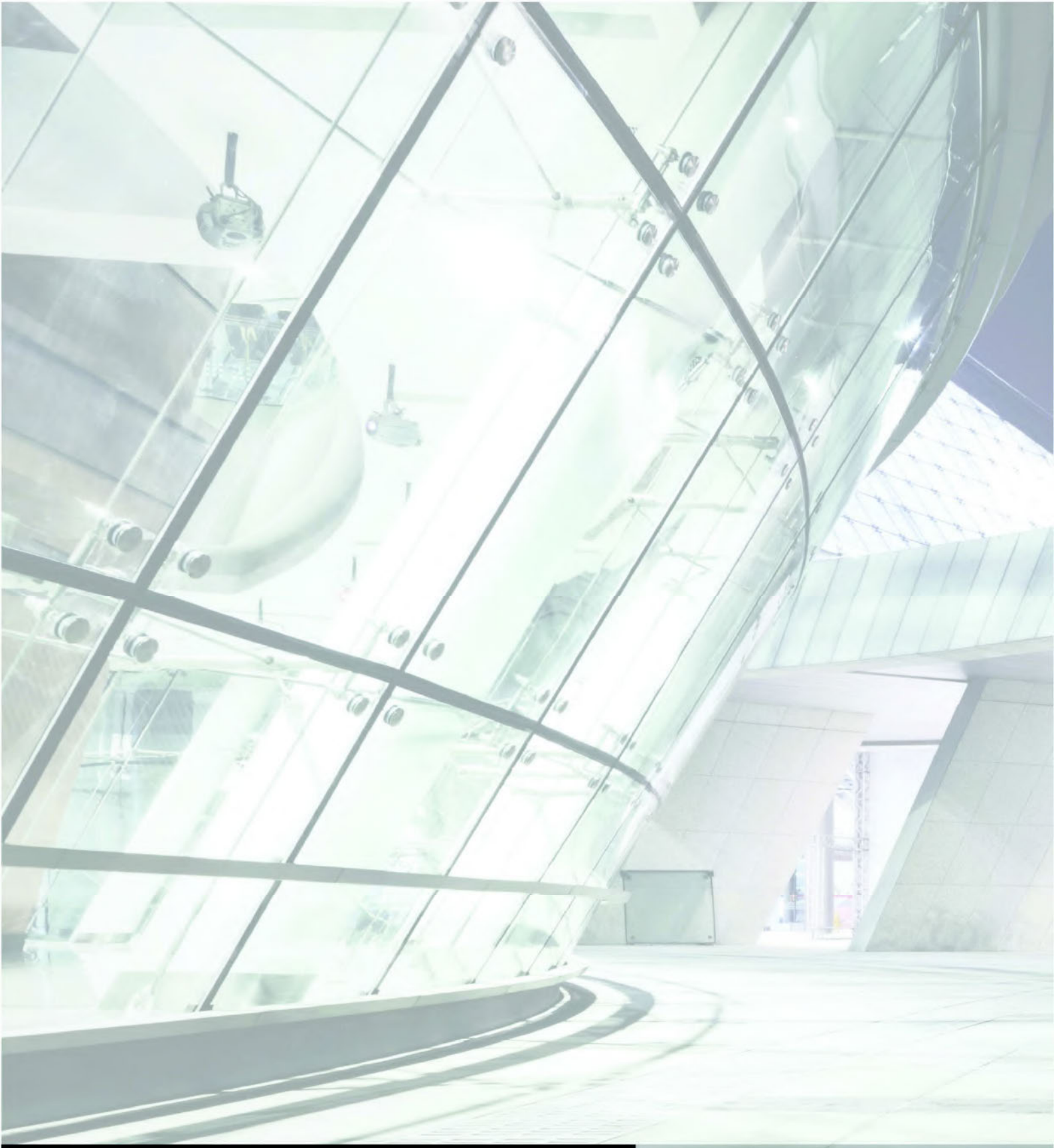

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Job title:	Cherry Tree Surgery
Report type:	Geo-Environmental Appraisal
Prepared for:	A to Z Medical Instruments
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Document Control Form	
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For and Behalf of Groundtech Consulting	

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SUMMARY

Site Details		
Site Location	*The site is located circa 1.73 miles north east of Dewsbury Town Centre and is approximately centred on National Grid Reference 424055, 424379.*	
Site Area	*The site comprises a rectangular area approximately 0.1 hectares in area. The western part of the site comprises a grassed area adjacent to the current surgery building. The eastern area of the site contains the surgery building which is of single storey, sandstone block construction.*	
Preliminary Risk Assessment		
History	*Historically, the site has been developed with residential properties which were demolished.*	
Geology/Hydrogeology	*No superficial deposits are indicated to be present beneath the site.* *The bedrock deposits are indicated to be the Emley Rock Formation comprising sandstone in the northern area and the Pennine Lower Coal Measures Formation (Secondary A Aquifer) which typically consists of mudstone, siltstone, sandstone and coal seams beneath the central and southern parts.*	
Mining	*The Coal Authority report indicates that the property is in an area where there is coal at or close to the surface which may have been worked at some time in the past.* *An area of probable shallow workings is indicated below the site on the Coal Authority Interactive Map which is also designated as a Development High Risk Area.*	
Environmental Setting	*The nearest watercourse is indicated to be the Carlinghow Brook located 183m north east of the site.* *The nearest surface water abstraction is located 1139m of the site and is a historical license.* *The nearest discharge consent is 182m north east of the site associated with sewage discharges.*	
Pollution Linkage (PL) Assessment	**Human Health**	*Low risk as significant contamination not anticipated.*
	Controlled Waters	*Low risk to groundwater as mobile contamination not anticipated.*
	Permanent Ground Gas	*Moderate to high risk as basic radon precautions required.*
Ground Model		
Made Ground Soils	*Made Ground was encountered in all locations to a maximum depth of 1.0m bgl and generally consisted of topsoil or gravel surfacing overlying gravelly sand with brick, plastic and sandstone.*	
Natural Soils	*No superficial deposits were encountered.*	
Bedrock	*Bedrock strata were identified in WS01 to WS03 between depths of 1.0m and 4.45m bgl and typically comprised extremely weak brown and grey residually weathered Mudstone recovered as firm to stiff gravelly clay between 1.0m and 2.0m bgl and a de-structered Mudstone recovered as brown grey clayey gravel between 1.0m and 4.45m bgl.*	

Groundwater	*Groundwater was not encountered during the Ground Investigation.*
	Ground Engineering Assessment
Foundations	*Raft foundations constructed atop of engineered granular material are considered to be the most suitable foundation solution for the proposed extension. A movement joint should be installed between the existing and proposed structures to mitigate differential settlement.*
CMRA	*From the preliminary CMRA, it has been determined that there is a potential risk from unrecorded workings beneath the site from the Flockton Thin Coal. Ground investigation works comprising rotary boreholes are required to determine the presence of any shallow workings beneath the proposed development area and the need for any stabilisation works.*
Highways	*CBR values of 2% to 3% are likely to be achieved in undisturbed natural cohesive soils for pavement design purposes. Untreated Made Ground should be assumed to have a CBR value of less than 2.5%.*
SuDS	*The use of SuDS drainage within the natural ground is not considered to be a feasible option as poor soil infiltration rates have been calculated through the falling head test conducted at the site.*
Constraints	*The main constraint associated with the development is the potential for probable shallow coal mine workings to be present beneath the site within an influencing distance of the surface of the site.* *Small retaining structures are to be incorporated within with proposed development based on the slope present along the western portion of the proposed development area.* *Trees to be removed are present beneath the proposed development area, foundations have been assessed based on the affect on cohesive soils beneath the site from these removed tress.*
	GQRA and Revised (PL) Assessment
Human Health	*Geo-environmental testing has not recorded any elevated Contaminants of Concern based on the site having a commercial end use. Asbestos has been detected in two of the samples of granular Made Ground at a trace concentration of <0.001%.* *The risk to human health is considered to be Moderate to Low as a possible pollution linkage exists in any areas of soft landscaping due to asbestos being detected in the granular Made Ground.*
Controlled Waters	*Mobile contamination has not been encountered and the risk to controlled waters is Low.*
Permanent Ground Gas	*Preliminary gas monitoring results places the site in CS1 and gas protection measures are not considered necessary. The level of precautions will be confirmed on completion of the monitoring. However, the risk is Moderate to High as the site is in an area requiring basic radon precautions.*
	Final Appraisal

