the zones of exceeded contaminants (i.e. WS101 and WS102) positioned under proposed hardstanding, there is no pathway for the exceeded contaminants to affect relevant receptors hence the risk to long term human health is considered low. Although no formal remediation is required, it is recommended that all soft landscaping areas are reduced by 300mm and replaced by clean tested imported material to provide a growth medium.
		P4	Leaching and migration of contaminants	R3/5	Secondary A Aquifer	Medium	Unlikely	Low Risk	
		P5	Lateral migration of soil gas / vapours	R1	Site users	Severe	Low	Moderate / Low Risk	The exceedances of DWS and EQS in WS101 (including high concentration of Lead) are not considered significant due to the lack of groundwater observed in the monitoring programme and the nearby surface water course (Rochdale Canal) is not in continuity with groundwater. The exceedances of DWS and EQS in WS102 are not considered significant due to the level of contamination observed and the lack of nearby surface water courses that could be in continuity with ground water beneath the site.
				R4	Property	Severe	Low	Moderate / Low Risk	

9.4 Remediation Requirements

Human Health – Soil

Based on the results of the chemical analysis, the site is considered likely to pose a risk to long term human health.

Notwithstanding, considering the proposed development and the location of the zones of exceeded contaminants (i.e. WS101 and WS102) positioned under proposed hardstanding, there is no pathway for the exceeded contaminants to affect relevant receptors hence the risk to long term human health is considered low.

Although no formal remediation is required, it is recommended that all soft landscaping areas are reduced by 300mm and replaced by clean tested imported material to provide a growth medium.

Human Health – Ground Gas

Based on the results of the gas monitoring, the site is currently classified as Characteristic Situation 1 – Very Low Risk and require no protective measures to be installed.

Notwithstanding, this is a preliminary assessment based on 2No. monitoring visit(s) and will be reviewed on the completion of the monitoring program (6No. visits) within the final report.

Controlled Waters

The exceedances of DWS and EQS in WS101 (including high concentration of Lead) are not considered significant due to the lack of groundwater observed in the monitoring programme and the nearby surface water course (Rochdale Canal) is not in continuity with groundwater.

The exceedances of DWS and EQS in WS102 are not considered significant due to the level of contamination observed and the lack of nearby surface water courses that could be in continuity with ground water beneath the site.

10 Recommendations

10.1 Further works

The following actions are recommended:

-  Design SMMP – management of material on and off site.
-  Good hygiene practices should be employed during construction work, in addition, the findings of this investigation should be included within the contractors H&S file and an assessment of risks associated with short term human health completed. No consumption of food or smoking should occur without prior hand washing. If dust is encountered, dust masks should be worn, and dust suppression employed.

11 References

-  BRE Special Digest (1991) 'Sulphate and acidic resistance of concrete in the ground' 363
-  BRE Special Digest (2001) 'Aggressive Chemical Environment for Concrete (ACEC) Site Classification.
-  CIRIA (1995) Report 149. 'Protecting development from methane. Methane and associated Hazards to Construction.' London
-  CIRIA (2007) C665. 'Assessing risks posed by hazardous ground gases to buildings.' London
-  DETR/Partners in Technology (1997) Passive venting of soil gases beneath buildings research report-guide for design.
-  Department of the Environment. Transport and the Regions. *Environment Protection Act* (1990) Part IIA: Contaminated Land.
-  Environment Agency (2000) 'Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination. Research and Development. Technical Report. P5-066/TR', Bristol.
-  Environment Agency (2002) 'Department for Environment, Food and Rural Affairs and The Environment Agency. Assessment Of Risks to Human Health from Land Contamination: An Overview of The Development of Soil Guideline Values and Related Research', Environment Agency, Bristol. CLR report No. 7.
-  Environment Agency (2002) 'Department for Environment, Food and Rural Affairs and The Environment Agency. 'Priority Contaminants for The Assessment of Land', Environment Agency, Bristol. CLR report No. 8
-  Environment Agency (2002) 'Department for Environment, Food and Rural Affairs and The Environment Agency. The Contaminated Land Exposure Assessment (CLEA) Model: Technical Basis and Algorithms', Environment Agency, Bristol. CLR report No. 1

Appendix A – General Notes

Generic Notes – Sutcliffe Investigations

Environmental Setting

General

Third party information obtained from the British Geological Survey (BGS), the Coal Authority, the Local Authority etc is presented in the Correspondence Appendix of the Geoenvironmental Report.

Geology, Mining & Quarrying

In order to establish the geological setting of a site, Sutcliffe Investigations refer to BGS maps for the area and the relevant geological memoir.

A coal mining report is obtained from the Coal Authority. Further information is sourced from the Local Authority and by reference to current and historical OS plans.

Landfills

Sutcliffe Investigations obtain data from the Landmark Information Group, the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Radon

Radon is a colourless, odourless gas, which is radioactive. It is formed in strata that contain uranium and radium (most notably granite) and can move through fissures eventually discharging to atmosphere, or the spaces under and within buildings. Where radon occurs in high concentrations, it can pose a risk to health.

In order to assess potential risks associated with radon gas, Sutcliffe Investigations refer to BRE Report BR211, 1999: *“Radon: guidance on protective measures for new dwellings”*.

BR211 provides a preliminary indication of the measures required for a particular site, but it is also often necessary to request a Stage 2 Protective Measures Site Report from the BGS.

The level of protection needed is site-specific and is determined by reference to the radon potential map for the area followed by a geological assessment of the site. This information is contained in the Annexes of BR211.

Annex A – derived from statistical analysis of radon measurements in existing houses carried out by the NRPB and grouped on 5km grid.

Annex B – based on an assessment of the same radon measurements grouped by geological units. The maps show the 5km grid squares underlain completely or in part, by geological units which potentially exceed the action levels for radon protective measures. The grid squares are coded according to highest potential within the square. In many cases the actual geological radon potential varies considerably within a grid square.

Sutcliffe Investigations adopt the following procedure when assessing risk associated with radon.

Firstly, Annex A maps are reviewed to see whether the site requires full, basic or no measures. If the site is in a dark brown square, full radon protection measures are required. If the site is in a light brown square, reference should be made to Annex B.

Secondly, Annex B maps are reviewed to see whether a further geological assessment is required which may result in upgrading the result from Annex A. If a site lies within a shaded square, it may require radon protection and Sutcliffe Investigations request a Stage 2 Protective Measures Site Report from the BGS.

If the site is in a square that is not coloured or shaded in either set of maps then no radon protection is needed and therefore a BGS Report is not normally necessary.

The BGS geological assessment involves checking whether the site is on or close to a geological unit that has statistically been found to have elevated radon potential. The geological assessment is based on either 1:50,000 or the 1:250,000 scale data. The search area specified as part of the request is increased by 50m in areas where 1:50,000 data is available and by 500m in areas with 1:250,000 scale data to allow for potential inaccuracies in the position of boundaries. The BGS report indicates the highest level of protection required within the search area and its buffer zone.

When requesting a BGS report, Sutcliffe Projects select the search radius carefully, since too large a search radius may result in the inclusion of areas underlain by geological units of a higher radon potential, thereby giving rise to recommending too high a level of protection.

The report also includes (where available), a list of the geological units included in the assessment. Sutcliffe Investigations check that these actually underlie the site, rather than the buffer zone only.

On the basis of radon measurements in dwellings and on their geological interpretation, the BGS report stipulates the level of protective measures required for the proposed development site, and this could be:

1. no measures
2. basic measures or
3. full measures

Details of these measures are provided in the Hazardous Gas section of this Geoenvironmental Report.

Hydrogeology

Sutcliffe Investigations obtain information from the Environment Agency (EA) and the Landmark Information Group with respect to:

- groundwater quality
- recorded pollution incidents
- licensed groundwater abstractions

Reference is also made to the EA document "Policy and Practice for the Protection of Groundwater" (1998) and the relevant Groundwater Vulnerability Map.

Bedrock and any overlying granular Drift deposits are classified by the EA.

Major aquifers: *"Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public water supply and other purposes".*

Minor aquifers: *"Fractured or potentially fractured rocks which do not have a high primary permeability, or other formations or variable permeability. Although these aquifers will seldom produce large quantities of water for abstractions, they are important both for local supplies and in supplying base flow to rivers".*

Non-aquifers: *"Formations which are generally regarded as containing insignificant quantities of groundwater. However groundwater flow through such rocks, although imperceptible, does take place and needs to be considered in assessing the risk associated with persistent pollutants. Some non-aquifers can yield water in sufficient quantities for domestic use".*

Groundwater vulnerability is determined by 4 variables:

1. The presence and nature of overlying soil (the weathered zone affected by living organisms; soil in the UK can extend up to 2m in depth). Physical properties of the soil affect the downward passage of water and its ability to attenuate pollutants. The EA make reference to a three-fold classification of soil types:-
 - Soils of **low** leaching potential are defined as “soils in which the pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal, or they have the ability to attenuate diffuse pollutants”.
 - Soils of **intermediate** leaching potential are defined as “soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-absorbed diffuse source pollutants and liquid discharges could penetrate the soil layer”.
 - Soils of high leaching potential are defined as “soils with little ability to attenuate diffuse source pollutants and in which non-absorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater”.

In urban areas and restored mineral workings the soil information is based on fewer observations than elsewhere. A worst-case vulnerability (H) is therefore assumed for these areas and for current mineral workings by the EA. All are given a designation of **HU** unless proved otherwise.
2. The presence and nature of Drift, which often overlies bedrock. Where Drift is of substantial thickness and low permeability, it can provide an effective barrier to surface pollutant migration. Permeability Drift is classified as a Minor Aquifer except where it is in probable hydraulic continuity with a Major Aquifer, where it is regarded as part of the Major Aquifer unless proven otherwise by site investigation.
3. The nature of the geological strata (bedrock). Rocks that contain groundwater in exploitable quantities are called aquifers.
4. The depth of the unsaturated zone; i.e. that part of the aquifer which lies above the water table.

The EA have also designated Source Protection Zones, which are based on proximity to a groundwater source (springs, wells and abstraction boreholes). The size of a Source Protection Zone may vary from tens to several thousand hectares.

Hydrology

Sutcliffe obtains information from the Environment Agency and the Landmark Information Group with respect to:

- Surface water quality
- Recorded pollution incidents
- Licensed abstractions (groundwater & surface waters)
- Licensed discharge consents
- Site susceptibility to flooding

The EA have set **water quality** targets for all rivers. These targets are known as River Quality Objectives (RQOs). The water quality scheme used to set RQO planning targets is known as the River Ecosystem scheme. The scheme comprises five classes (RE1 to RE5) which reflect the chemical quality requirements of communities of plants and animals occurring in our rivers.

General Quality Assessment (GQA) grades reflect actual water quality. They are based on the most recent analytical testing undertaken by the EA. There are six GQA grades (denoted A to F) defined by the concentrations of biochemical oxygen demand, total ammonia and dissolved oxygen.

The susceptibility of a site to **flooding** is assessed by reference to a Flood Map on the Environment Agency's website. These maps provide shows natural floodplains – areas potentially at risk of flooding if a river rises above its banks or high tides and stormy seas cause flooding in coastal areas.

There are different kinds of area shown on the Flood Map:

1. Dark blue areas could be flooded by the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year, or by a river by a flood that has a 1% (1 in 200) or greater chance of happening each year.
2. Light blue areas show the additional extend of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance or occurring each year.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

The maps also show all flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, or floods from the sea with a 0.5% (1 in 200) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

The Agency's assessment of the likelihood of flooding from rivers and the sea at any location is based on the presence and effect of all flood defences, predicted flood levels and ground levels.

It should also be noted that as the floodplain shown is the 1 in 100 year (or 1 in 200 year as appropriate) areas outside this may be flooded by more extreme floods (e.g. the 1 in 1000 year flood). Also, parts of the areas shown at risk of flooding will be flooded by lesser floods (e.g. the 1 in 5 year flood). In some places due to the shape of the river valley the smaller floods will flood a very similar extent to larger floods but to a lesser depth.

If a site falls within a floodplain, it is recommended that a flood survey be undertaken by a specialist consultant who can advise on appropriate mitigating measures; i.e. raising slab levels, provision of storage etc.

COMAH & Explosive Sites

Sutcliffe Investigations obtain information from the Landmark Information Group with respect to COMAH or explosive sites within 1km of the proposed development site. Sutcliffe Investigations' report refers to any that are present and recommends that the Client seeks further advice from the HSE.

Areas around COMAH sites (chemical plants etc) are zoned with respect to the implementation of emergency plans. The HSE are a statutory consultee to the local planning authority for all COMAH sites. The COMAH site may have to revise its emergency action plan if development occurs. This might be quite straightforward or could entail significant expenditure. Consequently, the COMAH site may object to a proposed development (although it is the Local Authority who have final say and they are likely to place more weight on advice from the HSE).

Preliminary Conceptual Ground Model

The site's environmental setting (and proposed end use) is used by Sutcliffe Investigations to assess the significance of any contamination encountered during the subsequent ground investigation.

Generic Notes – Sutcliffe Geoenvironmental Investigations

2. Ground Investigation Fieldwork

General

Sutcliffe Ground Investigations are undertaken in accordance with current UK guidance including:

- BS5930:1999 “*Code of practice for site investigation*”
- BS10175:2001 “*Code of practice for the identification of potentially contaminated sites*”
- Contaminated Land Reports 1 to 6, most notably CLR Report No. 4 “*Sampling strategies for contaminated land*”
- “*Guidance on the protection soil sampling strategies for land contamination*” – EA R&D Technical report P5-066/TR (2001)
- AGS: 1996 “*Guide to the selection of Geotechnical Soil Laboratory Testing*”

Exploratory hole logs are represented in Appendices to this Geoenvironmental Report. These logs include details of the:

- Investigation technique adopted
- Samples taken
- Descriptions of the solid strata and any groundwater encountered
- Results of any insitu testing
- Any gas/groundwater monitoring well installed

Exploratory Hole Locations

Exploratory hole locations are selected by Sutcliffe Investigations, prior to commencement of fieldwork, to provide a representative view of the strata beneath the site and to target potential contaminant sources identified during the preliminary investigation (desk study). Additional exploratory locations are often determined by the site engineer in light of the ground conditions actually encountered; this enables better delineation of the depth and lateral extent of organic contamination, poor ground, relict structures etc.

Investigation Techniques

Ground conditions can be investigated by a number of techniques; the procedures used are in general accordance with BS5930: 1999 and BS1377: 1990. Techniques most commonly used by Sutcliffe Investigations include:

- Machine excavated trial pits, usually equipped with a backactor and a 0.6m wide bucket
- Cable percussive (Shell & Auger) boreholes, typically using 150mm diameter tools and casing
- Window or windowless sampling boreholes. Constraints associated with existing buildings, operations and underground service runs can render some sites partly or wholly inaccessible to a mechanical excavator. In such circumstances, window sampling is often the most appropriate technique. A window sampling drilling rig can be manoeuvred in areas of restricted access and results in minimal disturbance of the ground (a 150mm diameter tarmac/concrete core can be lifted and put to one side). However, it should be noted that window sampling allows only a limited inspection of the ground (especially made ground with a significant proportion of coarse material).
- Rotary percussive open-hole probeholes are typically drilled using a tricone rock roller bit with air as the flushing medium. Probeholes are generally lined through made ground with temporary steel casing to prevent hole collapse.

Where installed, gas/groundwater monitoring wells typically comprise a lower slotted section, surrounded by a filter pack of 10mm non-calcareous gravel and an upper plain section surrounded in part by a bentonite seal and in part by gravel or arisings. The top of the plain pipe is cut off below ground level and the monitoring well protected by a square, stopcock type manhole cover set in concrete, or the plain pipe is cut off just above ground level and the well protected by 100mm diameter steel borehole helmet set in concrete.

Monitoring well details, including the location of the response zone and bentonite seal are presented on the relevant exploratory hole logs.

Insitu Testing

Where relative densities of granular materials given on the trial pit and window sample logs are based on visual inspection only, they do not relate to any specific bearing capacities. However, wherever possible, Sutcliffe Investigations employ a mackintosh probe to assess relative density. Mackintosh probe results can be related to approximate allowable bearing capacities.

The relative densities of granular materials encountered in cable percussive boreholes are based on Standard Penetration Test (SPT) results. SPTs are carried out boreholes, in accordance with BS 1377 1990, Part 9 Section 3.3. Where full penetration (600mm) is not possible, N values are calculated by linear extrapolation and are shown on the logs as $N^* = x$.

The strength of cohesive deposits is determined using a hand shear vane.

Shear strength test results reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

Representative soil/fill samples are taken at regular intervals from the exploratory holes to assist in description of the ground and to allow selected laboratory testing to be performed. The type of sample taken is dependent on the nature of the stratum and the purpose of the analysis.

Where the soils encountered contain a significant proportion of coarse grained material, truly representative samples are not typically obtained – only the finer fraction is placed in sample containers. However, a visual estimate of the amount of coarse material is made on site.

NB: Coarse constituents not sampled are defined as: coarse gravel, cobble and boulder (i.e. any 'particles' with an average diameter greater than 20mm).

Occasionally, unrepresentative 'spot' samples are also taken from some exploratory locations for contaminant analysis, typically where unusual, localised pockets of materials are encountered.

Samples of soil for chemical testing are placed into 1 litre plastic tubs prior to delivery to the selected laboratory. Samples of water are taken in one litre brown glass bottles and stored in cool boxes, at a temperature of approximately 4°C, until delivery to the selected laboratory. Soil/fill samples for organic analysis are also stored in cool boxes.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork.

It should be borne in mind that the rapid excavation rates used during a ground investigation may not allow the establishment of equilibrium water levels. Water levels are likely to fluctuate with season/rainfall and could be substantially higher at wetter times of the year than those found during this investigation.

Long term monitoring of standpipes or piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

Description of Strata

The soils encountered during an Sutcliffe's ground investigation are described (logged) in general accordance with BS 5930. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text.

The materials encountered in the trial pits are logged, samples taken and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

Key to Exploratory Hole Logs

Keys to logs are presented in the Appendix(ces) containing the logs. These are two keys – Symbols and Legends and Terms and Definitions.

Health and Safety

All work was carried out in accordance with the procedures detailed in the DGEL Health and Safety Manual and SUKD health and Safety Procedures.

Generic Notes – Sutcliffe Geoenvironmental Investigations

3. Geotechnical Laboratory Tests

General

Soil Samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Sutcliffe Investigations. All tests are carried out in accordance with BS 1377:1990.

The test results are presented as received in an Appendix to this Geoenvironmental Report.

The following laboratory testing are routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

The additional tests are typically only scheduled where significant earthworks regrade is anticipated:

- Grading
- Compaction tests
- Particle density

Atterberg Limits & Moisture Content

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each “type” of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth. Sutcliffe Investigations typically only consider a soil to be shrinkable if the proportion finer than 63µm is > 35%.

PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003) which advocates the use of modified Plasticity Index (I'p) defined as:

$$I'p = Ip * (\% < 425\mu m / 100)$$

ie if PI is 30%, but the soil contains 80% < 425µm, then I'p = 30 * 80/100 = 24%

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs.

Sutcliffe Investigations apply engineering judgement where PI results are spread over a range of classifications. Consideration is given to:

- The average values for each particular soil type (ie differentiate between residual soil and alluvium)
- The number of results in each class and
- The actual values

Unless the judgement strongly indicates otherwise, Sutcliffe Investigations typically adopt a conservative approach and recommend assumption of the higher classification.

Soluble Sulphate and pH

Sulphates in soil and groundwater are the chemical agents most likely to attack sub-surface concrete, resulting in expansion and softening of the concrete to a mush. Another common cause of concrete deterioration is groundwater acidity.

The rate of chemical attack depends on the concentration of aggressive ions and their replenishment at the reaction surface. The rate of replenishment is related to the presence and mobility of groundwater.

Sutcliffe Investigations refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2001). SD 1 provides definitions of:

- The nature of the site (Greenfield, brownfield or pyretic)
- The groundwater regime (static, mobile or highly mobile)
- The Design Sulphate Class (DC Class) and
- The Aggressive Chemical Environment for Concrete (ACEC Class)

Sutcliffe reports clearly state each of the above for the site being considered.

The concentrations of sulphate in aqueous soil/fill extracts are determined in the laboratory using the gravimetric method. The results are expressed in terms of SO_4 for direct comparison with BS 5328:1997. The pH value of each sample was determined by the electrometric method.