The following further work is considered necessary to progress the site to construction phase:

- *Further investigation to assess risk from shallow coal mine workings comprising rotary boreholes .*
- *Obtain BGS Site-Specific Radon Report.*
- *Completion of gas monitoring programme.*
- *Issue gas assessment.*

- *Demolition asbestos survey.*
- *Detailed Remedial Specification.*
- *Detailed foundation design.*
- *Confirmation of the recommendations made within this report with the regulators.*

TABLE OF CONTENTS

Plans

Plan Reference	*Revision*	*Title*
GRO-22384-P01	-	*Project Location Plan*
GRO-22384-P02	-	*Preliminary Development Constraints Plan*
GRO-22384-P03	-	*Illustrative Preliminary CSM*
GRO-22384-P04	-	*Exploratory Hole Location Plan*
GRO-22384-P05	-	*Generalised Ground Model*
GRO-22384-P06	-	*Illustrative Revised CSM*

1.0 INTRODUCTION

1.1 Project Objectives

Groundtech Consulting Limited have been instructed by DYSE Structure Engineers on behalf of A to Z Medical Instruments to undertake a Geo-Environmental Appraisal of a site at Cherry Tree Surgery in Batley.

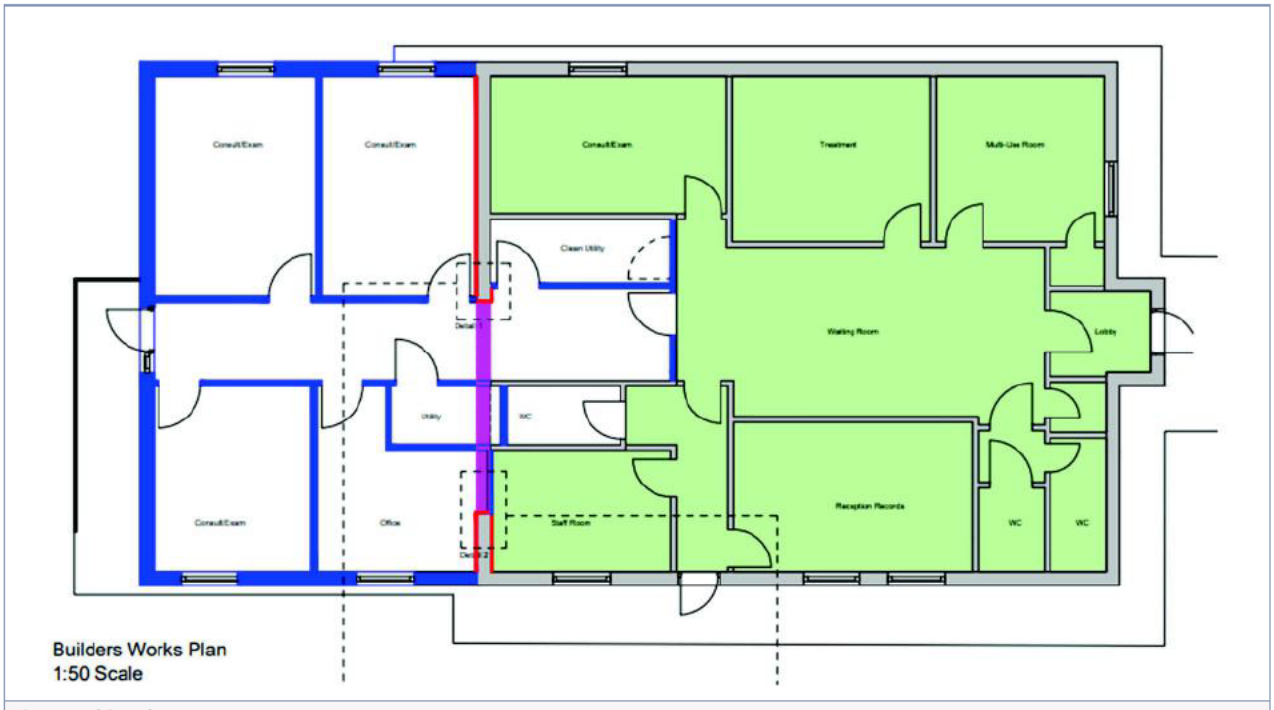
The objectives of the Preliminary Risk Assessment were to establish the sites environmental and geotechnical background in order to generate a Conceptual Site Model to identify any potential constraints and linkages which may affect the redevelopment of the site.

A main investigation was undertaken in accordance with BS 5930:2015, BS 10175:2017, BS 8576:2013 and Eurocode 7 to revise the CSM and quantify the level of risk identified in the PRA. The Appraisal has been prepared in accordance with current UK Legislation and to discharge Land Quality pre-commencement planning conditions.

The report has been undertaken to fulfil the requirements of a preliminary risk assessment in accordance with LCRM "Land Contamination Risk Management".

1.2 Proposed Development

The proposed development is commercial end use comprising a single storey extension of the existing building to the west to include new office and consultant rooms.



Proposed Development

1.3 Limitations

This Preliminary Risk Assessment is based on information obtained from a number of sources, and the information is assumed to be correct.

Other conditions may exist on the site that have not been taken into account in this assessment as they are outside the scope of works. Groundtech Consulting are not responsible for these circumstances that are not outlined in the report.

The assessment has been prepared for the exclusive use of the client. No third parties may rely on or reproduce the contents of the report without the written permission of Groundtech Consulting Limited. If any unauthorised third party comes into possession of the report, they rely on it at their own risk and Groundtech Consulting Limited will not be obliged to provide a duty of care.

2.0 SITE SETTING

2.1 Location

The site is located circa 1.73 miles north east of Dewsbury Town Centre, as shown on the Project Location Plan *GRO-22384-P01* and is approximately centred on National Grid Reference 424055, 424379.

Project Location

Access to the site is gained off Upper Commercial Street to the south.

2.2 Site Description

The site comprises a rectangular area approximately 0.1 hectares in area. The topography of this area is generally level in the east and the site slopes downwards to the west to meet Stocks Lane.

Site Features

The western part of the site comprises a grass surfaced area adjacent to the current surgery building. There are three large semi-mature to mature trees present in this area orientated in a line north to south.

The eastern area of the site contains the surgery building which is of single storey, sandstone block construction. Gravel surfacing is located around the perimeter of the building.

A car parking area is located to the south of the surgery building.

Boundaries and Surrounding Features

No discerning features are present around the boundaries of the site, the extents are formed by pavements to the south and west, a path to the north and the edge of a car park to the east.