SD1 also discusses determination of "representative" sulphate concentration from a number of tests. Essentially if <10 samples of a given soil-type have been tested, the highest measured sulphate concentration should be taken. If >10 samples have been tested, the mean of the highest 20% of the sulphate test can be taken. With respect to groundwater, the highest sulphate concentration should always be taken.

With respect to pH (soil & groundwater) the value used is the lowest value if <10 samples have been tested and the mean of the lowest 20% if >10 samples have been tested.

Generic Notes – Sutcliffe Investigations Geoenvironmental Investigations

4. Contamination Laboratory Analysis & Interpretation (including WAC)

General

An assessment of potential contaminants associated with the former usages of the site is undertaken with reference to CLR 8 “*Potential contaminants for the assessment of land*” and the relevant DETR Industry Profile(s).

Common Inorganic Contaminants

These include:

- Metals, most notably cadmium, copper, chromium, mercury, lead, nickel and zinc
- Semi-metals, most notably arsenic, selenium and (water soluble) boron
- Non-metals, most notably sulphur
- Inorganic anions, most notably cyanides (free & complex), sulphates, sulphides and nitrates

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction.

Complex cyanide is “bound” in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to uv digestion for determination of both free and total CN.

Thiocyanate (SCN) is a different species combined with sulphur.

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO₄) sulphates etc.

There are 2 forms of chromium (Cr), chromium VI and chromium III. Chromium VI is the more toxic of these. In soils, total chromium is determined by a strong aqua regia acid digestion. Chromium VI is an empirical method based on a water extract test.

Common Organic Contaminants

Petroleum hydrocarbons are a mixture of hydrocarbons produced from the distillation of crude oil. They include aliphatics (alkanes, alkenes and cycloalkanes), aromatics (single or multi benzene ringed compounds) and hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen.

Petroleum hydrocarbons can be grouped based on the carbon number range:-

GRO – Gasoline Range Organics (typically C₆ to C₁₀). Also referred to as PRO – Petroleum Range Organics

DRO – Diesel Range Organics (typically C₁₀ to C₂₈)

LRO – Lubricating Oil Range Organics (typically C₂₈ to C₄₀)

MRO – Mineral Oil Range Organics (typically C₁₈ to C₄₄)

However, it should be borne in mind that the terms “GRO” and “DRO” analysis are purely descriptive terms, the exact definition of which varies.

Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from C₅ – C₄₀, whereas others define TPH as C₁₀ – C₃₀.

The composition of a TPH plume migrating through the ground can vary significantly; this is primarily dictated by the nature of the source (eg petrol, diesel, engine oil etc). Furthermore, different hydrocarbons are affected differently by weathering processes and this can result in further variation in the chemical composition of the TPH.

Gasoline contains light aliphatic hydrocarbons rapidly (especially within the C₄ to C₅ range) that will evaporate. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polyaromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present.

Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar NSO compounds are also present.

Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

Polycyclic Aromatic Hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic. PAH compounds are present in both petrol and diesel, although insignificantly lower concentrations than in coal tars. Certain PAH compounds are carcinogenic (Benzo(a)pyrene) and/or mobile in the environment (naphthalene).

Polychlorinated Biphenyls (PCBs)

Volatile Organic Compounds (VOCs) The volatile organic compound (VOC) headspace concentration of all soil samples was made with a photoionization detector (PID) fitted with a 10.2 eV lamp. This gives a semi-quantitative VOC concentration record as parts per million (ppm) (Vol/Vol). Prior to the VOC headspace reading, the background levels of VOCs were recorded. The PID was recalibrated with standard isobutylene in zero air after every 10 headspace readings.

Semi-Volatile Organic Compounds (sVOCs)

Phenols

Solvents, pesticides, herbicides

Dioxins & furans

Methods of Analysis (Organic Compounds)

Toluene Extractable Matter (TEM) results provide a screening test for organic contamination. The sample is air dried at 30°C and ground prior to addition of the solvent (toluene). The solvent extraction is aggressive and most organic compounds (fuels, oils, tars, humic material, animal fats and vegetable oil) are dissolved, as are some other inorganic contaminants such as sulphur. However, the volatiles (lighter fuel fraction etc) are lost during evaporation of the solvent.

Total Petroleum Hydrocarbon (TPH) by IR (also known as mineral oil by some testing laboratories) is undertaken on "as received" samples. Tetrachloroethylene is the solvent, and fluorosil is used to removed humic material, animal fats and vegetable oil. Consequently this analysis detects a wide range of "mineral" organics from volatiles (BTEX and gasoline) through diesel and oils to tars (including the very heavy, stable tars such as asphalt and bitumen).

TPH by GC-FID is more refined analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C₁₀ to C₄₀ (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a breakdown of the TPH results into diesel range organics (**DRO**) and heavier lubricating oil range organics (**LRO**).

GRO (PRO) by GC-FID analysis detects the more volatile C₆ – C₉ hydrocarbons (aliphatic and aromatic) including those organic compounds present in petrol.

Speciated VOC (by GC-MS) analysis quantifies the concentrations of 30 USA-EPA priority compounds. These include chlorinated alkanes and alkenes (in the molecular weight range chloroethane to tetrachloroethane); trimethylbenzenes; and the 4 BTEX compounds (benzene, ethyl-benzene, toluene & xylene).

Speciated sVOC by (GC-MS) analysis quantifies the concentration of a variety of organic compounds, including the 16 USA-EPA priority PAHs, phenols, 7 USA EPA priority PCB congeners, herbicides & pesticides.

Note: PAHs are hydrocarbons and consequently (where present) will be picked up when scheduling TPH by GC-FID. Naphthalene (the lightest PAH) is also one of the 58 US EPA VOCs.

Speciated TPH by GC-FID provides a “banded” TPH, initially split into aromatic and aliphatic fractions and then further divided into fraction specific carbon bandings based upon behavioural characteristics.

Note: Risk assessment models require physiochemical properties (solubilities, toxicities etc) of compounds in order to model their behaviour in the environment. These physiochemical properties cannot be derived from a single “TPH”, “GRO” or “DRO” value. However, the carbon banded fractions can be used in risk assessment models.

If the relative proportion of each carbon banding within the “TPH” impact at a site is known, the risks posed by each individual fraction can be assessed and a simple back calculation applied to calculate an overall “TPH” screening value based upon the percentage weight fraction of each banding present in the “TPH”. Specialised analytical techniques and data interpretation skills are required to identify each carbon banding.

Current Guidance

The UK approach to the consideration of contaminated land is based upon the principles of risk assessment. This in turn is founded upon the use of so called source⇒ pathway⇒ target principles in order to establish the presence or potential presence of a pollutant linkage.

Sutcliffe Investigations adopt a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate guidance levels, intervention levels or remedial targets.

In March 2002 DEFRA and the Environment Agency published a series of technical research papers (R & D Publications CLR 7, 8, 9 and 10) introducing the UK approach to the assessment of risk to **human health** from land contamination. This methodology and approach represents current scientific knowledge and thinking. The overall methodology also included the Contaminated Land Exposure Model (CLEA) and some Soil Guidance Values (SGV's).

At the time of writing this report, these guidelines only address seven contaminants and the development of both the CLEA model and additional SGV's is ongoing. Where published, SGV's have been utilised as intervention values for the purpose of an initial Tier 1 assessment.

Where SGV's were not published at the time of writing this report, appropriate Tier 1 human health related assessment have been based upon information that was best available at the time of the study.

With respect to the assessment of potential **phytotoxic effects** of contaminants, Sutcliffe Investigations refer to “The Soil Code” (Maff, 1998) for copper and zinc. The CLEA SGV is adopted for nickel.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, ‘Sulphate and Acid Resistance of Concrete in the Ground’, 2001.

With respect to the interpretation of the calorific values, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 “Notes on the fire hazards of contaminated land” which states that:

“In general it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn”.

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate concentrations with the appropriate water quality standard. Depending upon the specific characteristics and environmental setting of the site the appropriate standard is likely to be one of the following:

- Water Supply (Water Quality) Regulations 1989
- Environmental Quality Standards (for Freshwater)
- The Surface Waters (Abstraction for Drinking Water) Regulations

The tier 1 risk assessment of **landfill gas** is undertaken through reference to the following documents:

- Approved Document C, Building Regulations 1991
- CIRIA Report 149, “Protecting Development from Methane”, 1995

Should any Tier 1 criteria be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

- Undertake further statistical following the approach set out in Appendix A of CLR 7 in order to determine whether contaminant concentrations of inorganic contaminants within soil/fill actually present a risk (only applicable to assessing the risk to human health).
- Based on a qualitative risk assessment, advocate an appropriate level of remediation to “break” the pollutant linkage – for example the removal of the contaminated materials or the provision of a clean cover.
- Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.

However, the issue of **averaging area** requires further consideration. CLR 7 is ambiguous and could be interpreted as advocating the concept of a single garden as an appropriate averaging area.

This concept has massive implications with respect to ground investigation design and cost. To comply, investigations for residential development on brownfield sites would need to recover and analyse about 6 samples from each garden; this implies exploratory locations on a very tight grid, perhaps 5m to 10m spacings, with a huge increase in the number of samples analysed (cf test schedules currently issued by most practitioners).

In any case, Sutcliffe Investigations consider the concept of a single garden as an averaging area to be inappropriate. Statistical analysis of sample results by fill type, and/or by former use in a given sub-area of the site (i.e. with reference to the Conceptual Site Model), is considered a more appropriate methodology.

Analysis by soil/fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil/fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass; ie contamination would be normally be more pervasive and significant in granular soils than cohesive soils.

There is a suggestion in para 4.7 of CLR 7 that the approach outlined above was intended and the Environment Agency have confirmed that an averaging area can be larger than a single garden, if:

- Contaminant concentrations are within the same statistical population as determined using the maximum value test. The sample data being representative of the averaging area and the mean concentration of the averaging area.
- “Hot spots” are treated as separate zones or averaging areas (as defined by the maximum value test).
- The sampling strategy takes into account uncertainty (spatial heterogeneity) in contaminant concentration

Waste Classification & WAC

In the context of waste soils generated by remediation and/or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated ‘natural soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds).
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds).

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

From 16th July 2005, landfill operators will require Waste Acceptance Criteria (WAC) laboratory data, if soil is classified as **hazardous** and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Sutcliffe Investigations typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated for example where redevelopment proposals include basement construction etc.

If off-site disposal of soils classified as hazardous waste were undertaken during redevelopment, then WAC analysis should be scheduled at an early stage in the remediation programme.

However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous. These contaminants can often be dealt with by alternative technologies (eg by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (eg WAC) is required.

Generic Notes – Sutcliffe Investigations

5. Hazardous Gas

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency).

In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 1 – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark information Group, the Environment Agency and the Local Authority and the British Geological Survey.

Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Where landfilling has occurred within 250m of the site boundary, the Local Planning Authority may request a landfill gas investigation in accordance with the Town and Country Planning General Development Order, 1988.

Sources

Potential sources of hazardous gas are:

- Landfill sites
- Made ground, especially where significant depths are present
- Shallow mineworks associated with coal extraction
- Geological strata, including peat, organic silts, coal-bearing strata and limestone (reaction with acidic waters), granite (radon)
- Groundwater can sometimes act as a “carrier” for hazardous gas
- Leakages from pipelines or storage tanks
- Sewers, septic tanks and cess pits

Generation

Wherever biodegradable material is deposited, landfill gas (principally a mixture of methane and carbon dioxide) is likely to be generated by microbial activity. Carbon dioxide is an asphyxiant and toxic; methane is flammable and a mixture containing between 5% and 15% methane by volume in air is explosive. Landfill gas in the ground is unlikely in itself to pose a significant risk, though it may damage vegetation. However, infiltration of landfill gas into confined spaces (e.g. cellars, services, etc) may give rise to considerable risk.

There is no typical figure for the length of time that landfill gas will be evolved, but at many sites significant gas generation continues for at least 15 years after the last deposit of waste.

Migration

Gas migration from a landfill site may occur in several ways. It may migrate through adjacent strata; the distance of migration being dependent on the pressure gradients, volume of gas and permeability of the strata. Where there are faults, cavities and fissures within the strata, gas may move considerable distances. Other migration pathways for gas include man-made features such as mine shafts, roadways and underground services.

Gas migration is influenced by a number of climatic factors, such as atmospheric pressure variations, water table level variations and the influence of a covering of snow or ice over the surface of the site and surrounding area.

Current Guidance

Guidance on landfill gas monitoring control at landfill sites is given two technical memoranda, Waste Management Paper Nos. 26 and 27 published by the Department of the Environment.

Waste Management Paper 27, 1991 recommends that no dwellings should be constructed within 50m of any landfill that has the capacity to produce large volumes of landfill gas. No garden should extend to within 10m of the landfilled waste. However, development closer to landfill has been permitted where a comprehensive gas risk assessment has been completed (typically based on a minimum of 6 to 12 month monitoring programme) and appropriate gas exclusion measures designed.

The current advice with regard to monitoring for landfill gas is that if the trigger value of 1% volume (20% LEL) for methane and 1.5% volume for carbon dioxide is exceeded then remedial/control measures will be required.

It should be noted that the guideline limit for carbon dioxide of 1.5% volume recommended in Waste Management paper No. 27 is the short term (10 minute) occupational exposure limit for carbon dioxide quoted by the Health and Safety Executive in their publication EH40. The long term (8 hour) occupational exposure limit for carbon dioxide is 0.5% volume.

Approved Document C to the Department of the Environment's Building Regulations 1992 requires what where there may be gaseous contamination of the ground but the level of methane is unlikely to exceed 1% by volume, the ground floor of any house or similar small building shall be constructed of suspended concrete and ventilated as described in BRE Digest Report "Construction of New Buildings on Gas Contaminated Land". The document also requires specific design measures to be taken if a level of 5% volume carbon dioxide exists or is exceeded within the ground.

Although the above guidance is still relevant it has been more recently updated within the following documents published by the Construction Industry Research and Information Association (CIRIA).

CIRIA Report 149	'Protecting Development from Methane' (1995)
CIRIA Report 150	'Methane Investigation Strategies' (1995)
CIRIA Report 151	'Interpreting Measurement of Gas in the Ground' (1995)
CIRIA Report 152	'Risk Assessment for Methane and other gases from the ground' (1995)

The above documents are intended to provide advice on how to investigate and deal with the gas contaminated ground with respect to development.

CIRIA Report 149 characterised sites based on the recorded methane/carbon dioxide concentration and emission rates recorded during a suitable gas investigation. Characteristic situation 1 is deemed to be the lowest risk scenario with the risk rating increasing up to 6. The characteristic situations are classified as follows:

Gassing regime in ground			
Methane (% by volume in air)	Carbon dioxide (% by volume in air)	Emission rate ¹ (m/s)	Characteristic situation ²
< 0.1	< 1.5	not detected	1
> 0.1 – 1	> 1.5 – 5	not detected	2
> 1 - 5	< 5	not detected	3
> 5 – 20	< 20	< 0.01	4
> 20	> 20	> 0.01 – 0.05	5
> 20	> 20	> 0.05	6

Notes:

1. Emission rate values measures as equivalent total gas flow velocity from a 50mm diameter borehole: for methods of measurement see Crowhurst and Manchester (1992).
2. Highest measures parameter used as determining factor.

CIRIA Report 151 (1995) identified that there is currently inadequate guidance on trigger concentrations for ground gases. The current emphasis on using gas concentrations for trigger values particularly in Waste Management Paper 27 and the Building Regulations, should be revised to consider gas pressures, borehole flow rates and estimated surface emission rates.

It was concluded that the most important aspect of relating the gas regime below or adjacent to a site, to the risk it poses to any development, is the surface emission rate i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. This is considered further in the DETR Partners in Technology Report 'Passive venting of soil gases beneath buildings' (September 1997).

CIRIA Report 149 (1995), reference Table 28, reviewed over 100 case studies of development affected by gas to establish current UK practices for gas control. The report classified the gassing regimes found within 6 Characteristic Situations. The highest measures parameter, either methane or carbon dioxide concentration and/or emission rate were used to define the Characteristic Situation for each case history site. The report then related the typical range of mitigation measures that has been adopted at each study site to the characteristic gas situation.

To achieve a more consistent design of protection measures Table 28 of CIRIA 149 was rewritten (Wilson and Card, 1999) in terms of borehole gas volume flow rate and gas concentrations, as reproduced in the table below. This was done to reflect the importance of recognising the gas surface emission rate.

Characteristic situations based on Gas Flux

Characteristic Situation	Limiting CH ₄ Concentration (% v/v)	Limiting CO ₂ Concentrations (% v/v)	Limiting Borehole Flow Velocity (m/s)	Limiting Borehole Gas Volume Flow (litre/hour)	
				CH ₄	CO ₂
1	< 0.1	< 0.1	< 0.005	< 0.035	< 0.035
2	< 1.0	< 1.5	< 0.005	< 0.35	< 0.5
3	< 5.0	< 5.0	< 0.005	< 1.75	< 1.75
4	< 20	< 20	< 0.01	< 14	< 14
5	> 20	> 20	< 0.05	< 70	< 70
6	> 20	> 20	< 0.05	> 70	> 70

Gas Monitoring Procedure

Sutcliffe Investigations adopt a standard gas monitoring procedure, in accordance with CIRIA guidance. This procedure involves the measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration on site immediately prior to and on completion of monitoring.
- Gas emission rate.
- Methane, oxygen and carbon dioxide concentrations using an infra-red gas analyser.
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism.

Where samples of gas are required for laboratory analysis, Gresham Tubes are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Appendix B – CIRIA Guidance Document C552 2001

RISK ASSESSMENT METHODOLOGY

GENERAL

The purpose of this appendix is to describe in detail the concepts underlying the risk based approach to assessing potentially contaminated land, introduce the roles of key legislation and describe the qualitative methodology adopted for evaluating and characterising risk.

Current best practice in the UK promotes a risk-based approach to dealing with both soil and groundwater contamination. The principal aim of the approach is to ensure protection of human health and the environment in a thorough, transparent and cost-effective manner.

Fundamental to the risk-based approach is the concept that for 'Contaminated Land' to be designated, as a consequence of historic activities, a pathway for contamination must be shown to exist between a source of contamination and a receptor. The combined presence of a source, pathway and a receptor is described as a 'pollutant linkage'.

The concepts associated with a contaminant source, pathway and receptor are defined in DETR Circular 02/2000 'Contaminated Land Environmental Protection Act 1990: Part II A'. A **source** of contamination may be considered as a 'substance, which is in, on or under land that has the potential to cause harm or to cause pollution of controlled waters'. A **receptor** can be considered as either 'a living organism, a group of living organisms, an ecological system or a piece of property which is being, or could be harmed, by a contaminant or controlled waters which are being, or could be, polluted by a contaminant'. A **pathway** may be considered as one or more routes by, or through, which a receptor is being, or could be, exposed to or affected, by a contaminant. Typical pathways may include migration in groundwater, surface water run-off or infiltration, inhalation, dermal contact and ingestion.

The risks posed by an identified pollutant linkage can often be mitigated by removing the source of contamination, treating the source of contamination, blocking the relevant pathway(s) or by protecting the receptor.

PRINCIPLES OF RISK EVALUATION

The risk evaluation methodology presented below is qualitative in nature, and is therefore a subjective method. It is based upon guidance presented in CIRIA publication referenced C552, 'Contaminated land risk assessment - A guide to good practice', 2001 and involves the classification of the following.

The magnitude of the potential **consequence** (severity) of risks occurring (Table 1).

The magnitude of the **probability** (likelihood) of the risk occurring (Table 2).

These are then considered in conjunction to give a risk matrix (Table 3)

Table 1 - Classification of consequence

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in “significant harm” as defined by the Environmental Protection Act 1990, Part IIA. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health (“significant harm” as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (Note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000).	Concentrations of a contaminant from site exceed the generic or site-specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services (“significant harm” as defined in the <i>Draft Circular on Contaminated Land</i> , DETR, 2000). Damage to sensitive buildings/structures/ services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discolouration of concrete.

Table 2 - Classification of probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 3 - Comparison of consequence against probability

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table 4 - Description of the classified risks and likely action required

Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

Table 5 - Response action likely to be required in relation to estimated risk

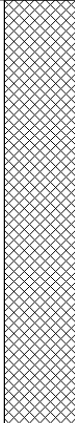
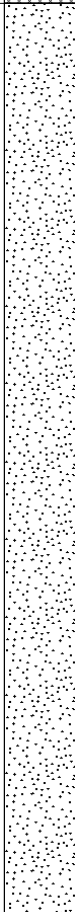
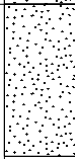
KEY

	Mitigation and remedial measures required
	Mitigation and remedial measures likely
	Remedial measures unlikely
	Remedial measures not required

Appendix C – Site Investigation Logs



Sutcliffe

Site Woodbine Street, Rochdale		Borehole Number BH101	
Client Arcon Housing		Job Number 31163LG	
Engineer AT		Sheet 1/2	
Description		Legend	Water
Grass over MADE GROUND: black fine to medium grained SAND with much root material (TOPSOIL)			
MADE GROUND: dark brown fine to medium grained SAND with fine to coarse brick concrete fragments and sandstone cobbles			
Medium dense orange brown fine to medium grained SAND			
Medium dense becoming dense orange brown fine to coarse grained SAND			
		Scale (approx)	Logged By
		1:50	AT
		Figure No. 31163LG.BH101	



Sutcliffe

Site

Woodbine Street, Rochdale

Borehole Number
BH101
Boring Method

Cable Percussion

Casing Diameter
Ground Level (mOD)
Client

Arcon Housing

Job Number

31163LG

Location

390367 E 412334 N

Dates

03/05/2022

Engineer

AT

Sheet

2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50-10.95	SPT N=29			6,7/7,7,7,8			cont....Medium dense becoming dense orange brown fine to coarse grained SAND		
12.00-12.45	SPT N=30			7,7/8,7,8,7		(6.45)			
13.50-13.95	SPT N=31			7,8/8,7,8,8					
15.00-15.45	SPT N=32			7,8/8,8,8,8		15.45	Complete at 15.45m		

Remarks
Scale (approx)

1:50

Logged By

AT

Figure No.

31163LG.BH101



Sutcliffe

Site Woodbine Street, Rochdale	Number WS101
Excavation Method Drive-in Windowless Sampler	Client Arcon Housing
Dimensions	Job Number 31163LG
Location 390355 E 412318 N	Engineer AT
Ground Level (mOD)	Sheet 1/1
Dates 28/04/2022	

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.50	ES1				0.10 (0.40) 0.50	Grass over MADE GROUND: black fine to medium grained SAND with much root material (TOPSOIL)			
						MADE GROUND: dark brown fine to medium grained SAND with large roots and fine brick fragments			
1.20-1.65	SPT N=8		2,2/2,2,2,2		(1.50)	Medium dense light brown gravelly fine to medium grained SAND. Gravel is fine to medium subangular to subrounded and of sandstone			
2.00-2.45	SPT N=11		1,2/3,3,3,2		2.00	Medium dense orange brown fine to medium grained SAND			
					(1.10)				
3.00-3.45	SPT N=10		1,1/1,3,3,3		3.10 (0.40)	Medium dense dark brown slightly peaty fine to medium grained SAND			
					3.50 (0.50)	Medium dense orange brown fine to medium grained SAND			
4.00-4.45	SPT N=10		2,3/3,2,2,3		4.00	Medium dense grey brown fine to medium grained SAND			
5.00-5.45	SPT N=10		Water strike(1) at 5.00m, no rise after 20 mins. 3,3/3,3,2,2		(2.45)				
6.00-6.45	SPT N=10		3,2/3,3,2,2		6.45	Complete at 6.45m			

Remarks	Scale (approx)	Logged By
	1:50	AT
	Figure No. 31163LG.WS101	

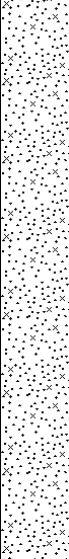
 Sutcliffe						Site Woodbine Street, Rochdale		Number WS102	
Excavation Method Drive-in Windowless Sampler		Dimensions		Ground Level (mOD)		Client Arcon Housing		Job Number 31163LG	
		Location 390372 E 412344 N		Dates 28/04/2022		Engineer AT		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.50	ES1				0.10	Grass over MADE GROUND: black fine to medium grained SAND with much root material (TOPSOIL)			
					(1.10)	MADE GROUND: Brown clayey fine grained SAND with fine to coarse sandstone brick fragments with half and whole bricks			
1.20-1.65	SPT N=8	3,3/2,2,2,2			1.20	Medium dense light brown and dark brown slightly clayey fine to medium grained SAND			
					(0.60)				
2.00-2.45	SPT N=4	1,1/1,1,1,1			1.80	Medium dense dark brown clayey fine to medium grained SAND			
					(0.20)				
2.60-3.00	ES2				2.60	Medium dense dark grey fine to medium grained SAND			
					(0.60)				
3.00-3.45	SPT N=27	Water strike(1) at 3.00m, no rise after 20 mins. 4,5/6,6,7,8			2.60	Medium dense dark brown clayey fine to medium grained SAND Hydrocarbon odour from 2.60m to 3.00m			
					(1.85)				
4.00-4.45	SPT(C) N=14	2,3/4,4,3,3			4.45	Complete at 6.45m			
5.00-5.45	SPT(C) N=11	1,2/2,3,3,3							
6.00-6.45	SPT(C) N=14	2,2/3,4,4,3							
Remarks borehole collapsed from 4.00m to 5.00m - Continued with CPT to 6.00m							Scale (approx) 1:50	Logged By AT	Figure No. 31163LG.WS102



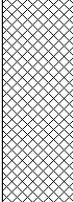
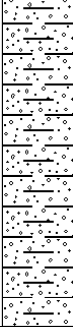
Sutcliffe

Site Woodbine Street, Rochdale		Number WS103	
Client Arcon Housing		Job Number 31163LG	
Engineer AT		Sheet 1/1	
Description	Legend	Water	Instr
Grass over MADE GROUND: black fine to medium grained SAND with much root material (TOPSOIL)			
MADE GROUND: dark brown fine to medium grained and fine to coarse brick fragments half and whole bricks			
MADE GROUND: Light grey fine to coarse grained SAND and graded granular limestone hardcore			
Medium dense light brown fine to medium grained SAND			
Medium dense orange brown fine to medium grained SAND			
Medium dense light brown fine to medium grained SAND		▼1	
Complete at 6.45m			
		Scale (approx) 1:50	Logged By AT
		Figure No. 31163LG.WS103	

Client Arcon Housing	Job Number 31163LG
Engineer AT	Sheet 1/1

Description	Legend	Water
Grass over MADE GROUND: black fine to medium grained SAND with much root material (TOPSOIL)		
Brown slightly clayey fine to medium grained SAND with occasional clay pockets		
Complete at 2.10m		

Scale (approx)	Logged By	Figure No.
1:25	AT	31163LG.SA101

 Sutcliffe					Site Woodbine Street, Rochdale		Trial Pit Number SA102		
Excavation Method BRE 365 'Soakaway'		Dimensions		Ground Level (mOD)		Client Arcon Housing		Job Number 31163LG	
		Location 390369 E 412345 N		Dates 01/05/2022		Engineer AT		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
					0.20 0.20 0.70 0.90 1.10 2.00	Grass over MADE GROUND: black fine to medium grained SAND with much root material (TOPSOIL) MADE GROUND: Brown very clayey fine to medium grained SAND with fine to coarse brick sandstone and metal fragments and half and whole bricks Brown very sandy slightly gravelly CLAY with some clayey silt pockets. Sand is fine to medium Gravel is fine subangular and of sandstone Complete at 2.00m	  		
					Remarks				
					Scale (approx) 1:25		Logged By AT		Figure No. 31163LG.SA102



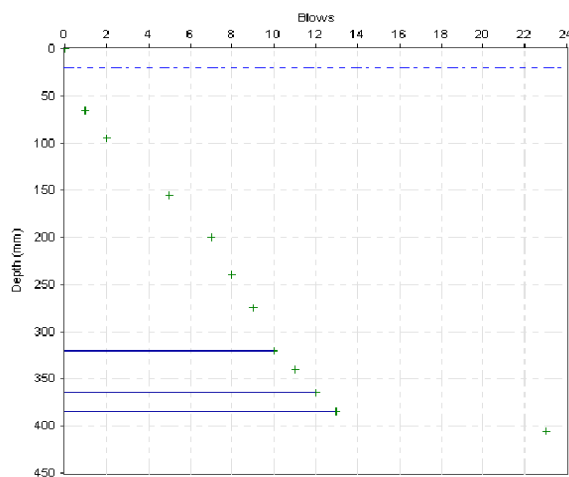
SUTCLIFFE INVESTIGATIONS

TEL: 0151 227 3155

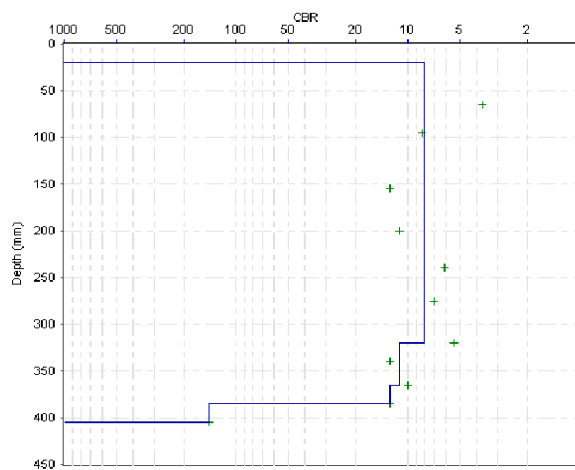
FAX: 0151 227 3156

Dynamic Cone Penetrometer Results

Job Name:	Woodbine Street, Rochdale	Job No.:	31163LG
Test Ref. No.:	CBR1	Date:	11/07/2022
Surface Material:	Grass over TOPSOIL	Material removed (mm):	0
Point number:	Blows	Penetration depth (mm)	
1	0	55	
2	1	120	
3	1	150	
4	3	210	
5	2	255	
6	1	295	
7	1	330	
8	1	375	
9	1	395	
10	1	420	
11	1	440	
12	10	460	
13	-	-	
14	-	-	
15	-	-	



Layer Boundaries Chart



CBR Chart

Layer	Penetration Rate (mm/blow)	Depth (mm)	CBR (%)
1	30.95	320	8
2	22.50	365	11
3	20.00	385	13
4	2.00	405	145
5	-	-	-

Comments:



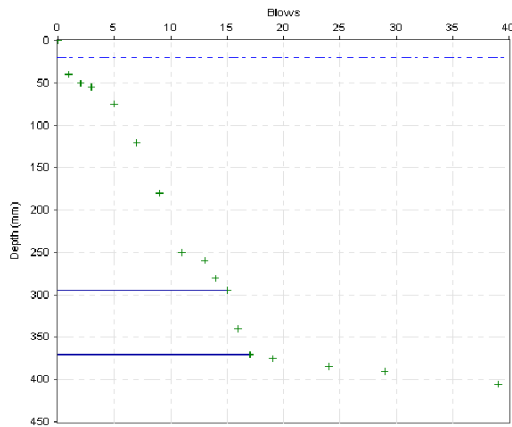
SUTCLIFFE INVESTIGATIONS

TEL: 0151 227 3155

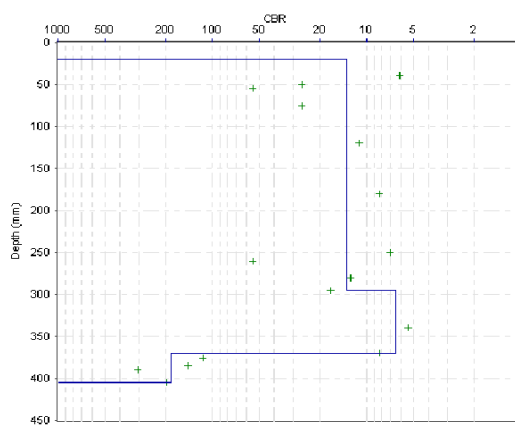
FAX: 0151 227 3156

Dynamic Cone Penetrometer Results

Job Name:	Woodbine Street, Rochdale	Job No.:	31163LG
Test Ref. No.:	CBR2	Date:	11/07/2022
Surface Material:	Grass over TOPSOIL	Material removed (mm):	0
Point number:	Blows	Penetration depth (mm)	
1	0	50	
2	1	90	
3	1	100	
4	1	105	
5	2	125	
6	2	170	
7	2	230	
8	2	300	
9	2	310	
10	1	330	
11	1	345	
12	1	390	
13	1	420	
14	2	425	
15	5	435	
16	5	440	
17	10	455	



Layer Boundaries Chart



CBR Chart

Layer	Penetration Rate (mm/blow)	Depth (mm)	CBR (%)
1	18.97	295	13
2	37.5	370	7
3	1.59	405	185
4	-	-	-
5	-	-	-

Comments:

Appendix D – Analytical Certificates

FINAL ANALYTICAL TEST REPORT

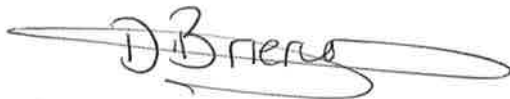
Envirolab Job Number: 22/04175
Issue Number: 1

Date: 11 May, 2022

Client: Sutcliffe
18-20 Harrington Street
Liverpool
L2 9QA

Project Manager: (Use) D Evans; D Bowen; A Tosh; W Baldwin/(Use) Sa
Project Name: Woodbine Street, Rochdale
Project Ref: Not specified
Order No: 9146
Date Samples Received: 28/04/22
Date Instructions Received: 29/04/22
Date Analysis Completed: 11/05/22

Approved by:



Danielle Brierley
Deputy Client Services Supervisor

Envirolab Job Number: 22/04175

Client Project Name: Woodbine Street, Rochdate

Client Project Ref: Not specified

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4					Units	Limit of Detection	Method ref
Client Sample No	1	1	1							
Client Sample ID	WS101	WS102	WS103							
Depth to Top	0.10	0.10	0.20							
Depth To Bottom	0.50	0.50	0.60							
Date Sampled	28-Apr-22	28-Apr-22	28-Apr-22							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4AE	5A	2AE							
% Moisture at <40C _A	19.0	14.6	14.7					% w/w	0.1	A-T-044
% Stones >10mm _A	4.3	18.3	1.6					% w/w	0.1	A-T-044
pH _D ^{M#}	6.65	8.01	7.82					pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	<0.01	<0.01	<0.01					g/l	0.01	A-T-026s
Sulphate (acid soluble) _D ^{M#}	400	<200	340					mg/kg	200	A-T-028s
Cyanide (total) _A ^{M#}	<1	<1	<1					mg/kg	1	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2					mg/kg	0.2	A-T-050s
Sulphide _A	69	62	15					mg/kg	5	A-T-043-s
Sulphur (elemental) _D ^{M#}	<5	8	<5					mg/kg	5	A-T-029s
Organic matter Default _D ^{M#}	9.9	3.1	5.6					% w/w	0.1	A-T-032 OM
Arsenic _D ^{M#}	27	5	20					mg/kg	1	A-T-024s
Boron (water soluble) _D	<1.0	<1.0	<1.0					mg/kg	1	A-T-027s
Cadmium _D ^{M#}	1.1	<0.5	1.6					mg/kg	0.5	A-T-024s
Copper _D ^{M#}	116	29	134					mg/kg	1	A-T-024s
Chromium _D ^{M#}	44	12	119					mg/kg	1	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1					mg/kg	1	A-T-040s
Chromium (trivalent)	44	12	119					mg/kg	1	Calc
Lead _D ^{M#}	332	55	232					mg/kg	1	A-T-024s
Mercury _D	0.36	<0.17	0.40					mg/kg	0.17	A-T-024s
Nickel _D ^{M#}	33	14	23					mg/kg	1	A-T-024s
Selenium _D ^{M#}	<1	<1	<1					mg/kg	1	A-T-024s
Zinc _D ^{M#}	130	49	146					mg/kg	5	A-T-024s
Leachate Prep NRA (10:1) _A	*	*	-							A-T-001
pH (leachable) _A [#]	6.94	7.56	-					pH	0.01	A-T-031w
Sulphate (leachable) _A [#]	1.78	4.55	-					mg/l	1	A-T-026w
Cyanide (total) (leachable) _A [#]	<0.005	<0.005	-					mg/l	0.005	A-T-042wTCN
Phenols (total by HPLC) (leachable) _A	<0.01	<0.01	-					mg/l	0.01	A-T-050w
Sulphide (leachable) _A	<0.1	<0.1	-					mg/l	0.1	A-T-043-w
DOC (leachable) _A [#]	44.6	25.4	-					mg/l	2	A-T-032w
Arsenic (leachable) _A [#]	73	<1	-					µg/l	1	A-T-025w
Boron (leachable) _A [#]	<20	<10	-					µg/l	10	A-T-025w
Cadmium (leachable) _A [#]	<2	<1	-					µg/l	1	A-T-025w
Copper (leachable) _A [#]	248	7	-					µg/l	1	A-T-025w

Envirolab Job Number: 22/04175

Client Project Name: Woodbine Street, Rochdale

Client Project Ref: Not specified

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4					Units	Limit of Detection	Method ref
Client Sample No	1	1	1							
Client Sample ID	WS101	WS102	WS103							
Depth to Top	0.10	0.10	0.20							
Depth To Bottom	0.50	0.50	0.60							
Date Sampled	28-Apr-22	28-Apr-22	28-Apr-22							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4AE	5A	2AE							
Chromium (leachable) _A [#]	35	1	-					µg/l	1	A-T-025w
Chromium (hexavalent) (leachable) _A	<0.05	<0.05	-					mg/l	0.05	A-T-040w
Chromium (trivalent)	<0.05	<0.05	-					mg/l	0.05	Calc
Lead (leachable) _A [#]	1610	13	-					µg/l	1	A-T-025w
Mercury (leachable) _A [#]	<0.2	<0.1	-					µg/l	0.1	A-T-025w
Nickel (leachable) _A [#]	33	1	-					µg/l	1	A-T-025w
Selenium (leachable) _A [#]	4	<1	-					µg/l	1	A-T-025w
Sulphur (elemental/free) (leachable) _A	<0.1	<0.1	-					mg/l	0.1	A-T-029w
Zinc (leachable) _A [#]	135	7	-					µg/l	1	A-T-025w
TPH total (>C6-C40) (leachable) _A	120	<80	-					µg/l	80	A-T-007w

Envirolab Job Number: 22/04175

Client Project Name: Woodbine Street, Rochdale

Client Project Ref: Not specified

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4					Units	Limit of Detection	Method ref
Client Sample No	1	1	1							
Client Sample ID	WS101	WS102	WS103							
Depth to Top	0.10	0.10	0.20							
Depth To Bottom	0.50	0.50	0.60							
Date Sampled	28-Apr-22	28-Apr-22	28-Apr-22							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4AE	5A	2AE							
Asbestos in Soil (inc. matrix)										
Asbestos in soil _D [#]	NAD	NAD	NAD							A-T-045
Asbestos Matrix (visual) _D	-	-	-							A-T-045
Asbestos Matrix (microscope) _D	-	-	-							A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	N/A	N/A	N/A							A-T-045

Envirolab Job Number: 22/04175

Client Project Name: Woodbine Street, Rochdale

Client Project Ref: Not specified

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4					Units	Limit of Detection	Method ref
Client Sample No	1	1	1							
Client Sample ID	WS101	WS102	WS103							
Depth to Top	0.10	0.10	0.20							
Depth To Bottom	0.50	0.50	0.60							
Date Sampled	28-Apr-22	28-Apr-22	28-Apr-22							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4AE	5A	2AE							
PAH-16MS										
Acenaphthene _A ^{M#}	0.26	8.51	0.15					mg/kg	0.01	A-T-019s
Acenaphthylene _A ^{M#}	0.06	0.13	0.02					mg/kg	0.01	A-T-019s
Anthracene _A ^{M#}	0.39	10.5	0.25					mg/kg	0.02	A-T-019s
Benzo(a)anthracene _A ^{M#}	2.00	8.24	0.95					mg/kg	0.04	A-T-019s
Benzo(a)pyrene _A ^{M#}	2.09	5.23	0.98					mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	2.39	5.57	1.10					mg/kg	0.05	A-T-019s
Benzo(ghi)perylene _A ^{M#}	1.24	1.87	0.63					mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.79	2.01	0.37					mg/kg	0.07	A-T-019s
Chrysene _A ^{M#}	2.35	8.16	1.10					mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.30	0.53	0.14					mg/kg	0.04	A-T-019s
Fluoranthene _A ^{M#}	4.45	23.3	2.30					mg/kg	0.08	A-T-019s
Fluorene _A ^{M#}	0.17	6.21	0.08					mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	1.56	2.42	0.81					mg/kg	0.03	A-T-019s
Naphthalene _A ^{M#}	0.14	11.6	0.08					mg/kg	0.03	A-T-019s
Phenanthrene _A ^{M#}	2.20	40	1.20					mg/kg	0.03	A-T-019s
Pyrene _A ^{M#}	4.15	20.8	2.11					mg/kg	0.07	A-T-019s
Total PAH-16MS _A ^{M#}	24.5	155	12.3					mg/kg	0.01	A-T-019s