The site is surrounded by the following features/land uses:

- *North - Health Centre and car park.*
- *East - A car park, Batley Community Centre followed by commercial properties.*
- *South - Residential and commercial properties.*
- *West - Residential and commercial properties.*

Site photographs are presented in *Appendix 2* and relevant features are recorded on the Preliminary Development Constraints Plan *GRO-22384-P02.*

3.0 ENVIRONMENTAL SETTING

3.1 Site History

Available historical maps have been obtained, a list of dates and scale are listed in the table below:

Scale	Date
1:500	*1890*
1:1,250	*1955, 1956, 1962, 1962/67, 1977/79, 1980, 1985/89, 1992, 1993, 1995, 2003*
1:2,500	*1894, 1907, 1922, 1933, 1956, 1971*
1:10,000/10,560	*1854, 1892, 1905/06, 1931/32, 1938, 1948, 1955/57, 1966/67, 1971/74, 1977/81, 1985/90, 2001, 2010, 2022*

The plans were examined and potential issues have been identified and summarised in the table below:

Date	Site	Surrounding Area
1854	*The site is occupied by buildings across much of the site. Their use is unclear.*	***Mills** are c.100m west, c.200m south east and c.220m north east.*
1890	*No change.*	***Smithy** c.40m south.* ***Woollen Mill** c.50m west.* ***Smithy Mill** c.50m south west with an associated **chimney** c.80m south west.* *Unnamed watercourse c.60m north west.* *Mill Pond c.100m south west.*
1894	*No change.*	***Grave Yard** c.70m north east.* ***Mills** c.210m north west, 200m north east and 250m south.* *Additional Mill Ponds shown c.120m south west, 180m north and 210m north west.* ***Iron Foundry** c.250m south and 250m east.* ***Batley Colliery** c.250m north.*
1907	*No change.*	***Machinery Works** c.240m north.* ***Iron Foundry** c.250m north east.*
1922	*No change.*	***Tanks** c.80m north west, 190m north west and 210m north east.* *The mill ponds are now depicted as reservoirs.*
1933	*Change in layout of buildings.*	***Reservoir** c.100m south west no longer shown, presumably **infilled**.* ***Mill** c.120m north.* ***Tanks** c.150m west and 160m north west.*
1955	*No change.*	***Steel Works** c.40m south.* ***Allotment gardens** c.50m north west.*
1962/67	*No buildings indicated, presumably being **demolished**.*	***Electricity substation** c.40m north west and 180m south east.*
1971/74	*No change.*	***Works** c.150m north.*
1977/79	*Site depicted as a car park with an embankment sloping down to Stock Lane in the west.*	*The reservoirs to the south west are no longer shown, presumably **infilled.***
1993	*No change.*	*Health Centre built to the immediate north.*

2003	*Surgery building constructed on the north eastern area.*	*No significant change.*
2022	*No change.*	*No significant change.*

The historical plans are presented in *Appendix 3.*

3.2 Geology

The following British Geological Survey (BGS) records and other available information were inspected to accurately determine the geology underlying the site:

- *1:50,000 Scale Geological Sheet 77, Huddersfield - Solid and Drift Edition.*
- *Memoir.*
- *BGS Records.*

Made Ground
No Made Ground is shown beneath the site on the available geological plans, however it is anticipated associated with the demolished structures that have been present on the site.

Superficial Deposits
No superficial deposits are indicated to be present beneath the site.

Solid Geology
The bedrock deposits are indicated to be the Emley Rock Formation comprising sandstone within the northern area of the site and the Pennine Lower Coal Measures Formation which typically consists of mudstone, siltstone, sandstone and coal seams beneath the central and southern parts.

Geological Map – Solid Geology

The Flockton Thick coal seam, which is 0.3m to 1.5m in thickness, is shown outcropping beneath the extreme southern part of the site. Based on the age of the strata in the area, the Flockton Thick coal seam dips to the south away from the proposed development area.

The nearest coal outcrop to the north is the Flockton Thin seam at a distance of circa 155m and this seam is likely to dip beneath the development area, a dip angle is not shown on the available geological plan. The seam is indicated to be 0.3m to 1.4m in thickness.

The memoir indicates that Flockton Thin coal seam is a compound seam formed of several layers separated by varying thicknesses of dirt and shale. The Flockton Thin seam has been worked to a considerable extent giving an excellent house coal with little ash. Fireclay is also associated with this seam and is considered to have been extracted.

BGS Records
The nearest BGS record is located circa 40m north of the site and the following ground conditions were encountered:

- *Topsoil - 0.0m to 0.27m bgl.*
- *Clay - 0.27m to 1.20m bgl.*
- *Sandstone - 1.20m to 9.00m bgl.*
- *Loose Material - 9.0m to 10.0m bgl.*
- *Fireclay - 10.0m to 10.6m bgl.*
- *Mudstone - 10.6m to 12.0m bgl.*

The BGS record is presented in *Appendix 4.*

3.3 Hydrogeology

The Pennine Lower Coal Measures Formation bedrock is classified as a Secondary A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

The soils beneath the site are described as being of low leaching potential.

The site is not indicated to lie within 500m of a Source Protection Zone and there are no potable water abstractions within 2000m of the site.

The nearest active groundwater abstraction licence is located 1812m north east associated with a borehole at Howley Hall Golf Club.

3.4 Hydrology

The nearest named watercourse is the Carlinghow Brook located 183m north east of the site.

Environment Agency information indicates that the Risk of Flooding from Rivers and the Sea is negligible.

There are no active surface water abstraction licences within 2000m.

3.5 Environmental Consultations

A request has been submitted to the Contaminated Land Officer at Kirklees Council for information pertaining to the site this information will be forwarded upon receipt.

An environmental consultation has been conducted through Groundsure, which accesses British Geological Survey and Environment Agency databases. The complete Groundsure Report can be found in *Appendix 5,* a summary of the more relevant points are presented in the table below.

Record	<250m	250 – 500m	Description
Authorised Processes	*1*	*4*	*Historical IPC located 436m north associated with dissolved chemicals. Four Part B licences have been present 187m to 394m away. The only current permit is 357m east at Tesco associated with the unloading of fuel.*
Pollution Incidents	*-*	*2*	*One incident 304m west associated with fumes with a category 3 air impact and one incident 440m east associated with petrol with no impact.*
Landfill and Waste Treatment	*4*	*4*	*Former refuse tip 271m north east.* *Historic waste sites 212m north west (ground workings and refuse heap) and 216m north (breakers yard).*
Discharge Consents	*4*	*6*	*Eight consents between 182m north east and 314m east associated with sewer storm overflow and two unspecified consents.*
Petrol Filling Stations	*-*	*2*	*Tesco extra 345m east and a BP 461m east.*
Current Industrial Uses	*18*	*-*	*Electricity substations 53m north west, 167m west, 188m south east and 231m north west.* *Unspecified Works c.87m north west.*

3.6 Radon

In accordance with the latest Radon maps launched by UKHSA in December 2022, the site falls in an area where an estimated 5% to 10% of homes exceed the Radon Action Level. However, the radon data in the Groundsure report is supplied by the BGS/Public Health England and is the definitive map of Radon Affected Areas in Great Britain and Northern Ireland, the Groundsure report indicates the classification of less than 1% on the radon maps. The dataset was created using long-term radon measurements in over 479,000 homes across Great Britain and 23,000 homes across Northern Ireland, combined with geological data. The dataset is considered accurate to 50m to allow for the margin of error in geological lines, and the findings of this report supersede any answer given in the less accurate Indicative Atlas of Radon in Great Britain, which simplifies the data to give the highest risk within any given 1km grid square.

The Groundsure report was commissioned before the new radon map were released. It is recommended that either a site-specific radon search is carried out through the BGS or basic radon precautions are incorporated in the proposed extension.

3.7 Coal Authority Consultation

The site lies in an area where the Law Society and Coal Authority recommends a mining consultation is undertaken due to past or current mining possible affecting the site.