Envirolab Job Number: 22/04175

Client Project Name: Woodbine Street, Rochdate

Client Project Ref: Not specified

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4					Units	Limit of Detection	Method ref
Client Sample No	1	1	1							
Client Sample ID	WS101	WS102	WS103							
Depth to Top	0.10	0.10	0.20							
Depth To Bottom	0.50	0.50	0.60							
Date Sampled	28-Apr-22	28-Apr-22	28-Apr-22							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4AE	5A	2AE							
PAH-16MS (leachable)										
Acenaphthene (leachable) _A	<0.02	0.03	-					µg/l	0.01	A-T-019w
Acenaphthylene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Anthracene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Benzo(a)anthracene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Benzo(a)pyrene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Benzo(b)fluoranthene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Benzo(ghi)perylene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Benzo(k)fluoranthene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Chrysene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Dibenzo(ah)anthracene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Fluoranthene (leachable) _A	0.05	0.03	-					µg/l	0.01	A-T-019w
Fluorene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Indeno(123-cd)pyrene (leachable) _A	<0.02	<0.01	-					µg/l	0.01	A-T-019w
Naphthalene (leachable) _A	0.03	0.06	-					µg/l	0.01	A-T-019w
Phenanthrene (leachable) _A	0.06	0.04	-					µg/l	0.01	A-T-019w
Pyrene (leachable) _A	0.05	0.02	-					µg/l	0.01	A-T-019w
Total PAH-16MS (leachable) _A	0.19	0.18	-					µg/l	0.01	A-T-019w

Envirolab Job Number: 22/04175

Client Project Name: Woodbine Street, Rochdale

Client Project Ref: Not specified

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4					Units	Limit of Detection	Method ref
Client Sample No	1	1	1							
Client Sample ID	WS101	WS102	WS103							
Depth to Top	0.10	0.10	0.20							
Depth To Bottom	0.50	0.50	0.60							
Date Sampled	28-Apr-22	28-Apr-22	28-Apr-22							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4AE	5A	2AE							
TPH UKCWG with Clean Up *C1										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
Ali >C8-C10 _A	<1	<1	<1					mg/kg	1	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	<1					mg/kg	1	A-T-055s
Ali >C12-C16 _A ^{M#}	1	4	2					mg/kg	1	A-T-055s
Ali >C16-C21 _A ^{M#}	2	6	2					mg/kg	1	A-T-055s
Ali >C21-C35 _A ^{M#}	22	52	45					mg/kg	1	A-T-055s
Ali >C35-C44 _A	15	17	20					mg/kg	1	A-T-055s
Total Aliphatics _A	41	80	69					mg/kg	1	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
Aro >C8-C10 _A	<1	<1	<1					mg/kg	1	A-T-055s
Aro >C10-C12 _A	1	10	<1					mg/kg	1	A-T-055s
Aro >C12-C16 _A	9	60	14					mg/kg	1	A-T-055s
Aro >C16-C21 _A ^{M#}	44	156	46					mg/kg	1	A-T-055s
Aro >C21-C35 _A	161	228	134					mg/kg	1	A-T-055s
Aro >C35-C44 _A	12	11	14					mg/kg	1	A-T-055s
Total Aromatics _A	227	466	208					mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C44) _A	268	546	277					mg/kg	1	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-022s

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample, 9 = INCINERATOR ASH.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

EPH CWG results have humics mathematically subtracted through instrument calculation

TPH results "with Cleanup" indicates results cleaned up with Silica during extraction

EPH CWG GCxGC ID from TPH CWG

Where we have identified humic substances in any ID's from TPH CWG with Clean Up please note that the concentration of these humic substances is not included in the quantified results and are included in the ID for information.

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Sutcliffe, 18-20 Harrington Street, Liverpool, L2 9QA

Project No: 22/04175

Project: Woodbine Street, Rochdale

Date Received: 29/04/2022 (am)

Clients Project No:

Cool Box Temperatures (°C): 13.5

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Envirolab Analysis Dates

Lab Sample ID	22/04175/1	22/04175/2	22/04175/4
Client Sample No	1	1	1
Client Sample ID/Depth	WS101 0.10-0.50m	WS102 0.10-0.50m	WS103 0.20-0.60m
Date Sampled	28/04/22	28/04/22	28/04/22
A-T-007w	06/05/2022	06/05/2022	
A-T-019s	06/05/2022	06/05/2022	06/05/2022
A-T-019w	11/05/2022	10/05/2022	
A-T-022s	05/05/2022	05/05/2022	05/05/2022
A-T-024s	06/05/2022	06/05/2022	06/05/2022
A-T-025w	10/05/2022	09/05/2022	
A-T-026s	09/05/2022	09/05/2022	09/05/2022
A-T-026w	09/05/2022	09/05/2022	
A-T-027s	06/05/2022	06/05/2022	06/05/2022
A-T-028s	06/05/2022	06/05/2022	06/05/2022
A-T-029s	09/05/2022	09/05/2022	09/05/2022
A-T-029w	09/05/2022	09/05/2022	
A-T-031s	06/05/2022	06/05/2022	06/05/2022
A-T-031w	06/05/2022	06/05/2022	
A-T-032 OM	06/05/2022	06/05/2022	06/05/2022
A-T-032w	09/05/2022	09/05/2022	
A-T-040s	06/05/2022	06/05/2022	06/05/2022
A-T-040w	09/05/2022	09/05/2022	
A-T-042sTCN	07/05/2022	07/05/2022	07/05/2022
A-T-042wTCN	07/05/2022	07/05/2022	
A-T-043-s	10/05/2022	10/05/2022	10/05/2022
A-T-043-w	10/05/2022	10/05/2022	
A-T-044	05/05/2022	05/05/2022	05/05/2022
A-T-045	04/05/2022	04/05/2022	04/05/2022
A-T-050s	06/05/2022	06/05/2022	06/05/2022
A-T-050w	09/05/2022	09/05/2022	
A-T-055s	06/05/2022	06/05/2022	06/05/2022
Calc	09/05/2022	09/05/2022	06/05/2022

The above dates are the analysis completion dates, please note that these are not necessarily the date that the analysis was weighed/extracted.

End of Report

FINAL ANALYTICAL TEST REPORT

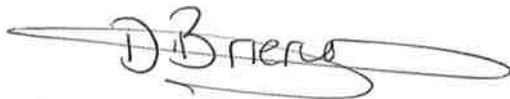
Envirolab Job Number: 22/04428
Issue Number: 1

Date: 13 May, 2022

Client: Sutcliffe
18-20 Harrington Street
Liverpool
L2 9QA

Project Manager: (Use) D Evans; D Bowen; A Tosh; W Baldwin/(Use) Sa
Project Name: Wood Bine St Rochdale
Project Ref: 31163LG
Order No: 9153
Date Samples Received: 05/05/22
Date Instructions Received: 06/05/22
Date Analysis Completed: 12/05/22

Approved by:



Danielle Brierley
Deputy Client Services Supervisor

Envirolab Job Number: 22/04428

Client Project Name: Wood Bine St Rochdale

Client Project Ref: 31163LG

Lab Sample ID	22/04428/1							Units	Limit of Detection	Method ref
Client Sample No	1									
Client Sample ID	BH101									
Depth to Top	0.20									
Depth To Bottom	0.60									
Date Sampled	03-May-22									
Sample Type	Soil - ES									
Sample Matrix Code	5AE									
% Moisture at <40C _A	14.5							% w/w	0.1	A-T-044
% Stones >10mm _A	11.7							% w/w	0.1	A-T-044
pH _D ^{M#}	7.68							pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	0.02							g/l	0.01	A-T-026s
Sulphate (acid soluble) _D ^{M#}	290							mg/kg	200	A-T-028s
Cyanide (total) _A ^{M#}	<1							mg/kg	1	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2							mg/kg	0.2	A-T-050s
Sulphide _A	37							mg/kg	5	A-T-043-s
Sulphur (elemental) _D ^{M#}	<5							mg/kg	5	A-T-029s
Organic matter Default _D ^{M#}	4.2							% w/w	0.1	A-T-032 OM
Arsenic _D ^{M#}	6							mg/kg	1	A-T-024s
Boron (water soluble) _D	<1.0							mg/kg	1	A-T-027s
Cadmium _D ^{M#}	1.2							mg/kg	0.5	A-T-024s
Copper _D ^{M#}	36							mg/kg	1	A-T-024s
Chromium _D ^{M#}	18							mg/kg	1	A-T-024s
Chromium (hexavalent) _D	<1							mg/kg	1	A-T-040s
Chromium (trivalent)	18							mg/kg	1	Calc
Lead _D ^{M#}	98							mg/kg	1	A-T-024s
Mercury _D	<0.17							mg/kg	0.17	A-T-024s
Nickel _D ^{M#}	18							mg/kg	1	A-T-024s
Selenium _D ^{M#}	<1							mg/kg	1	A-T-024s
Zinc _D ^{M#}	75							mg/kg	5	A-T-024s

Envirolab Job Number: 22/04428

Client Project Name: Wood Bine St Rochdale

Client Project Ref: 31163LG

Lab Sample ID	22/04428/1									
Client Sample No	1									
Client Sample ID	BH101									
Depth to Top	0.20									
Depth To Bottom	0.60									
Date Sampled	03-May-22									
Sample Type	Soil - ES									
Sample Matrix Code	5AE									
Asbestos in Soil (inc. matrix)										
Asbestos in soil _D [#]	NAD									A-T-045
Asbestos Matrix (visual) _D	-									A-T-045
Asbestos Matrix (microscope) _D	-									A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	N/A									A-T-045

Envirolab Job Number: 22/04428

Client Project Name: Wood Bine St Rochdale

Client Project Ref: 31163LG

Lab Sample ID	22/04428/1									
Client Sample No	1									
Client Sample ID	BH101									
Depth to Top	0.20									
Depth To Bottom	0.60									
Date Sampled	03-May-22									
Sample Type	Soil - ES									
Sample Matrix Code	5AE									
PAH-16MS										
Acenaphthene _A ^{M#}	0.15							mg/kg	0.01	A-T-019s
Acenaphthylene _A ^{M#}	0.03							mg/kg	0.01	A-T-019s
Anthracene _A ^{M#}	0.27							mg/kg	0.02	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.89							mg/kg	0.04	A-T-019s
Benzo(a)pyrene _A ^{M#}	1.02							mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	1.01							mg/kg	0.05	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.51							mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.36							mg/kg	0.07	A-T-019s
Chrysene _A ^{M#}	0.83							mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.13							mg/kg	0.04	A-T-019s
Fluoranthene _A ^{M#}	2.12							mg/kg	0.08	A-T-019s
Fluorene _A ^{M#}	0.10							mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.60							mg/kg	0.03	A-T-019s
Naphthalene _A ^{M#}	0.17							mg/kg	0.03	A-T-019s
Phenanthrene _A ^{M#}	1.23							mg/kg	0.03	A-T-019s
Pyrene _A ^{M#}	1.96							mg/kg	0.07	A-T-019s
Total PAH-16MS _A ^{M#}	11.4							mg/kg	0.01	A-T-019s

Envirolab Job Number: 22/04428

Client Project Name: Wood Bine St Rochdale

Client Project Ref: 31163LG

Lab Sample ID	22/04428/1									
Client Sample No	1									
Client Sample ID	BH101									
Depth to Top	0.20									
Depth To Bottom	0.60									
Date Sampled	03-May-22									
Sample Type	Soil - ES									
Sample Matrix Code	5AE									
TPH UKCWG with Clean Up *C1										
Ali >C5-C6 _A [#]	<0.01							mg/kg	0.01	A-T-022s
Ali >C6-C8 _A [#]	<0.01							mg/kg	0.01	A-T-022s
Ali >C8-C10 _A	<1							mg/kg	1	A-T-055s
Ali >C10-C12 _A ^{M#}	<1							mg/kg	1	A-T-055s
Ali >C12-C16 _A ^{M#}	1							mg/kg	1	A-T-055s
Ali >C16-C21 _A ^{M#}	2							mg/kg	1	A-T-055s
Ali >C21-C35 _A ^{M#}	34							mg/kg	1	A-T-055s
Ali >C35-C44 _A	18							mg/kg	1	A-T-055s
Total Aliphatics _A	55							mg/kg	1	A-T-055s
Aro >C5-C7 _A [#]	<0.01							mg/kg	0.01	A-T-022s
Aro >C7-C8 _A [#]	<0.01							mg/kg	0.01	A-T-022s
Aro >C8-C10 _A	<1							mg/kg	1	A-T-055s
Aro >C10-C12 _A	1							mg/kg	1	A-T-055s
Aro >C12-C16 _A	5							mg/kg	1	A-T-055s
Aro >C16-C21 _A ^{M#}	22							mg/kg	1	A-T-055s
Aro >C21-C35 _A	97							mg/kg	1	A-T-055s
Aro >C35-C44 _A	9							mg/kg	1	A-T-055s
Total Aromatics _A	134							mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C44) _A	189							mg/kg	1	A-T-055s
BTEX - Benzene _A [#]	<0.01							mg/kg	0.01	A-T-022s
BTEX - Toluene _A [#]	<0.01							mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01							mg/kg	0.01	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01							mg/kg	0.01	A-T-022s
BTEX - o Xylene _A [#]	<0.01							mg/kg	0.01	A-T-022s
MTBE _A [#]	<0.01							mg/kg	0.01	A-T-022s

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample, 9 = INCINERATOR ASH.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

EPH CWG results have humics mathematically subtracted through instrument calculation

TPH results "with Cleanup" indicates results cleaned up with Silica during extraction

EPH CWG GCxGC ID from TPH CWG

Where we have identified humic substances in any ID's from TPH CWG with Clean Up please note that the concentration of these humic substances is not included in the quantified results and are included in the ID for information.

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Sutcliffe, 18-20 Harrington Street, Liverpool, L2 9QA

Project No: 22/04428

Project: Wood Bine St Rochdale

Date Received: 06/05/2022 (am)

Clients Project No: 31163LG

Cool Box Temperatures (°C): 13.6

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Envirolab Analysis Dates

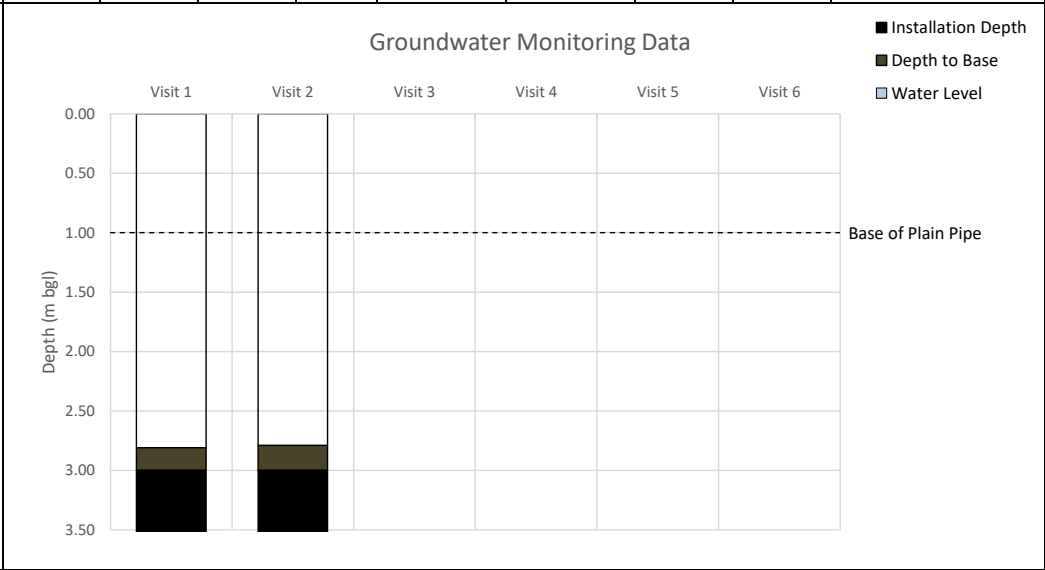
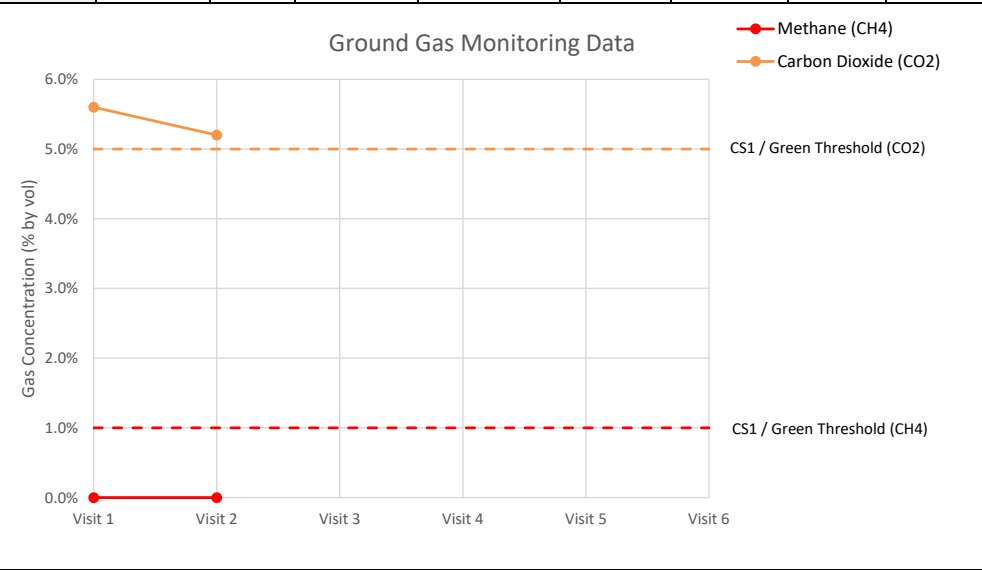
Lab Sample ID	22/04428/1
Client Sample No	1
Client Sample ID/Depth	BH101 0.20-0.60m
Date Sampled	03/05/22
A-T-019s	12/05/2022
A-T-022s	12/05/2022
A-T-024s	12/05/2022
A-T-026s	12/05/2022
A-T-027s	11/05/2022
A-T-028s	11/05/2022
A-T-029s	11/05/2022
A-T-031s	12/05/2022
A-T-032 OM	11/05/2022
A-T-040s	12/05/2022
A-T-042sTCN	12/05/2022
A-T-043-s	12/05/2022
A-T-044	11/05/2022
A-T-045	09/05/2022
A-T-050s	11/05/2022
A-T-055s	12/05/2022
Calc	12/05/2022

The above dates are the analysis completion dates, please note that these are not necessarily the date that the analysis was weighed/extracted.