A consultation was carried out with the Coal Authority, which is presented in *Appendix 6*, the main findings are outlined below.

Past Mining
The property is in a surface area that could be affected by underground mining in 1 seam of coal at 100m depth, and last worked in 1890.

Any movement in the ground due to coal mining activity associated with these workings should have stopped by now.

In addition, the property is in an area where the Coal Authority believes there is coal at or close to the surface. This coal may have been worked at some time in the past.

Present Mining
The site is not within the zone of influence of any present underground coal workings.

Future Mining
The property is not in an area where the Coal Authority are determining whether to grant a licence to remove coal by underground workings.

The property is not in an area likely to be affected at the surface by any planned underground workings.

Reserves of coal exist in the local area that may be worked in the future.

No notice of the risk of land being affected by subsidence has been given under section 46 of the Coal Mining Subsidence Act 1991.

Mine Entries
There are no records of any mine entries on or within 20m of site boundary.

Coal Mining Geology
The Authority is not aware of any damage arising due to geological faults or lines of weakness that have been affected by coal mining.

Based on the Coal Authority's knowledge of the mining circumstances at the time of this enquiry, there may be unrecorded mine entries in the local area that do not appear on Coal Authority records.

Opencast Coal Mining
The property is not in an area affected by past or present coal mining extracted by opencast methods. The property is also not in an area affected by a proposed opencast coal mine.

The property is not within 800 metres of the boundary of an opencast site for which a licence to remove coal by opencast methods has been granted.

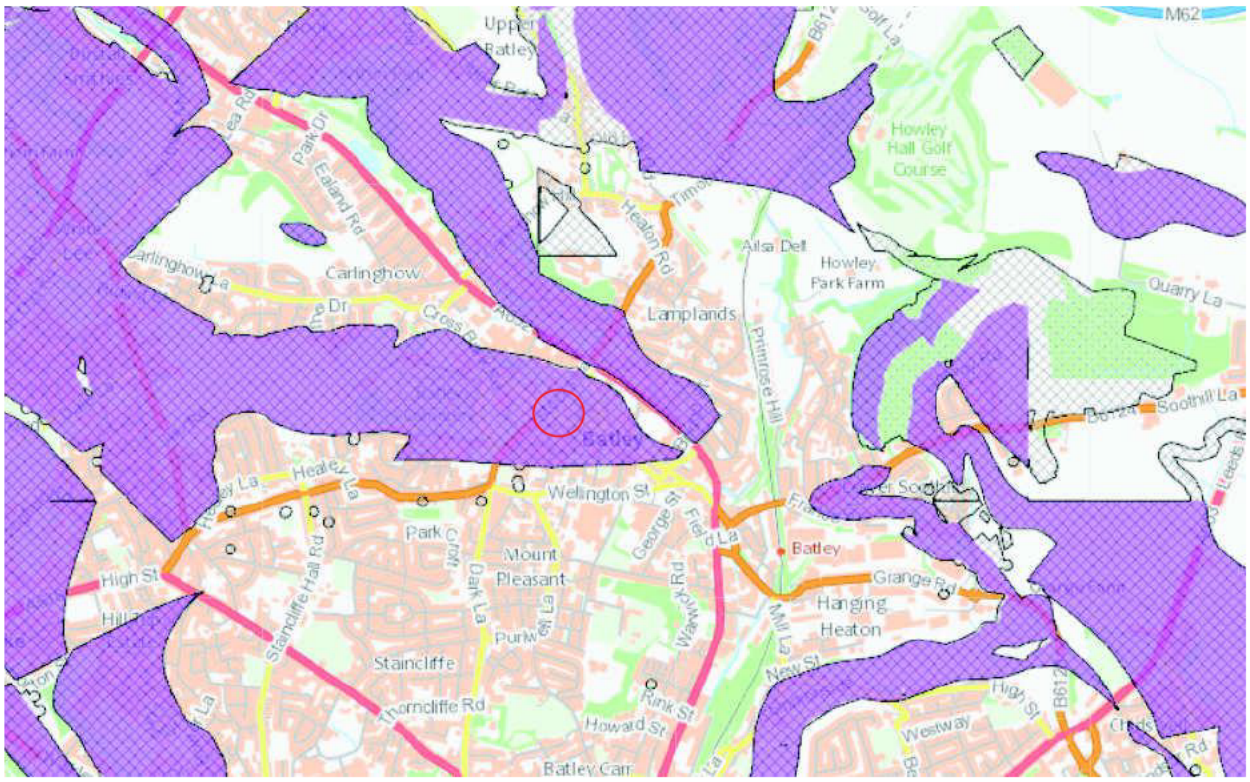
Subsidence
The Coal Authority has not received a damage notice or claim for the subject property or within 50m since 31 October 1994.

Mine Gas
There is no record of mine gas emission requiring action by the Coal Authority within the boundary of the property.

Withdrawal of Support

The property is not in an area which notice of entitlement to withdraw support has been published.

Coal Authority Interactive Map
From the Coal Authority Interactive Map, it can be observed that the site is within a Development High Risk Area due to the risk from probable shallow workings.



Coal Authority Interactive Map

3.8 Preliminary Coal Mining Risk Assessment

The information presented within this Coal Mining Risk Assessment was obtained from a number of sources including:

- *1:50,000 Scale Geological Sheet 77, Huddersfield – Solid and Drift Edition.*
- *Memoir for BGS Sheet 77.*
- *Coal Authority online interactive map.*

Site History
The site has been shown as occupied by buildings across much of the area from 1854, the layout of these buildings changed in 1933 and were later demolished in the 1960s. A car park area was constructed in the late 1970s and later, the current surgery building was constructed by 2003.

Coal Mining Geology and History
The Coal Authority report indicates that the property is in an area where there is coal at or close to the surface which may have been worked at some time in the past.

An area of probable shallow coal mine workings is indicated below the site on the Coal Authority Interactive Map and is therefore designated as a Development High Risk Area.

No superficial deposits are indicated to be present beneath the site. The solid geology is shown to be the Emley Rock Formation comprising sandstone within the northern area of the site and the Pennine Lower Coal Measures Formation which typically consists of mudstone, siltstone, sandstone and coal seams beneath the central and southern parts.

In the extreme southern part of the site, a coal seam outcrops which is inferred as being the Flockton Thick. This seam is indicated as being 0.3m to 1.5m in thickness and, due to the age of the strata in the area, the seam dips to the south away from the proposed development area.

The nearest coal outcrop is the Flockton Thin seam circa 155m to the north and this seam is likely to dip beneath the proposed development area. The seam is indicated to be 0.3m to 1.4m in thickness. The only dip in the area of the site shown on the available geological plans indicates strata dipping at a shallow angle of 3°. If this is the case, the Flockton Thin seam would be circa 8.1m bgl.

Coal Mining Risk Assessment

The Coal Mining Risk Assessment presented in the table below has been compiled to assess the risks associated with historic coal mining based on the information obtained from all sources.

Issue	Site Affected
Recorded Coal Workings	*N*
Recorded Mine Entries	*N*
Unrecorded Coal Workings	*Y*
Unrecorded Mine Entries	*Y*
Coal Mining Geology (fissures)	*N*
Records of mine gas emissions	*N*
Recorded coal mining surface hazard	*N*
Surface mining (opencast workings)	*N*

Recorded Coal Mining

The Coal Authority Report indicates that the shallowest mine workings are 100m below the surface of the site. This is at significant depth and does not pose a risk to the stability of the surface of the site. The thickness of bedrock cover is sufficient to prevent the upward migration of voids to the surface of the site and movement will have stopped since the seam was last worked in 1890. The risk from recorded workings is *negligible*.

Recorded Mine Entries

There are no recorded mine entries onsite or within 20m of the boundary of the site and the risk is *negligible*.

Unrecorded Coal Mining

Probable shallow coal workings are shown to be present beneath the entire site and the surrounding area and the proposed development area of the site is depicted as being in a Development High Risk Area. This is likely related to possible workings in the Flockton Thin Coal which dips beneath the site and will be at a depth of approximately 8.1m bgl below the surface of the bedrock.

The Flockton Thin coal is described as being 0.3m to 1.4m in thickness, there is the potential for there not being ten times the seam thickness of rock cover above the seam. In addition, the BGS memoir indicates

that the Flockton Thin coal seam was worked to a considerable extent giving an excellent house coal with little ash and also for the mining of fireclay within the strata.

The Flockton Thick coal seam is not indicated to be beneath the proposed extension and is not considered to pose a risk to the development.

Based on the above information, there is the potential for unrecorded workings to be present at a shallow depth beneath the proposed development area and therefore the risk from unrecorded mine workings is considered to be *Moderate*.

The previous report determined that no further action is required regarding the presence of unrecorded workings at the site and there is a low risk of this. This report also considers the risk of residual mining to be very low. From the assessment undertaken by Groundtech consulting the risks associated within the previous report are not considered to be accurate.

Further Work

It is therefore recommended that rotary open boreholes are drilled to a minimum depth of 20m bgl to determine if the Flockton Thin coal seam is present and to determine whether it has been worked. The revised Coal Mining Risk Assessment will be produced based on the findings of the intrusive investigation.

4.0 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

4.1 Introduction

The potential level of risk posed by contaminants in soil and/or groundwater will be influenced by the type and concentration of the contamination at source, the likelihood of exposure occurring, the potential pollution linkages and the likely chronic or acute effects on the receptors.

A contaminant is defined as a substance that has the potential to cause harm, a risk is considered to exist if such a substance is present at sufficient concentrations to cause harm and if a pathway is present a receptor could be exposed to the contaminant.

Section 4.0 compiles the information from the previous sections to assemble a Conceptual Site Model to inform the risk assessment process. The potential sources identified on the site and off the site that are within influencing distance are assessed to determine if pollution linkages exist and an unacceptable risk is posed to human health and controlled waters. The assessment has been carried out on a qualitative basis and aims to produce a complete and comprehensive Preliminary Conceptual Site Model, the potential pollution linkages are displayed on *GRO-22384-P03* Illustrative Preliminary CSM.

Three potential types of impacts exist for a site and all three need to be considered in the qualitative preliminary risk assessment:

- *Impacts from sources on the subject site.*
- *Impacts to the surrounding area from the subject site.*
- *Impacts to the subject site from the surrounding area.*

4.2 Potential Contamination Sources

Onsite Sources and Associated Contaminants of Concern (CoC)
From the information obtained during the preliminary risk assessment, there are minimal onsite sources of potential contamination which may affect the redevelopment of the site for commercial end use.

The former developments at the site included residential buildings which were demolished and replaced with a car park and more recently a health centre. Made Ground is therefore likely to be beneath the proposed development area and associated Contaminants of Concern may include heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs), asbestos and permanent ground gases.

The site is indicated to be located in an area of probable coal mine workings therefore, the site may be affected by mine gases. The site is also shown to be in an area requiring basic radon precautions.

Offsite Sources and Associated Contaminants of Concern (CoC)
Several possible offsite sources of contamination have been identified and include the following:

- *Steel works 40m south*
- *Electricity substation 40m north west*
- *Allotment gardens 50m north west*
- *Former woollen mill 50m west*
- *Former smithy mill 50m south west*
- *Grave yard 70m north east*
- *Tanks, the nearest being 80m north west*

- *Infilled ponds/reservoirs, the nearest being c.100m south west*
- *Historic waste site 210m north west*
- *Machine works 240m north*
- *Iron foundries 250m south and 250m east*
- *Colliery 250m north*

The steel works, smithy mill, foundries, machine works and colliery are all forms of industrial land use that are potential sources of heavy metals, speciated PAHs, fuel derived hydrocarbons and asbestos.

The electricity substation is a potential source of Polychlorinated Biphenyls (PCBs) which were used as cooling agents in the transformers.

The allotment gardens are a possible source of herbicides, fertilisers, heavy metals and speciated PAHs.

The DoE profile for Textile Works and Dye Works indicates that potential Contaminants of Concern associated with the woollen mill may include heavy metals, inorganic compounds, chlorinated organic solvents including TCE and PCE, sizing agents, organic compounds, pesticides, asbestos, fuel derived hydrocarbons and ground gases.

The former mill ponds/reservoirs, grave yard and historic waste site are potential sources of permanent ground gases.

The tanks are potential sources of fuel derived hydrocarbons or chemicals dependant on the liquids stored within them.

4.3 Pollution Linkages

The definition of a pollution linkage is a medium which allows a contaminant to impact a receptor. Potential pollution linkages have been recognised for the commercial development from the identified contamination sources that exist.

At this stage, the contaminants identified above are considered to potentially pose an unacceptable risk to human health and controlled waters through the following pollution linkages:

- *Direct soil and dust ingestion.*
- *Dermal contact with soil both indoors and outdoors.*
- *Indoor air inhalation from soil and vapour.*
- *Outdoor inhalation of soil and vapour.*
- *Migration and accumulation of ground gas into internal spaces.*
- *Impaction of groundwater from soil contamination (diffuse and point).*
- *Impaction of groundwater from groundwater plume.*
- *Migration of soil and groundwater contamination impacting surface waters.*

4.4 Receptors

Receptors generally fall into the categories of human health or controlled waters within the river basin system. The recognised receptors are listed below:

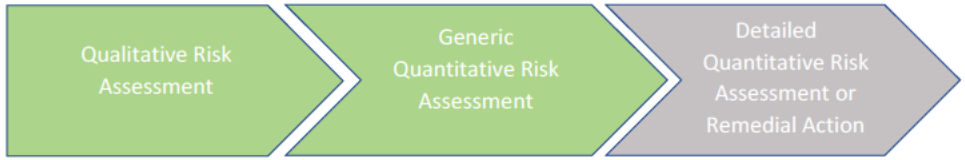
- *Site end users*

- *Underlying Secondary A Aquifer*
- *Carlinghow Brook c.180m north east*
- *Clean potable water supply pipes*

4.5 Preliminary Conceptual Site Model (CSM)

The factual information obtained from the consultations and summarised in Section 2.0 and 3.0 has been used to compile a Preliminary CSM. Using Source-Pathway-Receptor assessment criteria that is applicable in the UK, a risk assessment has been completed to determine if a plausible pollution linkage exists between the identified contaminants and receptors. The risk classification has been estimated in accordance with the CIRIA C552 assessment criteria outlined in *Appendix 7.*