End of Report

Appendix E – Ground Gas & Groundwater Monitoring Data

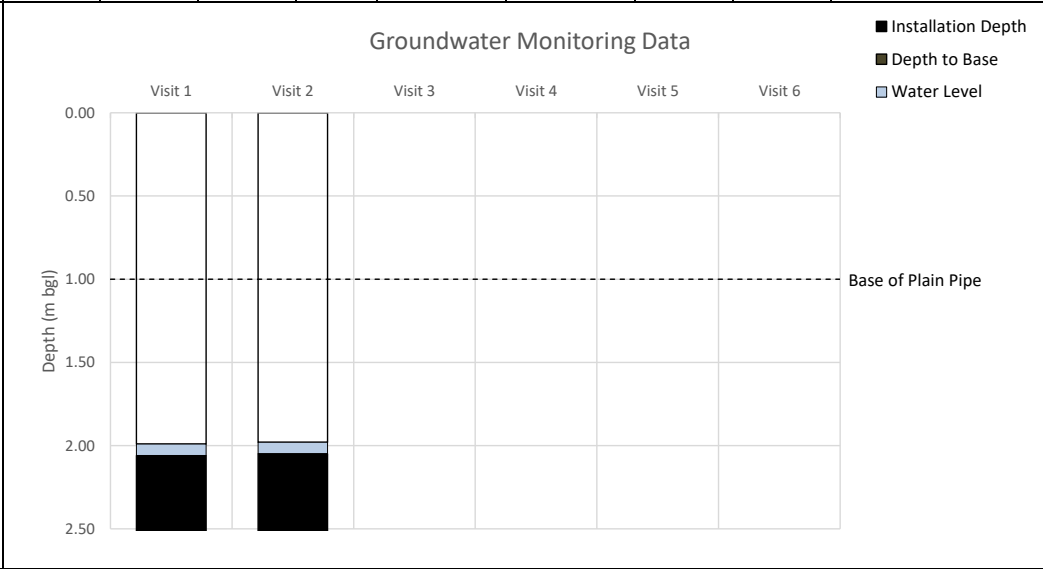
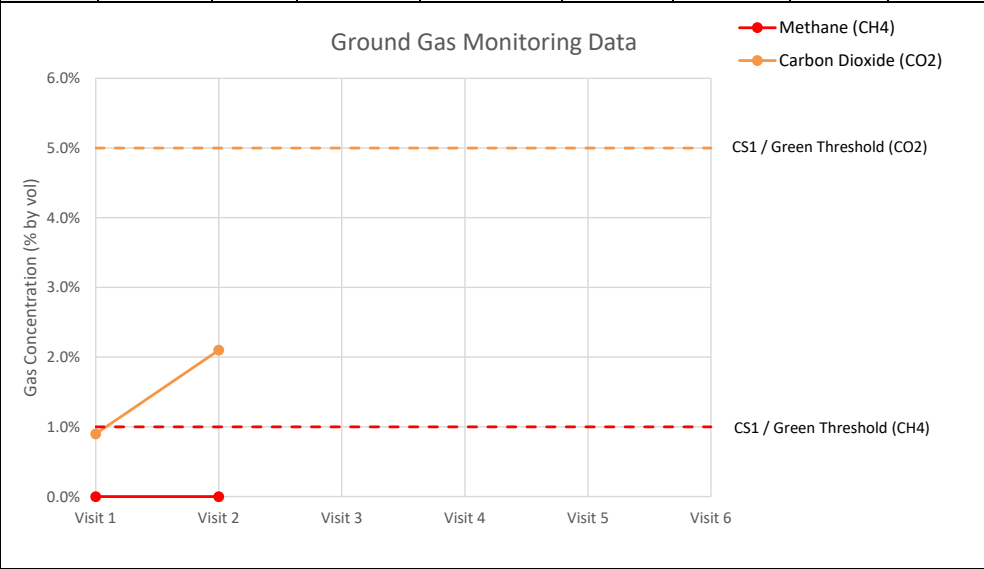
	SUTCLIFFE INVESTIGATIONS						Site Details						Installation Details				Position Ref.:	
							Job No.:		31163LG				Installation Date:		28/04/2022		WS101	
	TEL: 0151 227 3155						Site Name:		Oldham Road Woodbine Street, Rochdale				Installation Depth (m bgl):		3.00			
	FAX: 0151 227 3156						Client:		Arcon Housing				Base of Plain Pipe (m bgl):		1.00			
Site Monitoring Visit Details							Gas and Groundwater Monitoring Data								Ground Gas Risk Assessment			
Visit No.	Visit Date	Logged By	Weather	Atmospheric Pressure	Pressure Trend	Relative Pressure	Flow Rate	Max CH ₄	Max CH ₄	Max CO ₂	Min O ₂	Max PID	Water Level	Depth to Base	HGFR ¹ CH ₄ ^{2,3}	HGFR ¹ CO ₂ ^{2,3}	Characteristic Situation (CS)	
						(mb)	(l/h)	(% LEL)	(% by vol)	(% by vol)	(% by vol)	(ppm)	(m bgl)	(m bgl)	(l/h)	(l/h)		
Visit 1	28/06/2022	MW	Cloudy	995mB	Falling	-	0.0	0.0%	0.0%	5.6%	15.9%	-	Dry	2.81	0.0001	0.0056	CS1	
Visit 2	07/07/2022	MW	Sunny	1013mB	Steady	-	0.0	#N/A	0.0%	5.2%	16.1%	-	Dry	2.79	0.0001	0.0052	CS1	
Visit 3	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	
Visit 4	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	
Visit 5	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	
Visit 6	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	



Comments:

¹ Hazardous Gas Flow Rate Assessment Methodology (HGFR).
² Where maximum recorded flow is <0.1l/h, 0.1l/h has been used to calculate HGFR as recommended in CIRIA C665.
³ Where maximum recorded concentration is <0.1%, 0.1% has been used as recommended in BS8485.
* Peak flow recorded is likely to be due to a build-up of hydrolic pressure caused by rising water trapping the gas within the solid section of pipe; the initial peak flow is not representative of the rate of gas generation within the ground and can be discounted from the dataset.

		SUTCLIFFE INVESTIGATIONS					Site Details						Installation Details				Position Ref.:
							Job No.:		31163LG				Installation Date:		28/04/2022		WS102
		TEL: 0151 227 3155					Site Name:		Oldham Road Woodbine Street, Rochdale				Installation Depth (m bgl):		2.00		
		FAX: 0151 227 3156					Client:		Arcon Housing				Base of Plain Pipe (m bgl):		1.00		
Site Monitoring Visit Details							Gas and Groundwater Monitoring Data								Ground Gas Risk Assessment		
Visit No.	Visit Date	Logged By	Weather	Atmospheric Pressure	Pressure Trend	Relative Pressure (mb)	Flow Rate (l/h)	Max CH ₄ (% LEL)	Max CH ₄ (% by vol)	Max CO ₂ (% by vol)	Min O ₂ (% by vol)	Max PID (ppm)	Water Level (m bgl)	Depth to Base (m bgl)	HGFR ¹ CH ₄ ^{2,3} (l/h)	HGFR ¹ CO ₂ ^{2,3} (l/h)	Characteristic Situation (CS)
Visit 1	28/06/2022	MW	Cloudy	995mB	Falling	-	0.0	0.0%	0.0%	0.9%	20.0%	-	1.99	2.06	0.0001	0.0009	CS1
Visit 2	07/07/2022	MW	Sunny	1013mB	Steady	-	0.0	#N/A	0.0%	2.1%	18.0%	-	1.98	2.05	0.0001	0.0021	CS1
Visit 3	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-
Visit 4	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-
Visit 5	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-
Visit 6	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-



Comments:

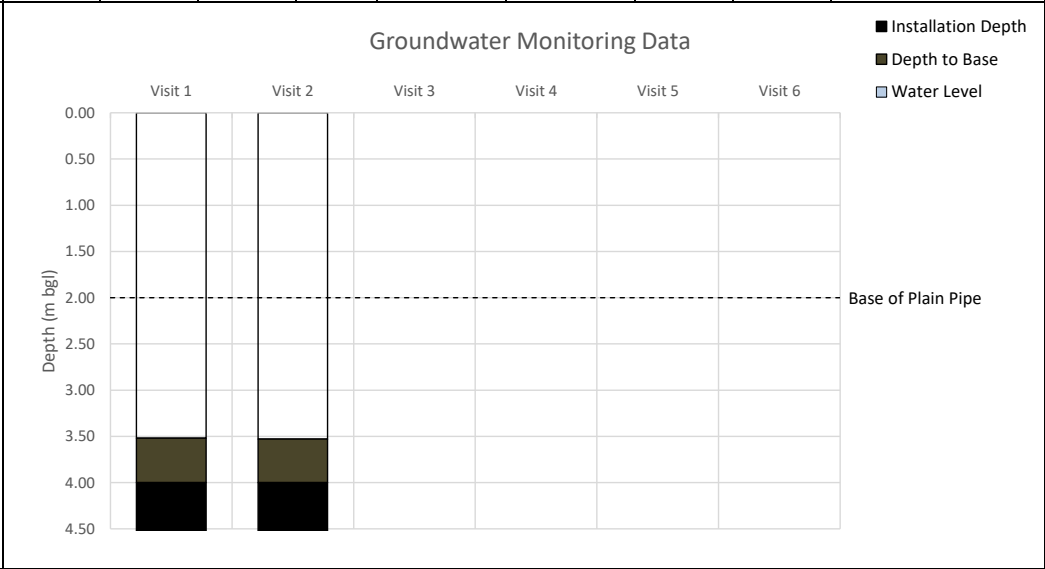
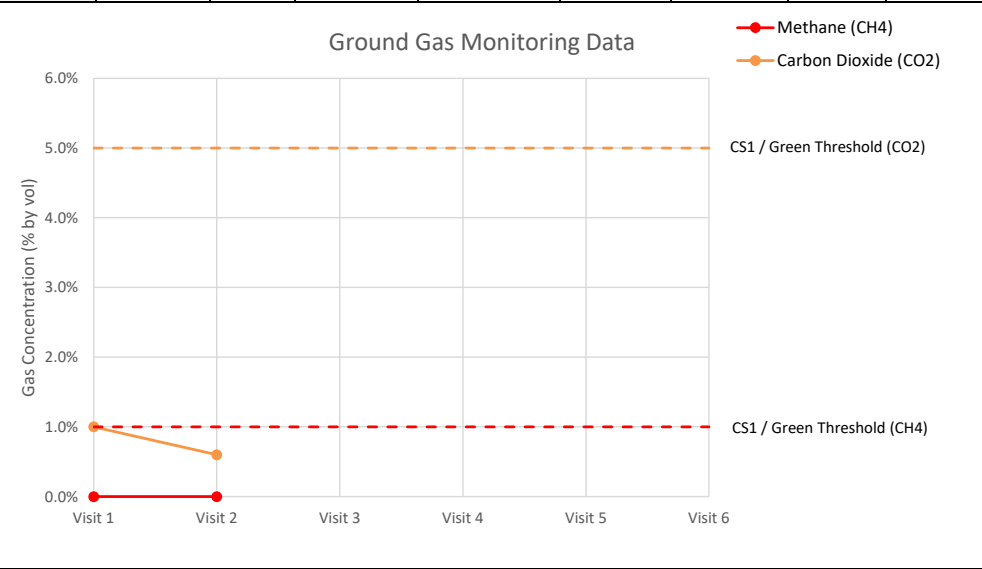
¹ Hazardous Gas Flow Rate Assessment Methodology (HGFR).

² Where maximum recorded flow is <0.1l/h, 0.1l/h has been used to calculate HGFR as recommended in CIRIA C665.

³ Where maximum recorded concentration is <0.1%, 0.1% has been used as recommended in BS8485.

* Peak flow recorded is likely to be due to a build-up of hydrolic pressure caused by rising water trapping the gas within the solid section of pipe; the initial peak flow is not representative of the rate of gas generation within the ground and can be discounted from the dataset.

	SUTCLIFFE INVESTIGATIONS						Site Details						Installation Details				Position Ref.:	
							Job No.:		31163LG				Installation Date:		28/04/2022		WS103	
	TEL: 0151 227 3155						Site Name:		Oldham Road Woodbine Street, Rochdale				Installation Depth (m bgl):		4.00			
	FAX: 0151 227 3156						Client:		Arcon Housing				Base of Plain Pipe (m bgl):		2.00			
Site Monitoring Visit Details							Gas and Groundwater Monitoring Data								Ground Gas Risk Assessment			
Visit No.	Visit Date	Logged By	Weather	Atmospheric Pressure	Pressure Trend	Relative Pressure	Flow Rate	Max CH ₄	Max CH ₄	Max CO ₂	Min O ₂	Max PID	Water Level	Depth to Base	HGFR ¹ CH ₄ ^{2,3}	HGFR ¹ CO ₂ ^{2,3}	Characteristic Situation (CS)	
						(mb)	(l/h)	(% LEL)	(% by vol)	(% by vol)	(% by vol)	(ppm)	(m bgl)	(m bgl)	(l/h)	(l/h)		
Visit 1	28/06/2022	MW	Cloudy	995mB	Falling	-	0.0	0.0%	0.0%	1.0%	19.7%	-	Dry	3.52	0.0001	0.0010	CS1	
Visit 2	07/07/2022	MW	Sunny	1013mB	Steady	-	0.0	#N/A	0.0%	0.6%	20.2%	-	Dry	3.53	0.0001	0.0006	CS1	
Visit 3	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	
Visit 4	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	
Visit 5	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	
Visit 6	-	-	-	-	-	-	-	#N/A	#N/A	#N/A	#N/A	-	-	-	-	-	-	



Comments:

¹ Hazardous Gas Flow Rate Assessment Methodology (HGFR).
² Where maximum recorded flow is <0.1l/h, 0.1l/h has been used to calculate HGFR as recommended in CIRIA C665.
³ Where maximum recorded concentration is <0.1%, 0.1% has been used as recommended in BS8485.
* Peak flow recorded is likely to be due to a build-up of hydrolic pressure caused by rising water trapping the gas within the solid section of pipe; the initial peak flow is not representative of the rate of gas generation within the ground and can be discounted from the dataset.

Appendix F – Geotechnical Laboratory Certificates

Units 1 & 2
Deltic Place
Deltic Way
Knowsley Industrial Estate
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L33 7BU

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www.ccgeotechnical.com



LABORATORY REPORT

CONTRACT NUMBER: CCG-C-22-13130

CONTRACT TITLE: WOODBINE STREET, ROCHDALE

CLIENT: SUTCLIFFE
18-20 Harrington Street, Liverpool L2 9QA

DATE RECEIVED: 05/05/22
DATE COMMENCED: 06/05/22
DATE COMPLETED: 10/05/22
REPORT DATE: 10/05/22

Test Description	Qty
Particle Size Distribution BS 1377-2:1990 (a)	4

Notes: Observations and interpretations are not accredited by UKAS
All testing undertaken at laboratory permanent facilities
denotes non-accredited test
a denotes UKAS accredited test
s denotes test undertaken by approved subcontractor
Test results only relate to the samples tested
Sample and sample information supplied by client

This report is issued in accordance with the requirements of the United Kingdom Accreditation Services and EN ISO/IEC 17025:2017. The results reported herein relate only to the material supplied to the laboratory. This report shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved Signatories: Chris Bolan (Managing Director) – Daniel Kerfoot (Laboratory Manager)

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
BH101	B	5.00	5.00	-	-	-	-	-	-	-	-	-	Y	Brown very gravelly slightly silty fine to medium SAND. Gravel is fine to coarse subrounded sandstone. (BS1377Pt2:9.2)
WS101	B	1.00	2.00	-	-	-	-	-	-	-	-	-	Y	Brown silty gravelly fine to medium SAND. Gravel is fine to coarse subrounded sandstone. (BS1377Pt2:9.2)
WS102	B	1.00	2.00	-	-	-	-	-	-	-	-	-	Y	Grey very silty gravelly fine to medium SAND. Gravel is fine to coarse subrounded sandstone. (BS1377Pt2:9.2)
WS103	B	1.00	2.00	-	-	-	-	-	-	-	-	-	Y	Brown slightly silty slightly gravelly fine to medium SAND. Gravel is fine to medium subrounded sandstone. (BS1377Pt2:9.2)

SITE: WOODBINE STREET, ROCHDALE (CCG-C-22-13130)
CLIENT: SUTCLIFFE

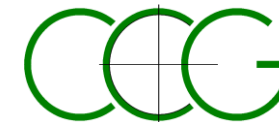
DATE: 10.05.22

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS





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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-22-13130

Borehole/Pit No.

BH101

Site Name

WOODBINE STREET, ROCHDALE

Sample No.

1

Specimen
Description

Brown very gravelly slightly silty fine to medium SAND

Depth, m

5.00

Specimen
Reference

Specimen
Depth

m

Sample Type

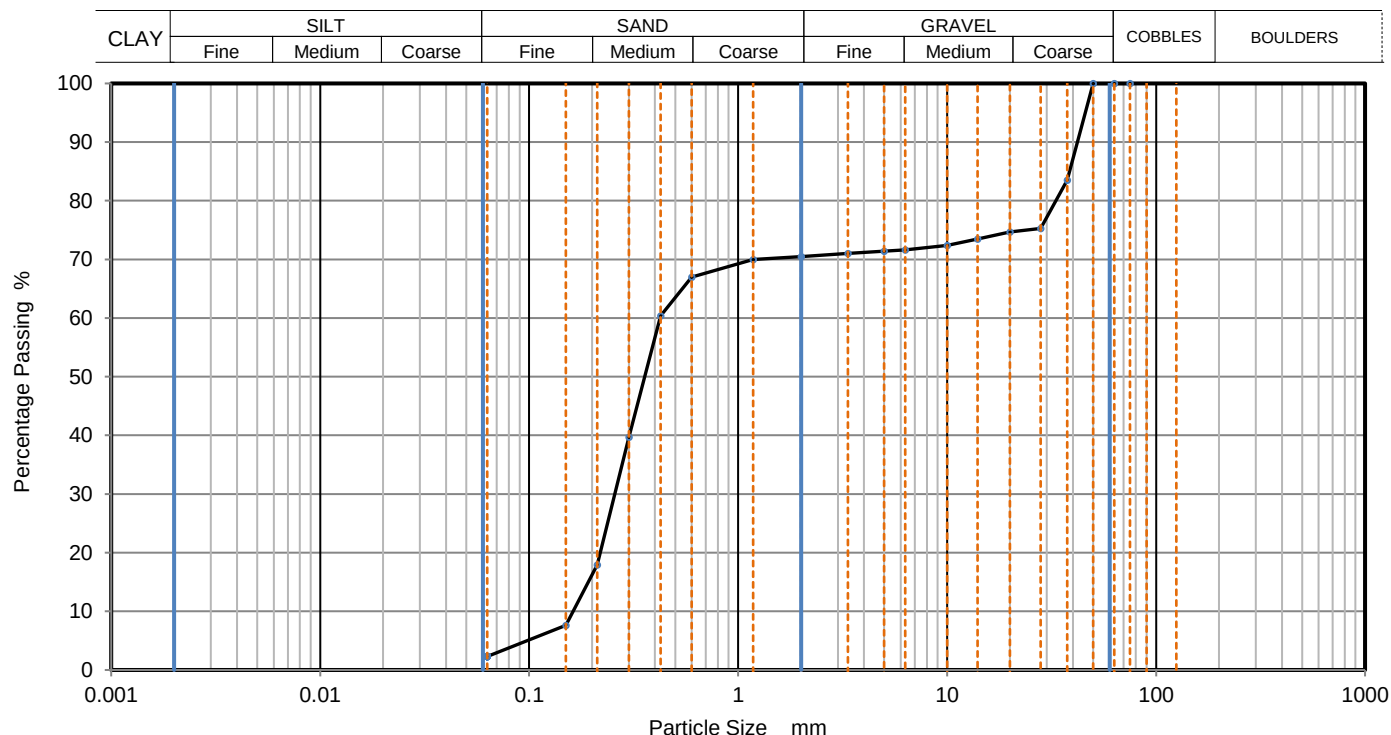
B

Test Method

BS1377:Part 2:1990, clause 9.2

KeyLAB ID

CCGL202205107



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	84		
28	75		
20	75		
14	74		
10	72		
6.3	72		
5	71		
3.35	71		
2	71		
1.18	70		
0.6	67		
0.425	60		
0.3	40		
0.212	18		
0.15	8		
0.063	2		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	30
Sand	68
Fines <0.063mm	2

Grading Analysis		
D100	mm	
D60	mm	0.422
D30	mm	0.257
D10	mm	0.163
Uniformity Coefficient		2.6
Curvature Coefficient		0.96

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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Fig 1

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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-22-13130

Borehole/Pit No.

WS101

Site Name

WOODBINE STREET, ROCHDALE

Sample No.