Human Health Pollution Linkage Assessment



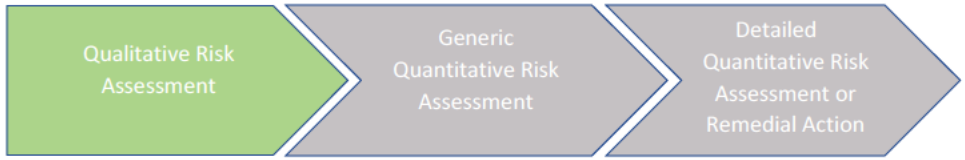
- The table below represents the first stage in the land quality risk assessment process - **the Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					***Qualitative Risk Assessment***	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Unlikely	Medium	Low	*Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site.* *The site is currently utilised as an office/surgery building associated with the adjacent health centre. The proposed development area is soft landscaped at present.* *Made Ground is likely to be present beneath the site due to the previous buildings onsite which were demolished. Therefore, heavy metals, speciated PAHs and asbestos may be present in the underlying Made Ground soils.* *Several potential sources of contamination have been identified in the general area of the site, however significant mobile contamination is not likely to be associated with these features. In addition, where cohesive Lower Pennine Coal Measures strata are present, this will have prevented the lateral migration of potential contaminants onto the subject site.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
						The proposed development is to construct an extension to the existing surgery building to the west. The proposed development area will therefore be covered with hardsurfacing breaking the pathway to proposed site end users. *Therefore, a viable pollution linkage is not considered to exist.*
PL2	Contaminated Soils	Inhalation of vapour.	Unlikely	Medium to Severe	Low	*This pollution linkage refers to volatile vapours migrating into confined spaces within the proposed development. Based on the history of the site, volatile contamination is unlikely present beneath the site and a has not been identified. Therefore, a realistic pollution linkage has not been recognised.*
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	*Pollution Linkage 3 relates to contamination on the subject site affecting adjacent site users. Significant sources of mobile contamination have not been identified on the site and more impactful sources of contamination surround the site. Therefore, no pollution linkage is considered to exist.*
PL4	Contaminated Soils	Attacking potable water supply pipe.	Unlikely	Medium	Low	*Pollution Linkage 4 refers to the possible contaminants permeating potable water pipes and consumption by the future site end users of the tainted water supply. Made Ground is potentially present at water pipe installation depth. However, it is likely that existing water supply pipes will be used to feed the proposed extension and a pollution linkage is not considered to exist.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Likely	Medium to Severe	Moderate to High	*The site was formerly occupied by a number of buildings which were subsequently demolished, there is the potential for deep Made Ground to be present beneath the proposed development area.* *The site is also shown to be in an area of probable shallow coal mine workings and mine gas could potentially affect the development.* *Potential offsite sources of permanent ground gases include a grave yard, infilled ponds/reservoirs and a historic waste site.* *The site is also in an area requiring basic radon measures in foundations.* *As possible onsite and offsite sources of ground gases have been identified, and the site requires radon precautions, a realistic pollution linkage has been identified.*

Controlled Waters Pollution Linkage Assessment



- The table below represents the first stage in the land quality risk assessment process – **Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Unlikely	Medium	Low	*Made Ground deposits are likely to be present beneath the proposed development area associated with the former buildings that were located on the site which have been demolished. However, significant mobile contamination is not anticipated.* *Geological maps indicate that the site is underlain by the Emley Rock Formation in the extreme north and the Pennine Lower Coal Measures Formation in beneath the remaining areas. The bedrock is classified as a Secondary A Aquifer.* *The site is not within 500m of a SPZ therefore, the groundwater is not considered to be a sensitive resource. In addition, there are no potable water abstractions within 2000m of the site.* *Furthermore, the hardsurfacing of the proposed development will increase and will considerably reduce infiltration and leaching of potential contaminants.* *Therefore, no plausible pollution linkage is considered to exist.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	*Pollution Linkage 7 refers to the impaction of Carlinghow Brook 183m north east of the site from contaminated soils and groundwater.* *A source of mobile contamination has not been identified and more impactful sources have been identified offsite. A realistic pollution linkage has not been identified.*

5.0 SCOPE OF INVESTIGATION AND RATIONALE

5.1 Project Objectives

The aim of the fieldwork was to:

Determine the stratification beneath the site.
Maintain a watching brief for visual and olfactory evidence of contamination.
Obtain samples using methodology in current guidance for contamination analysis.
Identify realistic pollution linkages to groundwater.
Obtain relevant geotechnical parameters for preliminary foundation design to address both ULS and SLS conditions.
Determine soil infiltration rates.
Determine if targeted supplementary investigation in areas of concern is required and for remedial design.
Install monitoring standpipes for gas and groundwater monitoring.
Assess the identified pollution linkages in the CSM.

5.2 Scope of Works

The following scope of works was completed on the 21st November 2022:

- *Three windowless sample boreholes (WS01 to WS03) were drilled to depths between 2.45m and 4.45m bgl using a Dando Terrier rig.*
- *A falling head test was conducted within WS01 to determine soil infiltration rates.*
- *Three hand excavated trial pits (HP01 to HP03) were excavated to depths of between 0.25m and 0.4m bgl to determine the geometrics of the existing foundations beneath the surgery building.*

The exploratory hole locations are presented on Groundtech Plan *GRO-22384-P04* and the logs are in *Appendix 8.*

The exploratory holes were positioned to establish the stratification beneath the site and target any areas of concern as summarised in the table below:

Location	Target Rationale
WS01 to WS03	*Footprint of the proposed extension* *Former construction*
HP01 to HP03	*Existing foundations of the surgery building*

The exploratory holes were logged by a suitably experienced geo-environmental engineer in general accordance with the following current guidance:

- *BS 5930 'Code of Practice for Site Investigations' 2015.*
- *BS EN 14688-1:2002 'Geotechnical Investigation and Testing – Identification and classification of soil'.*
- *BS EN ISO 14689:2002 'Geotechnical investigation and testing – Identification and classification of rock'.*

5.3 Soil Sampling

During the intrusive investigation, representative samples were taken at regular intervals, changes of strata and where evidence of contamination existed. Laboratory analysis was scheduled on the samples obtained.

The samples obtained are summarised in the table below:

Soil Sample	Number
Environmental Sample	*7*
Disturbed Sample	*7*

The samples have been obtained in accordance with current environmental and geotechnical guidance. The sampling plan has been designed to obtain samples from all required strata using the correct methodology.

Disturbed samples of soil for geo-environmental testing were placed in the correct sampling containers as required by the laboratory in accordance with their MCERTS and UKAS Accreditation. Transportation was arranged in a timely manner and the samples were at the correct temperature.

The sample locations and depths are recorded on the exploratory logs.

5.4 Geo-Environmental Testing

To inform the Generic Quantitative Risk Assessment, the following geo-environmental testing was scheduled to assess the risk from contamination on the site. The testing is based on the potential sources identified in the PRA and observations made during the Ground Investigation.

Contaminants of Concern	Matrix	Number
Arsenic, Cadmium, Chromium (total and hex), Copper, Nickel, Mercury, Lead, Zinc, Selenium, Organic Matter, Sulphate and pH value.	*Soil*	*6*
Speciated Polycyclic Aromatic Hydrocarbons (PAHs)	*Soil*	*6*
Asbestos Screening	*Soil*	*6*
Asbestos Quantification	*Soil*	*2*

The Geo-Environmental Laboratory Testing Results are presented in *Appendix 9*.

Representative disturbed samples were obtained for all soil types encountered. Selected samples were scheduled for testing at an approved laboratory in accordance with BS 1377 'Method of Test for Soils for Civil Engineering Purposes' 1990. The following tests were scheduled:

British Standard	Test Method	Number
Part 2	*Water Content*	*3*
Part 2	*Plasticity Index Analysis*	*3*
Part 3	*SD1 BRE Full Suite*	*3*

The Geotechnical Laboratory Testing Results are also presented in *Appendix 10.*

5.5 Gas and Groundwater Monitoring

Gas and groundwater monitoring installations were constructed in the boreholes. The standpipes consisted of polyvinyl chloride (PVC) pipe - a bentonite seal was placed around the plain pipe and a clean gravel pack was placed around the slotted pipe. A summary of the installation construction is presented in the table below:

Location	Depth (m bgl)	Response Zone (m bgl)	Targeted Strata	Reason
WS01	*4.0*	*1.0 – 4.0*	*Mudstone*	*Ground Gas*
WS02	*3.0*	*1.0 – 3.0*	*Mudstone*	*Ground Gas*
WS03	*3.0*	*1.0 – 3.0*	*Mudstone*	*Ground Gas*

Permanent gas and flow rate monitoring was carried out using a GFM 436 infrared gas monitor with integral electronic flow analyser. The measurements taken are listed below:

- *Oxygen (O_2), carbon dioxide (CO_2) and methane (CH_4) as the percentage volume in air (%v/v).*
- *Hydrogen sulphide (H_2S) and carbon monoxide (CO) as the percentage volume in air (%v/v).*
- *Lower Explosive Limit (%LEL) of methane.*
- *Atmospheric and borehole pressure, including pressure trend.*
- *Flow measurements (l/hr).*
- *Weather and ground surface conditions.*

Both peak and steady state conditions were monitored to understand the behaviour of the permanent ground gas, the steady state conditions were recorded by allowing the gas monitor to run for a minimum of 3 minutes.

Interim permanent gas and groundwater monitoring results are presented in *Appendix 11*.

6.0 GROUND MODEL

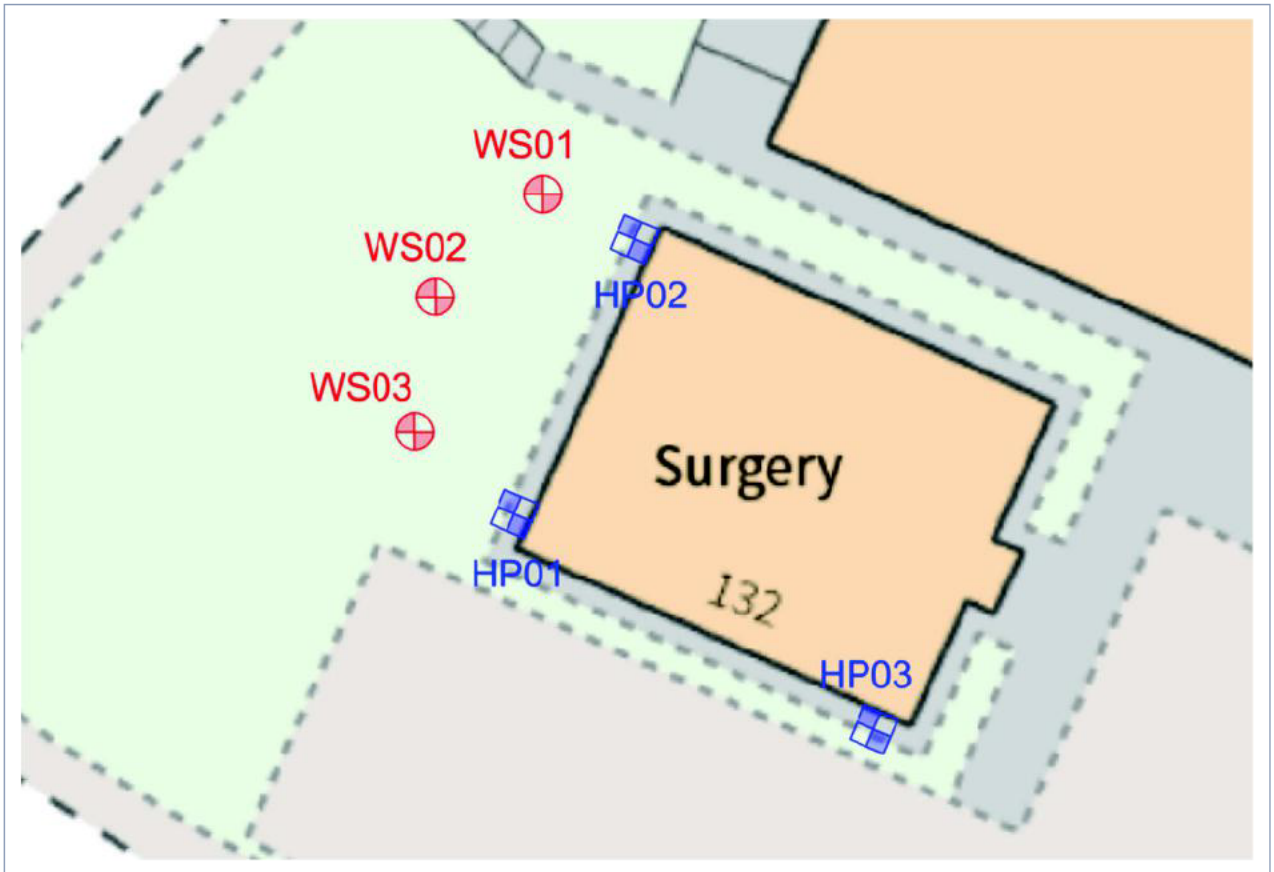
6.1 Made Ground

Made Ground was encountered in all locations at the site to a maximum depth of 1.0m bgl.

In WS01 to WS03, topsoil was encountered from ground level to a maximum depth of 0.3m bgl, gravel surfacing was present in HP01 to HP03 to a maximum depth of 0.1m bgl.

One main Made Ground population was encountered during the investigation and is described below:

- *Dark brown and orange brown gravelly sand with brick, plastic and sandstone was present in all of the exploratory holes to a maximum depth of 1.0m bgl.*



Exploratory Hole Locations

6.2 Natural Ground

No superficial deposits were encountered beneath the site.

6.3 Bedrock

Bedrock strata were identified in WS01 to WS03 between depths of 1.0m and 4.45m bgl and typically comprised extremely weak brown and grey residually weathered Mudstone recovered as firm to stiff gravelly clay between 1.0m and 2.0m bgl and a de-structered Mudstone recovered as brown grey clayey gravel between 1.0m and 4.45m bgl.

No coal was encountered in any of the exploratory holes.

6.4 Groundwater

Groundwater was not encountered during the Ground Investigation.

6.5 Watching Brief

A watching brief was maintained during the investigation, no visual and olfactory evidence of contamination was noted.

6.6 Excavation Stability

No evidence of spalling or collapse was noted during excavation of the hand dug trial pits.

6.7 Excavation Progress

Slow progress while excavating the hand excavated trial pits was not experienced.

Advancement of the boreholes became difficult from 2.0m bgl where the bedrock was encountered.

7.0 GROUND ENGINEERING

7.1 Geotechnical Testing Results

Comparison of water content and the value of 0.4 times the Liquid Limit in accordance with BRE Digest 412 'Desiccation in Clay Soils' suggests significant desiccation has taken place when 0.4 times the Liquid Limit is greater than the actual water measured water content. This is a rudimentary method but also a good guide.

Results of the plasticity testing and the volume change potential of the Clay is summarised in the table below:

Reference	Depth (m)	Modified PI	Volume Change Potential	Desiccated Y/N
WS01	*1.5*	*27.8*	*Medium*	*N*
WS01	*3.1*	*35.5*	*Medium*	*Y*
WS02	*1.5*	*38.4*	*Medium*	*Y*

7.2 Existing Foundations

Three foundation pits (HP01 to HP03) were excavated adjacent to the surgery building to determine the geometrics of the existing foundations. Cross sections of the foundation excavations are presented in *Appendix 12.*

A shallow foundation, possibly a raft, was encountered in each of the hand dug trial pits. The depth to the top of the footings was between 0.08m and 0.2m bgl and the foundations stepped out from the wall by 0.05m to 0.17m. The base of the footing was encountered between 0.16m and 0.3m bgl.