1

Specimen
Description

Brown silty gravelly fine to medium SAND

Depth, m

1.00

Specimen
Reference

Specimen
Depth

m

Sample Type

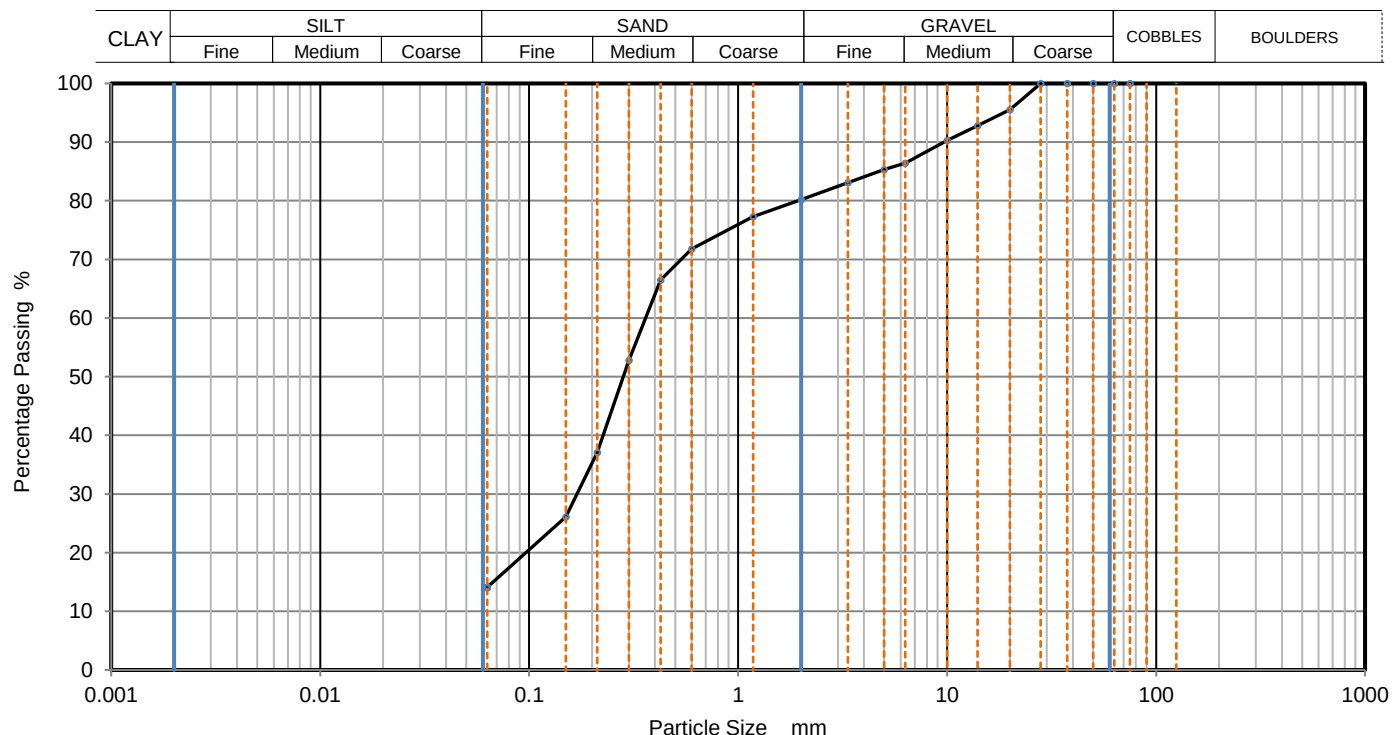
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Test Method

BS1377:Part 2:1990, clause 9.2

KeyLAB ID

CCGL202205108



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	96		
14	93		
10	90		
6.3	86		
5	85		
3.35	83		
2	80		
1.18	77		
0.6	72		
0.425	67		
0.3	53		
0.212	37		
0.15	26		
0.063	14		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	20
Sand	66
Fines <0.063mm	14

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

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-22-13130

Borehole/Pit No.

WS102

Site Name

WOODBINE STREET, ROCHDALE

Sample No.

1

Specimen
Description

Grey very silty gravelly fine to medium SAND

Depth, m

1.00

Specimen
Reference

Specimen
Depth

m

Sample Type

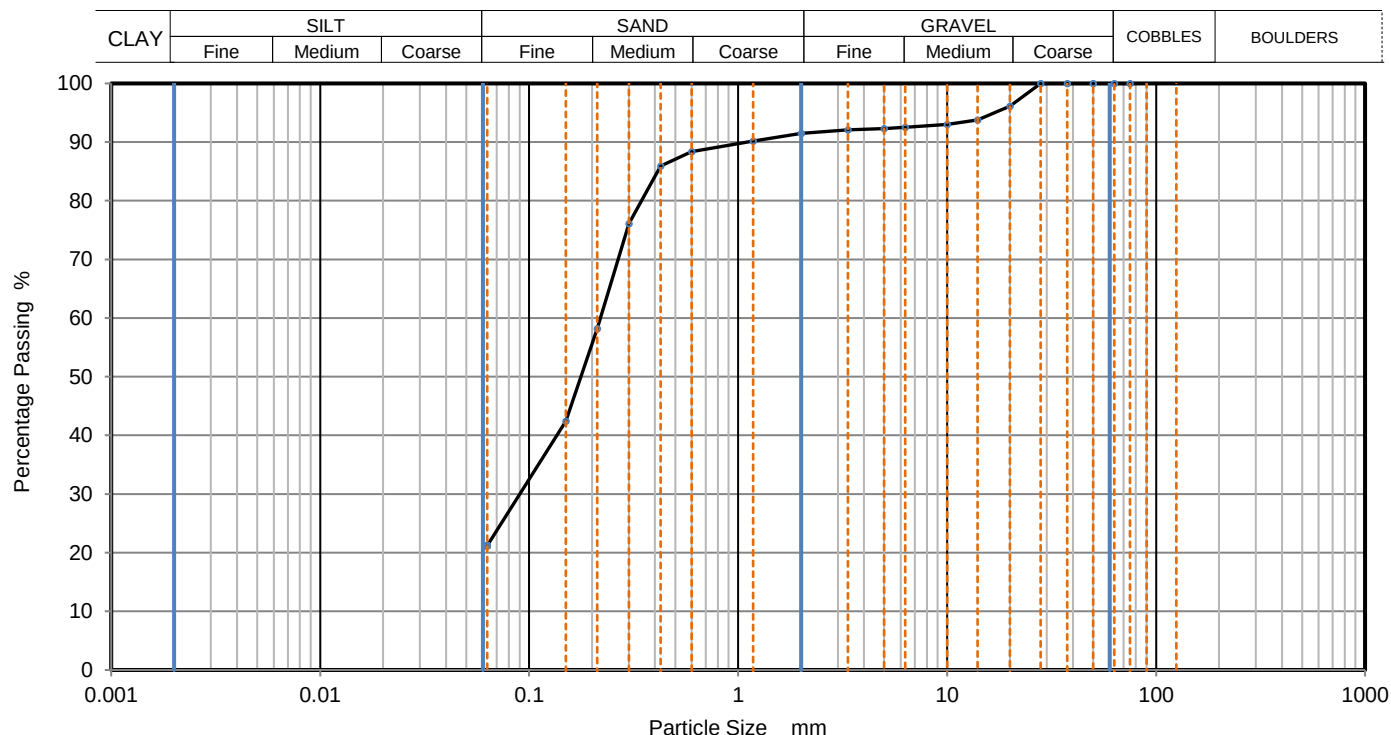
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Test Method

BS1377:Part 2:1990, clause 9.2

KeyLAB ID

CCGL202205109



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	96		
14	94		
10	93		
6.3	93		
5	92		
3.35	92		
2	92		
1.18	90		
0.6	88		
0.425	86		
0.3	76		
0.212	58		
0.15	42		
0.063	21		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	9
Sand	70
Fines <0.063mm	21

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

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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				Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-22-13130

Borehole/Pit No.

WS103

Site Name

WOODBINE STREET, ROCHDALE

Sample No.

1

Specimen
Description

Brown slightly silty slightly gravelly fine to medium SAND

Depth, m

1.00

Specimen
Reference

Specimen
Depth

m

Sample Type

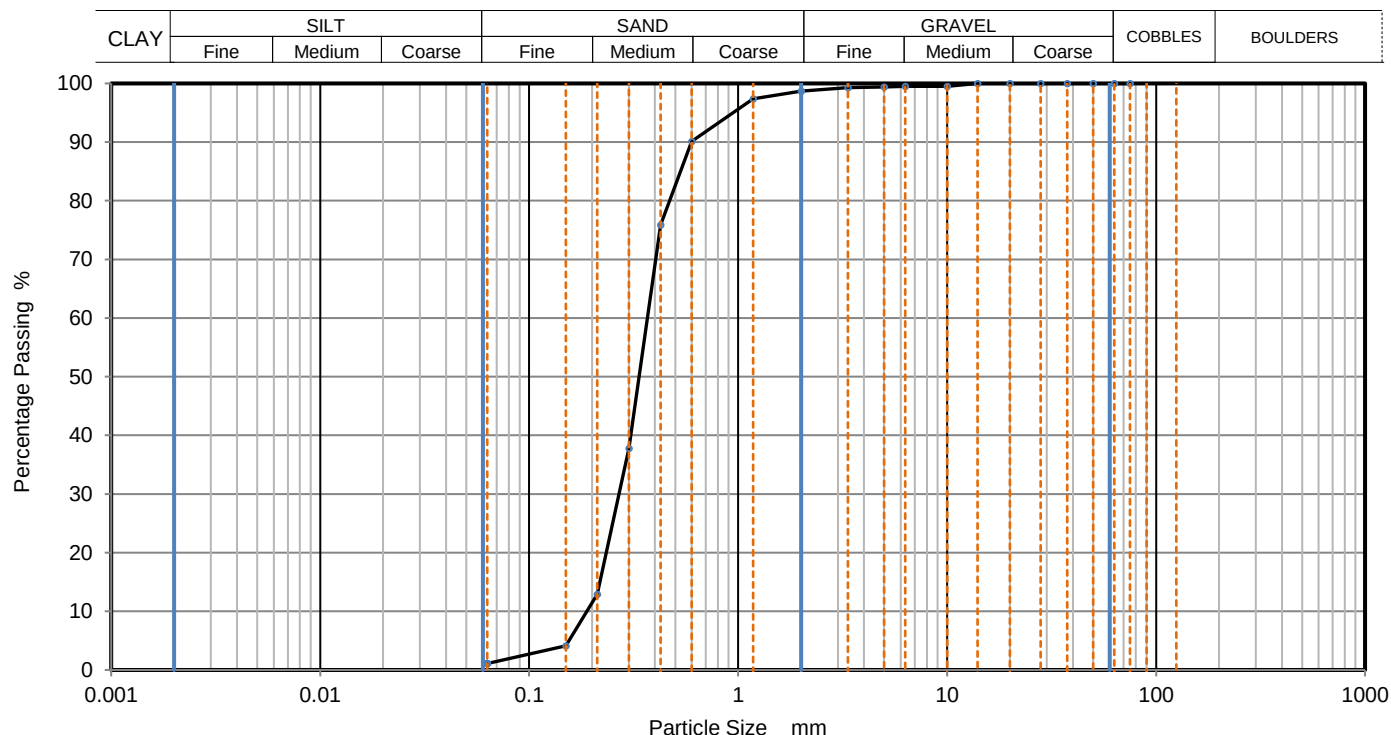
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Test Method

BS1377:Part 2:1990, clause 9.2

KeyLAB ID

CCGL2022051010



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	99		
2	99		
1.18	97		
0.6	90		
0.425	76		
0.3	38		
0.212	13		
0.15	4		
0.063	1		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	98
Fines <0.063mm	1

Grading Analysis		
D100	mm	
D60	mm	0.367
D30	mm	0.269
D10	mm	0.189
Uniformity Coefficient		1.9
Curvature Coefficient		1

Remarks

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Appendix G – Soil Screening Tables

		SUTCLIFFE INVESTIGATIONS		Human Health Assessment					
		TEL: 0151 227 3155							
		FAX: 0151 227 3156							
	Job Name:	Woodbine Street	Job No.:	31163LG					
Proposed Land Use:	Residential Without Plant Uptake	S.O.M.:		6.0					
Above Threshold:			Sample ID:		WS101	WS102	WS103	BH101	
Below Limit of Detection:		<0.01	Depth Top (m bgl):		0.10	0.10	0.20	0.20	
Not Tested:		n/t	Depth Base (m bgl):		0.50	0.50	0.60	0.60	
No Asbestos Detected:		NAD	Date Sampled:		28-Apr-22	28-Apr-22	28-Apr-22	03-May-22	
Contaminant		Units	Threshold Source	Threshold Value	WS101	WS102	WS103	BH101	
Metals / Non-Metals / Other Suite	Arsenic (Total)	mg/kg	LQM S4UL	40	27	5	20	6	
	Boron (Soluble)	mg/kg	LQM S4UL	11000	<1.0	<1.0	<1.0	<1.0	
	Cadmium (Total)	mg/kg	LQM S4UL	85	1.1	<0.5	1.6	1.2	
	Chromium III	mg/kg	LQM S4UL	910	44	12	119	18	
	Chromium VI	mg/kg	LQM S4UL	6	<1	<1	<1	<1	
	Copper (Total)	mg/kg	LQM S4UL	7100	116	29	134	36	
	Lead (Total)	mg/kg	C4SL	310	332	55	232	98	
	Mercury (Total)	mg/kg	LQM S4UL	56	0.36	<0.17	0.4	<0.17	
	Nickel (Total)	mg/kg	LQM S4UL	180	33	14	23	18	
	Selenium (Total)	mg/kg	LQM S4UL	430	<1	<1	<1	<1	
	Zinc (Total)	mg/kg	LQM S4UL	40000	130	49	146	75	
	Cyanide (Total)	mg/kg	ATKINS	34	<1	<1	<1	<1	
	Phenols (Total)	mg/kg	LQM S4UL	2300	<0.2	<0.2	<0.2	<0.2	
	Organic matter	%	LQM S4UL	N/a	9.9	3.1	5.6	4.2	
	Sulphate (Acid Soluble)	mg/kg	LQM S4UL	N/a	400	<200	340	290	
	Sulphate as Water Soluble	g/l	LQM S4UL	N/a	<0.01	<0.01	<0.01	0.02	
	Sulphide	mg/kg	LQM S4UL	N/a	69	62	15	37	
pH	pH units	LQM S4UL	N/a	6.65	8.01	7.82	7.68		
Sulphur (Elemental)	mg/kg	LQM S4UL	N/a	<5	8	<5	<5		
Asbestos Suite	Asbestos in soil	N/a		N/a	NAD	NAD	NAD	NAD	
	Asbestos Matrix (microscope)	N/a		N/a	n/t	n/t	n/t	n/t	
	ACM - Suitable for Water Absorption Test?	N/a		N/a	n/t	n/t	n/t	n/t	
	Asbestos in soil % composition	% w/w		0.001	n/t	n/t	n/t	n/t	
TPH Suite	TPH (Total)	mg/kg		N/a	268	546	277	189	
	Total Aliphatic	mg/kg		N/a	41	80	69	55	
	C5 to C6 aliphatic	mg/kg	LQM S4UL	160	<0.01	<0.01	<0.01	<0.01	
	C6 to C8 aliphatic	mg/kg	LQM S4UL	530	<0.01	<0.01	<0.01	<0.01	
	C8 to C10 aliphatic	mg/kg	LQM S4UL	150	<1	<1	<1	<1	
	C10 to C12 aliphatic	mg/kg	LQM S4UL	770	<1	<1	<1	<1	
	C12 to C16 aliphatic	mg/kg	LQM S4UL	4400	1	4	2	1	
	C16 to C35 aliphatic	mg/kg	LQM S4UL	110000	24	58	47	36	
	C35 to C44 aliphatic	mg/kg	LQM S4UL	110000	15	17	20	18	
	Total Aromatic	mg/kg		N/a	227	466	208	134	
	C5 to C7 aromatic (Benzene)	mg/kg	LQM S4UL	1400	<0.01	<0.01	<0.01	<0.01	
	C7 to C8 aromatic (Toluene)	mg/kg	LQM S4UL	3900	<0.01	<0.01	<0.01	<0.01	
	C8 to C10 aromatic	mg/kg	LQM S4UL	270	<1	<1	<1	<1	
	C10 to C12 aromatic	mg/kg	LQM S4UL	1200	1	10	<1	1	
	C12 to C16 aromatic	mg/kg	LQM S4UL	2500	9	60	14	5	
	C16 to C21 aromatic	mg/kg	LQM S4UL	1900	44	156	46	22	
	C21 to C35 aromatic	mg/kg	LQM S4UL	1900	161	228	134	97	
C35 to C44 aromatic	mg/kg	LQM S4UL	1900	12	11	14	9		
Aliphatic + Aromatic EC >44-70	mg/kg	LQM S4UL	N/a	n/t	n/t	n/t	n/t		
BTEX Suite	benzene	mg/kg	LQM S4UL	1.4	<0.01	<0.01	<0.01	<0.01	
	toluene	mg/kg	LQM S4UL	3900	<0.01	<0.01	<0.01	<0.01	
	ethylbenzene	mg/kg	LQM S4UL	450	<0.01	<0.01	<0.01	<0.01	
	M&P Xylene	mg/kg	LQM S4UL	430	<0.01	<0.01	<0.01	<0.01	
	O-Xylene	mg/kg	LQM S4UL	480	<0.01	<0.01	<0.01	<0.01	
PAH Suite	naphthalene	mg/kg	LQM S4UL	13	0.14	11.6	0.08	0.17	
	acenaphthylene	mg/kg	LQM S4UL	6000	0.06	0.13	0.02	0.03	
	acenaphthene	mg/kg	LQM S4UL	6000	0.26	8.51	0.15	0.15	
	fluorene	mg/kg	LQM S4UL	4500	0.17	6.21	0.08	0.1	
	phenanthrene	mg/kg	LQM S4UL	1500	2.2	40	1.2	1.23	
	anthracene	mg/kg	LQM S4UL	37000	0.39	10.5	0.25	0.27	
	fluoranthene	mg/kg	LQM S4UL	1600	4.45	23.3	2.3	2.12	
	pyrene	mg/kg	LQM S4UL	3800	4.15	20.8	2.11	1.96	
	benzo(a)anthracene	mg/kg	LQM S4UL	15	2	8.24	0.95	0.89	
	chrysene	mg/kg	LQM S4UL	32	2.35	8.16	1.1	0.83	
	benzo(b)fluoranthene	mg/kg	LQM S4UL	4	2.39	5.57	1.1	1.01	
	benzo(k)fluoranthene	mg/kg	LQM S4UL	110	0.79	2.01	0.37	0.36	
	benzo(a)pyrene	mg/kg	LQM S4UL	3.2	2.09	5.23	0.98	1.02	
	dibenzo(ah)anthracene	mg/kg	LQM S4UL	0.32	0.3	0.53	0.14	0.13	
	benzo(ghi)perylene	mg/kg	LQM S4UL	360	1.24	1.87	0.63	0.51	
	indeno(123cd)pyrene	mg/kg	LQM S4UL	46	1.56	2.42	0.81	0.6	



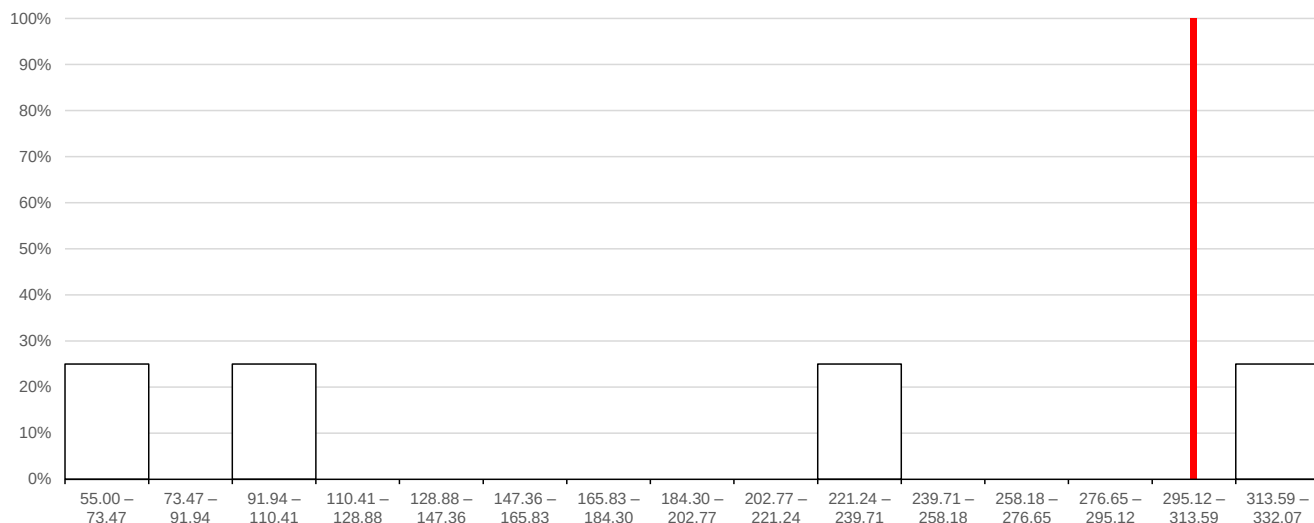
SUTCLIFFE INVESTIGATIONS

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FAX: 0151 227 3156

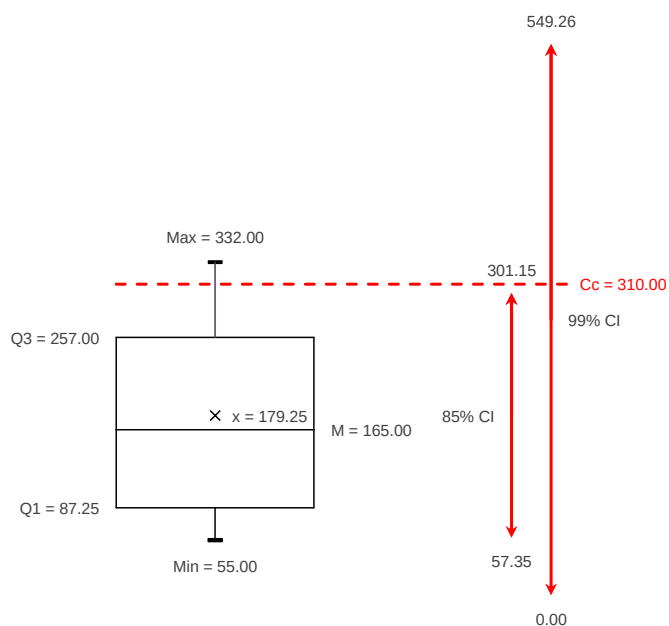
Statistical Analysis (2-Way Confidence Intervals)

Job Name:	Woodbine Street	Job No.:	31163LG
Proposed Land Use:	Residential Without Plant Uptake	No. of Samples:	4
Contaminant:	Lead (Total)	No. of Bin:	15
Data Type:	Symmetric	% Confidence Interval:	85% CI
Non-detect Rule	No Non-detects		99% CI



Maximum (Max):	332.00	Critical Concentration (Cc):	310.00
Upper Quartile (Q3):	257.00	Mean (x):	179.25
Median (M):	165.00	Range (R):	277.00
Lower Quartile (Q1):	87.25	Standard Deviation (s):	126.69
Minimum (Min):	55.00	Interquartile Range (IQR):	169.75
85% CI	57.35	99% CI	0.00

313.59 – 332.07	◇								
295.12 – 313.59	—								
276.65 – 295.12									
258.18 – 276.65									
239.71 – 258.18									
221.24 – 239.71	◇								
202.77 – 221.24									
184.30 – 202.77									
165.83 – 184.30									
147.36 – 165.83									
128.88 – 147.36									
110.41 – 128.88									
91.94 – 110.41	◇								
73.47 – 91.94									
55.00 – 73.47	◇								



Summary

Sutcliffe are 85% confident that the true mean concentration (μ) for Lead (Total) lies between 57.35mg/kg and 301.15mg/kg.
 Sutcliffe are 99% confident that the true mean concentration (μ) for Lead (Total) does not lie outside of 0.00mg/kg and 549.26mg/kg.
 The Critical Concentration (Cc) for Lead (Total) under a 6.0% S.O.M. Residential Without Plant Uptake end use is 310.00mg/kg.



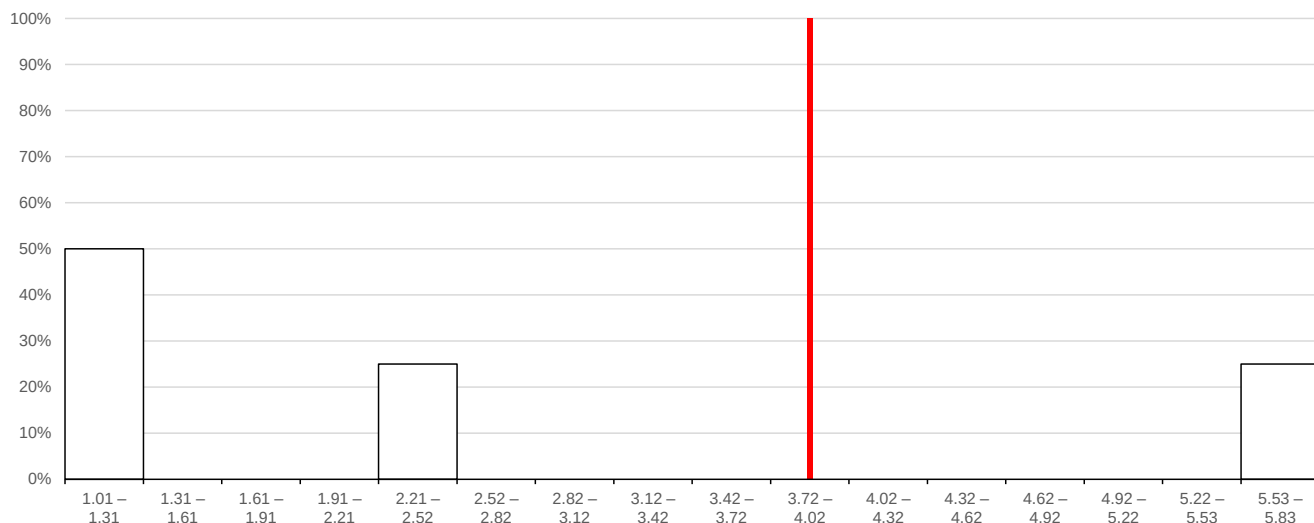
SUTCLIFFE INVESTIGATIONS

TEL: 0151 227 3155

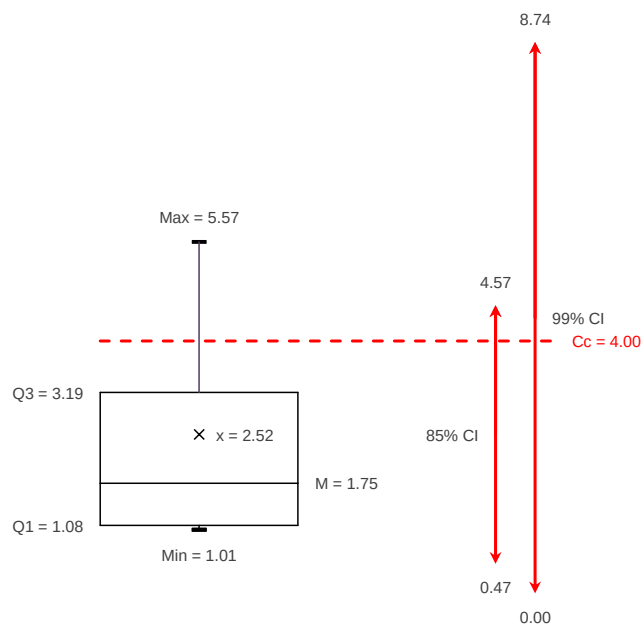
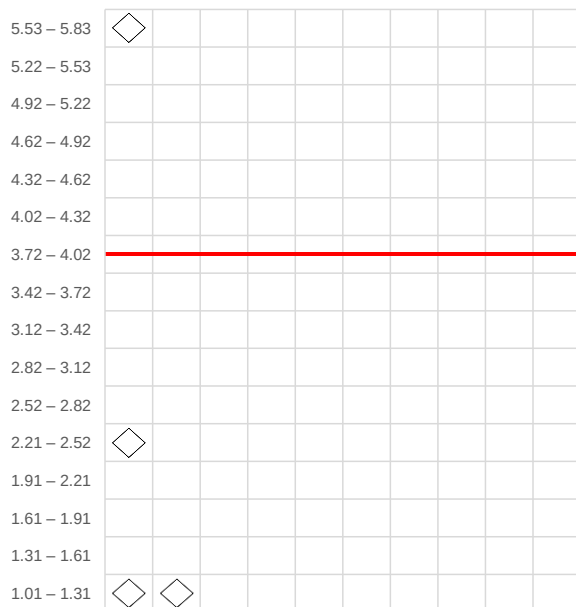
FAX: 0151 227 3156

Statistical Analysis (2-Way Confidence Intervals)

Job Name:	Woodbine Street	Job No.:	31163LG
Proposed Land Use:	Residential Without Plant Uptake	No. of Samples:	4
Contaminant:	benzo(b)fluoranthene	No. of Bin:	15
Data Type:	Symmetric	% Confidence Interval:	85% CI
Non-detect Rule:	No Non-detects		99% CI



Maximum (Max):	5.57	Critical Concentration (Cc):	4.00
Upper Quartile (Q3):	3.19	Mean (x):	2.52
Median (M):	1.75	Range (R):	4.56
Lower Quartile (Q1):	1.08	Standard Deviation (s):	2.13
Minimum (Min):	1.01	Interquartile Range (IQR):	2.11
85% CI	0.47	99% CI	0.00
	4.57		8.74



Summary

Sutcliffe are 85% confident that the true mean concentration (μ) for benzo(b)fluoranthene lies between 0.47mg/kg and 4.57mg/kg.
 Sutcliffe are 99% confident that the true mean concentration (μ) for benzo(b)fluoranthene does not lie outside of 0.00mg/kg and 8.74mg/kg.
 The Critical Concentration (Cc) for benzo(b)fluoranthene under a 6.0% S.O.M. Residential Without Plant Uptake end use is 4.00mg/kg.



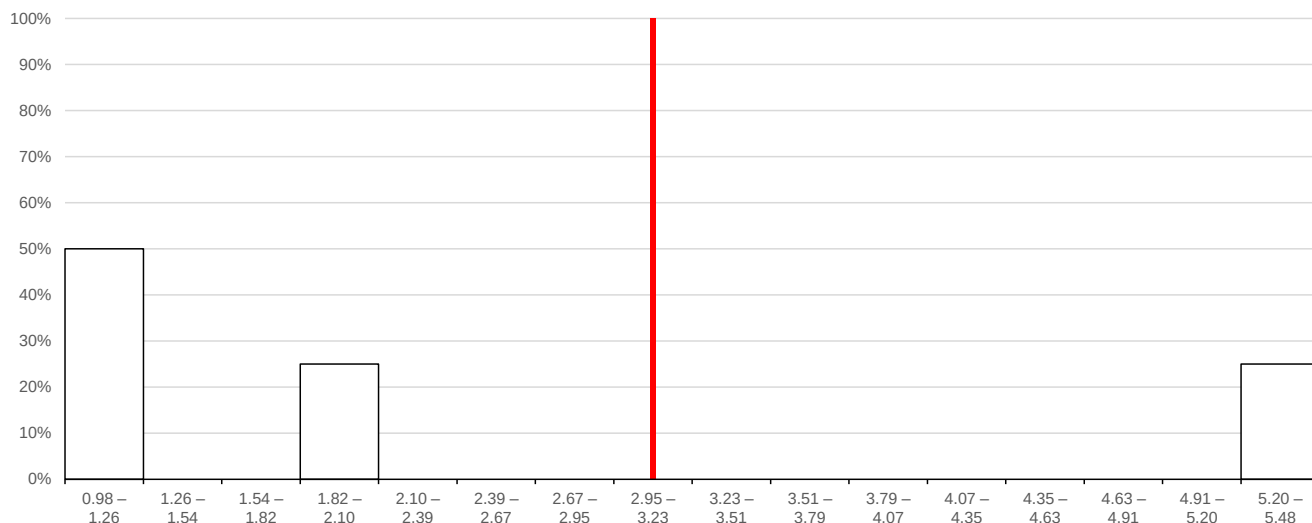
SUTCLIFFE INVESTIGATIONS

TEL: 0151 227 3155

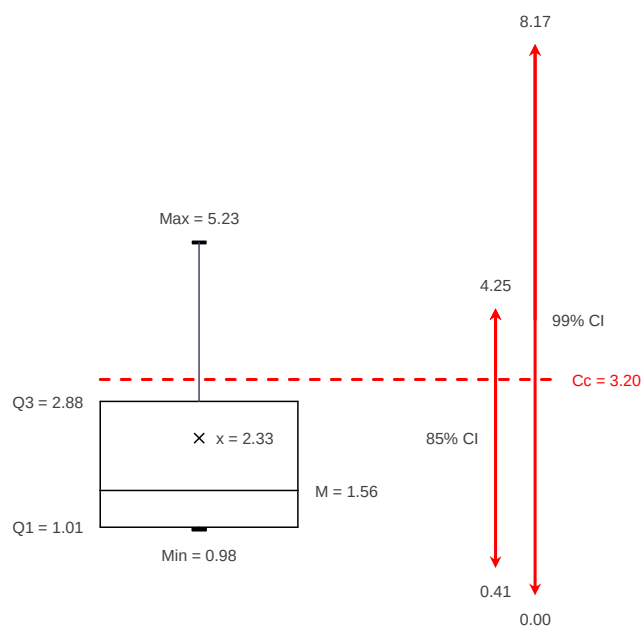
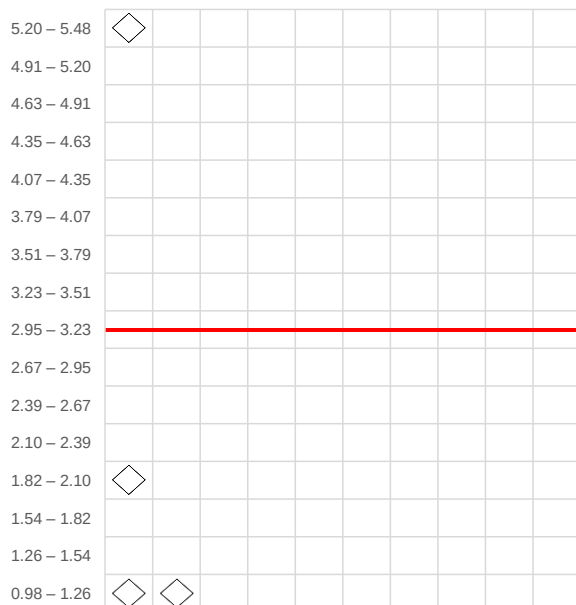
FAX: 0151 227 3156

Statistical Analysis (2-Way Confidence Intervals)

Job Name:	Woodbine Street	Job No.:	31163LG
Proposed Land Use:	Residential Without Plant Uptake	No. of Samples:	4
Contaminant:	benzo(a)pyrene	No. of Bin:	15
Data Type:	Symmetric	% Confidence Interval:	85% CI
Non-detect Rule:	No Non-detects		99% CI



Maximum (Max):	5.23	Critical Concentration (Cc):	3.20
Upper Quartile (Q3):	2.88	Mean (x):	2.33
Median (M):	1.56	Range (R):	4.25
Lower Quartile (Q1):	1.01	Standard Deviation (s):	2.00
Minimum (Min):	0.98	Interquartile Range (IQR):	1.87
85% CI	0.41	99% CI	0.00
	4.25		8.17



Summary

Sutcliffe are 85% confident that the true mean concentration (μ) for benzo(a)pyrene lies between 0.41mg/kg and 4.25mg/kg.

Sutcliffe are 99% confident that the true mean concentration (μ) for benzo(a)pyrene does not lie outside of 0.00mg/kg and 8.17mg/kg.

The Critical Concentration (Cc) for benzo(a)pyrene under a 6.0% S.O.M. Residential Without Plant Uptake end use is 3.20mg/kg.



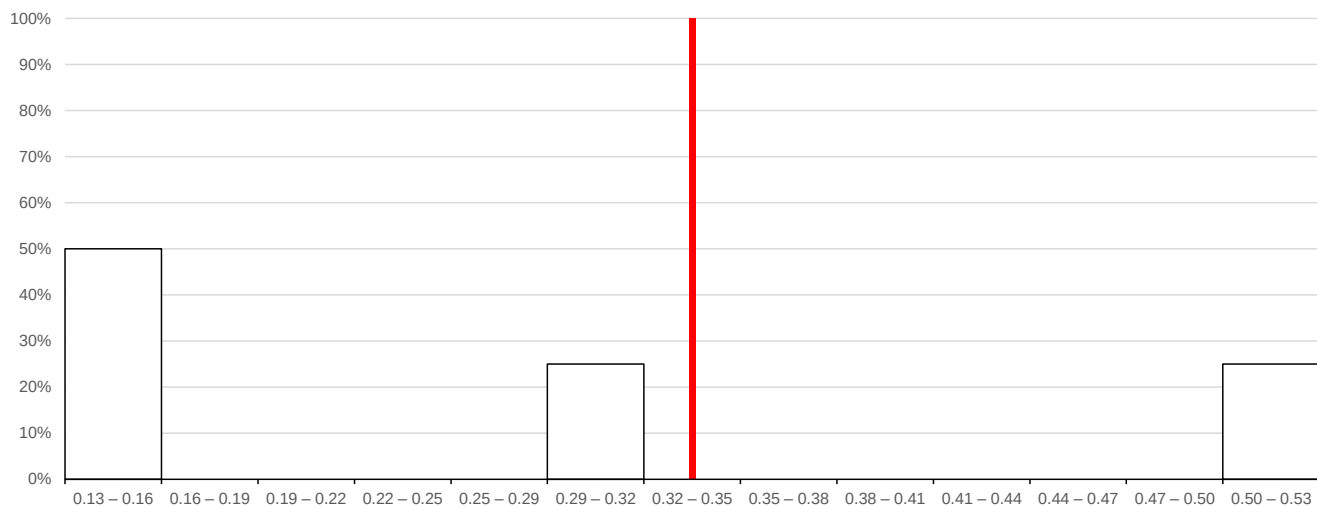
SUTCLIFFE INVESTIGATIONS

TEL: 0151 227 3155

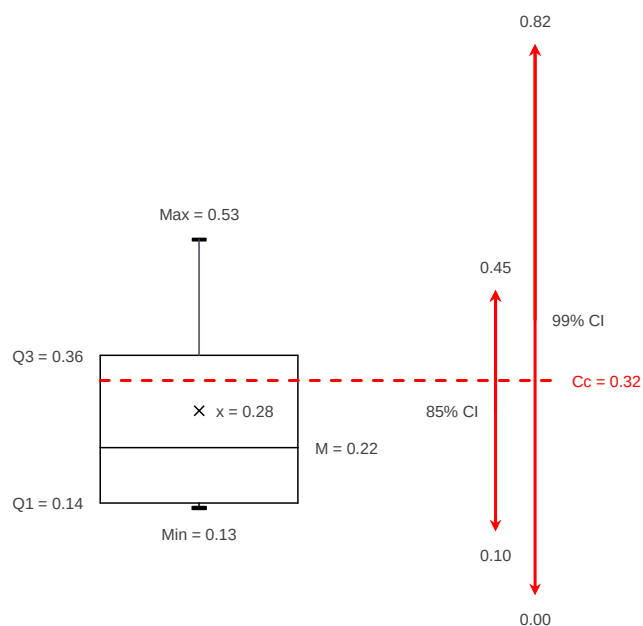
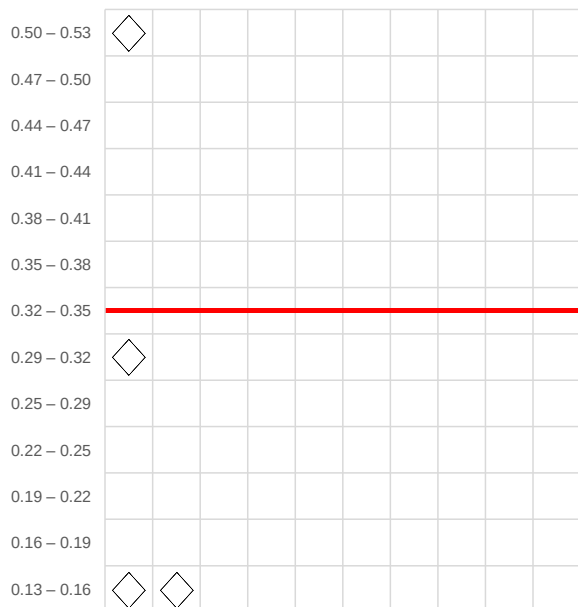
FAX: 0151 227 3156

Statistical Analysis (2-Way Confidence Intervals)

Job Name:	Woodbine Street	Job No.:	31163LG
Proposed Land Use:	Residential Without Plant Uptake	No. of Samples:	4
Contaminant:	dibenzo(ah)anthracene	No. of Bin:	15
Data Type:	Symmetric	% Confidence Interval:	85% CI
Non-detect Rule:	No Non-detects		99% CI



Maximum (Max):	0.53	Critical Concentration (Cc):	0.32
Upper Quartile (Q3):	0.36	Mean (x):	0.28
Median (M):	0.22	Range (R):	0.40
Lower Quartile (Q1):	0.14	Standard Deviation (s):	0.19
Minimum (Min):	0.13	Interquartile Range (IQR):	0.22
85% CI	0.10	99% CI	0.00
	0.45		0.82



Summary

Sutcliffe are 85% confident that the true mean concentration (μ) for dibenzo(ah)anthracene lies between 0.10mg/kg and 0.45mg/kg.

Sutcliffe are 99% confident that the true mean concentration (μ) for dibenzo(ah)anthracene does not lie outside of 0.00mg/kg and 0.82mg/kg.

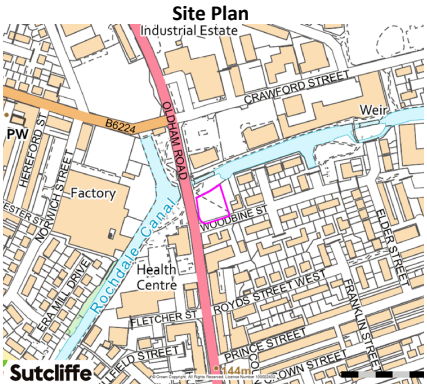
The Critical Concentration (Cc) for dibenzo(ah)anthracene under a 6.0% S.O.M. Residential Without Plant Uptake end use is 0.32mg/kg.

	SUTCLIFFE INVESTIGATIONS		Controlled Waters Assessment			
	TEL: 0151 227 3155					
	FAX: 0151 227 3156					
Job Name:	Woodbine Street		Job No.:	31163LG		
Above EQS Threshold:			Sample ID:		WS101	WS102
Above UK DWS Threshold:						
Above all Thresholds:			Depth Top:		0.10	0.10
Below Limit of Detection:		<0.01	Depth Base:		0.50	0.50
Not tested:		n/t	Date Sampled:		28-Apr-22	28-Apr-22
Contaminant Leachate Prep (10:1 Std NRA)*		Units	EQS Threshold	UK DWS Threshold	WS101	WS102
Metals / Non-Metals / Other Suite	Arsenic (Soluble)*	µg/l	50	10	73	<1
	Boron (Soluble)	µg/l	1000	1000	<20	<10
	Cadmium (Soluble)	µg/l	0.45 - 1.5	5	<2	<1
	Chromium Trivalent (Soluble)	µg/l	4.7	50	<0.05	<0.05
	Chromium Hexavalent (Soluble)	µg/l	3.4	50	<0.05	<0.05
	Copper (Soluble)	µg/l	1	2000	248	7
	Lead (Soluble)	µg/l	14	10	1610	13
	Mercury (Soluble)	µg/l	0.07	1	<0.2	<0.1
	Nickel (Soluble)	µg/l	34	20	33	1
	Selenium (Soluble)*	µg/l	-	10	4	<1
	Sulphur (Free)	mg/l	-	-	<0.1	<0.1
	Zinc (Soluble)	µg/l	10.9	5000	135	7
	Cyanide (Total)*	mg/l	1	50	<0.005	<0.005
	Phenols (Total)	µg/l	7.7	-	<0.01	<0.01
	Sulphate as SO ₃	mg/l	400	250	1.78	4.55
	Sulphide as S	µg/l	0.25	-	<0.1	<0.1
pH	pH units	-	-	6.94	7.56	
TPH Total C6-C40 (leachable)			-	-	120	<80
PAH Suite	naphthalene*	µg/l	130	-	0.03	0.06
	acenaphthylene*	µg/l	-	-	<0.02	<0.01
	acenaphthene*	µg/l	-	-	<0.02	0.03
	fluorene*	µg/l	-	-	<0.02	<0.01
	phenanthrene*	µg/l	-	-	0.06	0.04
	anthracene*	µg/l	0.1	-	<0.02	<0.01
	fluoranthene*	µg/l	0.12	-	0.05	0.03
	pyrene*	µg/l	-	-	0.05	0.02
	benzo(a)anthracene*	µg/l	-	-	<0.02	<0.01
	chrysene*	µg/l	-	-	<0.02	<0.01
	benzo(b)fluoranthene*	µg/l	0.017	-	<0.02	<0.01
	benzo(k)fluoranthene*	µg/l	0.017	-	<0.02	<0.01
	benzo(a)pyrene*	µg/l	0.27	0.01	<0.02	<0.01
	dibenzo(ah)anthracene*	µg/l	-	-	<0.02	<0.01
	benzo(ghi)perylene*	µg/l	0.0082	-	<0.02	<0.01
	indeno(123cd)pyrene*	µg/l	0.002	-	<0.02	<0.01

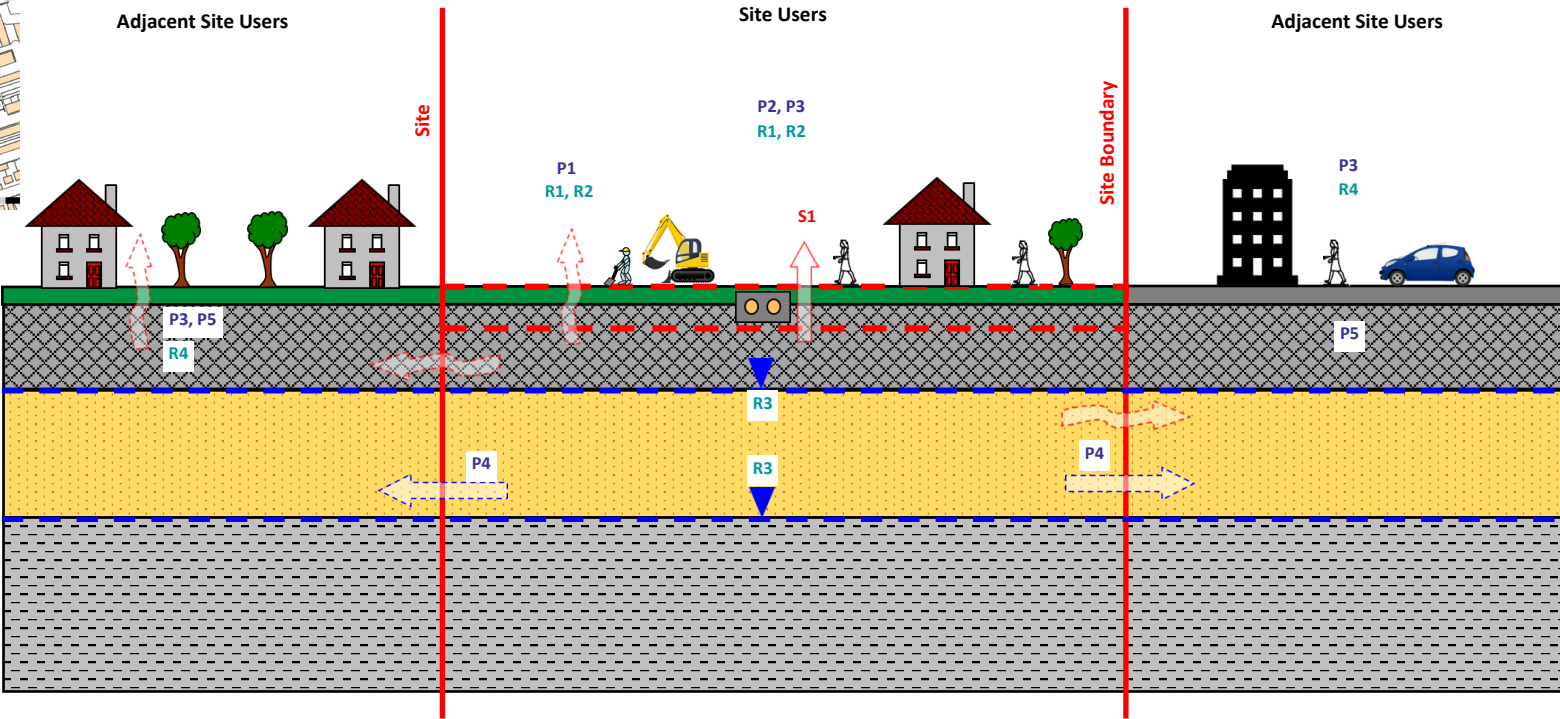
	SUTCLIFFE INVESTIGATIONS			Concrete Classification Assessment	
	TEL: 0151 227 3155				
FAX: 0151 227 3156					
Job Name:		Woodbine Street		Job No.:	31163LG
Max. Water Soluble Sulphate (mg/l):		20		Min. pH:	6.7
Site Class:		Water Table:		Intended Working Life:	
Brownfield		Static		50 Years	
Design Sulphate Class:		ACEC Class:		Design Chemical Class:	
DS-1		AC-1s		DC-1	
Sample ID	Depth Top (m bgl)	Depth Bottom (m bgl)	Date Sampled	Water Soluble Sulphate (mg/l)	pH
WS101	0.10	0.50	28-Apr-22	<10	6.7
WS102	0.10	0.50	28-Apr-22	<10	8.0
WS103	0.20	0.60	28-Apr-22	<10	7.8
BH101	0.20	0.60	03-May-22	20	7.7

Figure 3 – Preliminary Conceptual Site Model

Preliminary Conceptual Site Model (CSM)	
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Stratum	Aquifer
MADE GROUND	N/A
GLACIOFLUVIAL DEPOSITS, DEVENSIAN	SECONDARY A
OLD LAWRENCE ROCK / PENNINE LOWER COAL MEASURES	SECONDARY A



Contamination Source	
S1	Potentially Contaminated Soil—Onsite

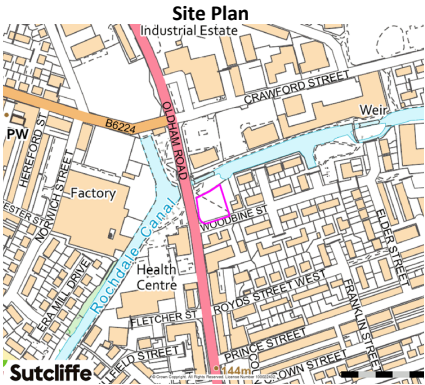
Pathway	
	Direct Contact / Ingestion
	Leachate Migration
	Ground Gas Migration
P1	Direct Contact
P2	Ingestion
P3	Inhalation
P4	Leaching & Migration
P5	Vertical & Lateral migration of Ground Gas

Receptor	
R1	Future Site Users
R2	Construction Workers
R3	Controlled Waters
R4	Adjacent Site Users
R5	Infrastructure & Buried Services

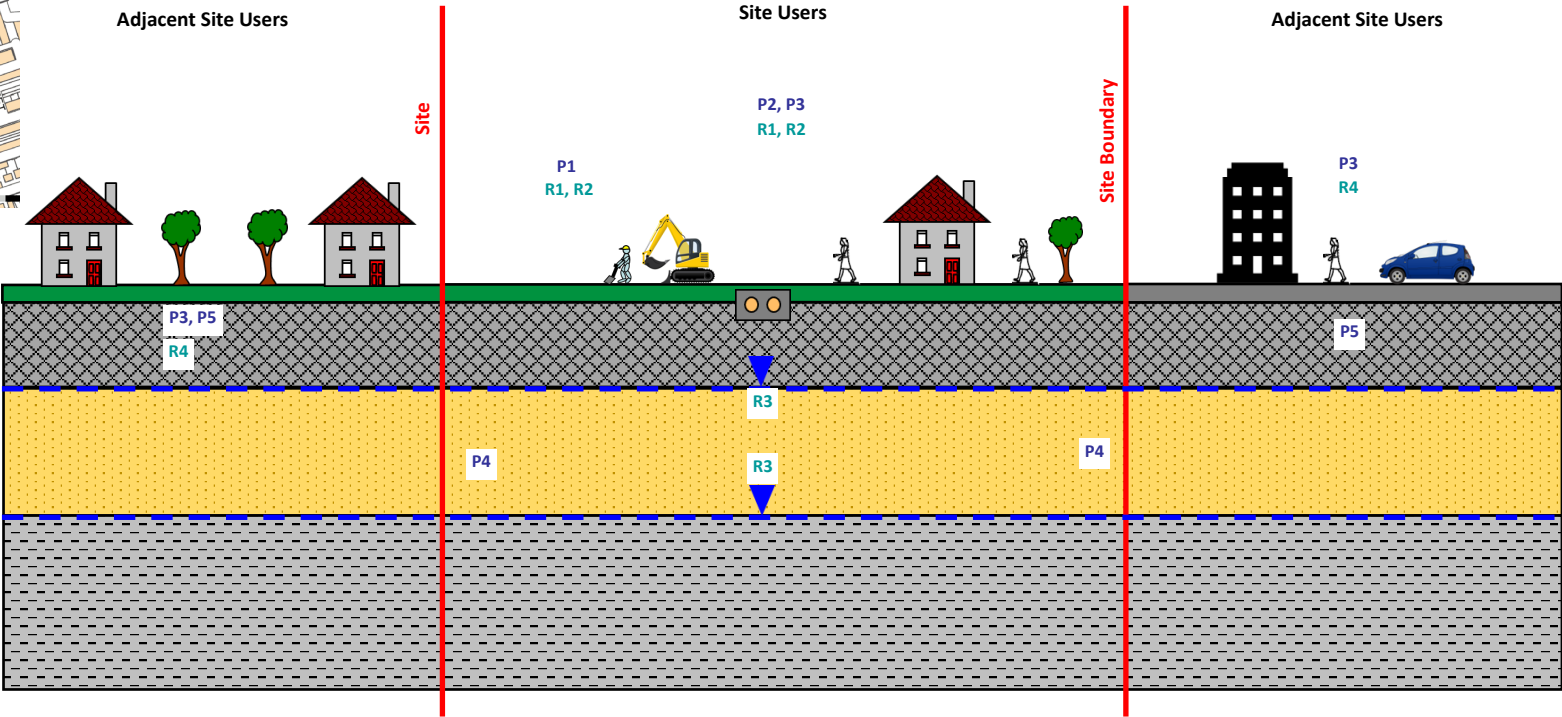
 Sutcliffe	Client: Arcon		
	Project: Woodbine Street, Rochdale		
	Title: Preliminary Conceptual Site Model (CSM)		
	Reference: 31163-SUT-ZZ-00-RP-G-701-0001		
Purpose: Report	Draft	1	Scale (at A3): Not to scale
	Issue	1	
Issuing Office: Liverpool	Drawing number: 1		Version: A
Telephone: 0151 227 3155			

Figure 7 – Revised Conceptual Site Model

Revised Conceptual Site Model (CSM)



Stratum	Aquifer
MADE GROUND	N/A
GLACIOFLUVIAL DEPOSITS, DEVENSIAN	SECONDARY A
OLD LAWRENCE ROCK / PENNINE LOWER COAL MEASURES	SECONDARY A



Contamination Source	
S1	Potentially Contaminated Soil—Onsite

Pathway	
	Direct Contact / Ingestion
	Leachate Migration
	Ground Gas Migration
P1	Direct Contact
P2	Ingestion
P3	Inhalation
P4	Leaching & Migration
P5	Vertical & Lateral migration of Ground Gas

Receptor	
R1	Future Site Users
R2	Construction Workers
R3	Controlled Waters
R4	Adjacent Site Users
R5	Infrastructure & Buried Services

	Client: Arcon		
	Project: Woodbine Street, Rochdale		
	Title: Revised Conceptual Site Model (CSM)		
	Reference: 31163-SUT-ZZ-00-RP-G-701-0001		
Purpose: Report	Draft	1	Scale (at A3): Not to scale
	Issue	1	
Issuing Office: Liverpool	Drawing number: 1		Version: A
Telephone: 0151 227 3155			

Drawing Ref: 31163-SUT-ZZ-00-DR-G-720-0001 (Site Investigation on Existing Layout)

KEY



WINDOW SAMPLING
BOREHOLE LOCATION



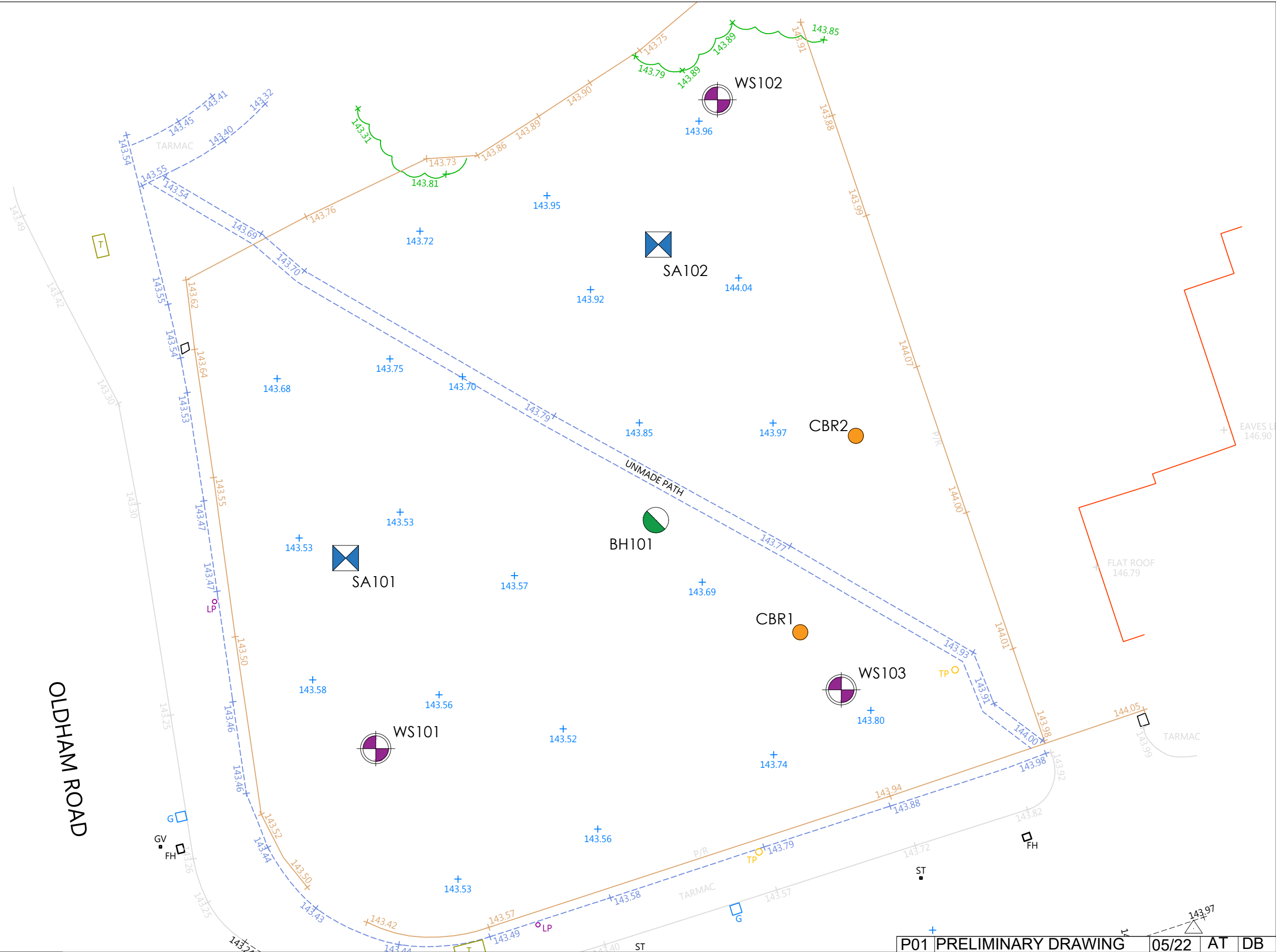
BRE 365 'SOAKAWAY' TEST
LOCATION



LIGHT CABLE PERCUSSION
BOREHOLE LOCATION



CALIFORNIA BEARING
RATIO TEST LOCATION





Sutcliffe

Structural & Civil Engineering

Geotechnical & Environmental Investigations

Building Surveying

Pre Planning Services

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Manchester Office:
0161 817 5180

North Wales Office:
01978 664 071

London Office:
020 8016 4320



Drawing Status

FOR INFORMATION

Client

ARCON HOUSING

Project

WOODBINE STREET
ROCHDALE

Drawing Title

SITE INVESTIGATION LOCATIONS
ON EXISTING PLAN

P01 PRELIMINARY DRAWING		05/22	AT	DB
Rev	Description	Date	By	Chkd
Date MAY 2022		Drawn By A TOSH		Checked By DB
Scale at A3 NTS			Project Number 31163lg	
Sheet Number 31163-SUT-ZZ-00-DR-G-720-0001				Revision P01

Drawing Ref: 31163-SUT-ZZ-00-DR-G-720-0002 (Site Investigation on Proposed Layout)





Structural & Civil Engineering
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Manchester Office:
0161 817 5180

North Wales Office:
01978 664 071

London Office:
020 8016 4320



Drawing Status

FOR INFORMATION

Client

ARCON HOUSING

Project

OLDHAM ROAD WOODBINE STREET
ROCHDALE

Drawing Title

SITE INVESTIGATION LOCATIONS
ON PROPOSED PLAN

P01	SI LOCATIONS	06/22	ED	DB
Rev	Description	Date	By	Chkd
Date	Drawn By	Checked By		
JUNE 2022	E DAVIES	D BOWEN		
Scale at A3 NTS		Project Number 31163LG		
Sheet Number 31163-SUT-ZZ-00-DR-G-720-0002				Revision P01