7.3 Assessment Background

The ground engineering investigation has been undertaken to formulate an accurate ground model in order to undertake preliminary foundation design. The ground model has been constructed with a moderate to high level of confidence and has evolved from the information obtained by the PRA.

The proposed development is commercial end use comprising the construction of a single storey extension to the west of the existing building. At this stage, loadings associated with the proposed development are not available and the following recommendations are based on existing site levels. Site levels slope downwards towards Stocks Lane and stability of this slope should be taken into account.

Boreholes advanced in the area of the proposed footprint indicate that Made Ground is present to a maximum depth of 1.0m bgl and is underlain by extremely weak Mudstone to depth of up to 4.45m bgl. The mudstone was recovered as clayey gravel or firm to stiff gravelly Clay. No groundwater was encountered during the Ground Investigation.

Enabling works are to be undertaken at the site to remove trees located within the development area and to generate a level working platform to construct the proposed development. The topsoil should be stripped and stockpiled separately, and the surplus removed offsite.

From the preliminary CMRA, it has been determined that there is a potential risk from unrecorded workings beneath the site from the Flockton Thin and Thick seams. Ground investigation works comprising rotary boreholes to determine if any shallow workings are present beneath the proposed development area and the need for any stabilisation works. Existing foundations associated with the current building potentially

comprise of a raft foundation which has likely been implemented due to the potential risk of unrecorded coal workings.

7.4 Geotechnical Parameters

The geotechnical test results have been evaluated to derive geotechnical parameters for the soils underlying the site. A '*Depth to SPT N value*' graph is presented on Plan *GRO-22384-P05* in *Appendix 13* to provide a generalised ground model for the site.

Characterisation of the geotechnical parameters above has been undertaken to select a characteristic value, which is a cautious estimate of the value affecting the occurrence of the limit state. The characteristic values for the Ultimate Limit State (ULS) conditions selected are presented in the table below:

Stratum	Parameter	Selected Characteristic Value
Residually weathered Mudstone recovered as firm to stiff clay	*Undrained shear strength (C_u)*	*85kN/m²*
De-structured Mustone recovered as clayey gravel	*Drained angle of friction (ϕ')*	*39°*

From empirical data and published values, a magnitude of consolidation (m_v) of 0.175m²/MN has been selected for the residually weathered Mudstone bedrock.

7.5 Preliminary Foundation Design

The most suitable foundation solution for the proposed extension is considered to be a reinforced raft cast within reengineered granular materials. The residually weathered cohesive Mudstone deposits should be excavated from beneath the proposed extension to where the Mudstone becomes destructed and gravelly at circa 2m bgl. The cohesive soils should be replaced with reengineered granular materials built up in compacted layers.

The current building at the site is anticipated to have been constructed on a raft foundation due to the potential unrecorded workings beneath the site and so the proposed development should be constructed using the same foundation solution and foundations should be tied into the existing ones.

Foundations for the proposed extension should be designed such that they do not undermine the existing foundations.

The engineered granular materials should be constructed and tested to provide a safe allowable bearing capacity of 150kN/m². As the proposed foundations will be cast on top of granular material, immediate settlement will occur however a movement joint should still be installed between the existing and proposed structures to mitigate differential settlement/movement between the new and old structures. The angle of distortion between the structures should be taken into consideration by the structural design.

Alternative Mini Pile Solution

Due to the slope present at the site and the need to remove cohesive soils present, a mini pile foundation solution may be preferable for the proposed extension. Mini Piles driven to circa 4m to 5m bgl will transfer loads through the Made Ground and cohesive deposits to found within the destructured Mudstone deposits at depth. Pile caps and a reinforced ring beam should be constructed to span between piles to support loadings from walls. At this stage, the loadings are not available for the proposed development.

Lateral support by the variable Made Ground needs to be considered in the design. If concrete piles do not offer the lateral support required, steel piles should be considered.

Piled Solution – Design by Calculation
Preliminary design by calculation has been carried out using due skill and care using the global factor of safety method for pile design. The preliminary design by calculation is based on the following ground model:

- *Made Ground to 1.0m*
- *Residually weathered cohesive mudstone to 2.0m*
- *Destructured Granular Mudstone to 4.0m*

For a single pile 225mm in diameter end bearing in the destructured granular mudstone at circa 4.0m bgl, an allowable load of 85kN has been calculated. If greater loads are required, the diameter of the piles should be increased and/or the piles installed in groups. This should be considered once the site layout and loadings are confirmed.

The ground conditions and the below ground construction indicate downdrag is unlikely to be an issue and has not been taken into consideration in the preliminary design.

It is recommended that the piles are bottom driven to limit vibrations which could affect the adjacent buildings.

Construction Recommendations
The recommendations in this appraisal are preliminary and the detailed design should be developed in advance and during the construction phase. If the ground conditions or groundwater regime encountered during the construction phase differ significantly to the conditions encountered during the Ground Investigation, work should cease and Groundtech Consulting contacted for further advice.

During the construction phase, supervision by a suitably qualified geotechnical engineer should be on a continuous basis to check the design assumptions are correct and construction conforms to design in accordance with EC7. Supervision should include inspections, Control Ground Investigations and monitoring by a suitably qualified geotechnical engineer.

7.6 Building Near Trees

Trees are located adjacent to the proposed development area, these are indicated to be mature in age and will require removal as part of the enabling works. Foundation excavations will not encounter cohesive strata as these are to be excavated out and replaced with an engineered granular fill negating the effects of building near trees.

7.7 Floor Slabs

The raft foundation should be designed to incorporate basic radon precautions.

7.8 Construction

The boreholes indicate that instability of excavations is not anticipated provided they are not exposed to adverse weather conditions for any substantial period of time. Instability of the Made Ground is a possibility and should be considered in the groundworks method statements.

Tracked high specification plant is recommended to maintain the build programme.

Groundwater is not expected to be encountered in foundation excavations.

7.9 Concrete Classification

Made Ground
Water soluble sulphate testing was undertaken on five samples of the Made Ground. The range of soluble sulphate (SO_4) recorded is 19.2mg/l to 87.1mg/l and associated pH values ranged between 7.7 and 8.1 indicating slightly alkaline conditions.

In a dataset where there are five to nine results, the mean of the highest two sulphate results should be taken together with the mean of the lowest two pH values. The characteristic sulphate concentration is therefore 74.35mg/l and the pH value is 7.7.

Natural Strata
Water soluble sulphate testing was undertaken on three samples of the natural strata. The range of soluble sulphate (SO_4) recorded is 66.6mg/l to 136mg/l and associated pH values ranged between 7.8 and 7.9 indicating slightly alkaline conditions.

In a dataset where there are less than five results, the highest sulphate result should be taken together with the lowest pH values. The characteristic sulphate concentration is therefore 136mg/l and the pH value is 7.8.

The groundwater at the site is considered to be static as natural cohesive deposits have been encountered.

The results of laboratory pH and sulphate content indicate that ACEC Class AC-1s and sulphate class DS-1 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005. The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site-specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

Pyrite Potential
Three samples on natural strata were tested for their pyrite potential.

The amount of oxidisable sulphides (OS as % SO_4) in the suspected pyritic ground is determined by subtracting the acid soluble sulphates (AS % SO_4) from the total potential sulphate content:

$$OS\ \%\ SO_4 = TPS\ \%\ SO_4 - AS\ \%\ SO_4$$

If the value of oxidisable sulphides is greater than 0.3% SO_4 in a significant number of samples, pyrite is probably present. The amount of oxidizable sulphides was less than 0.3% SO_4 in all three samples tested therefore, the potential for pyrite is not considered to be present.

7.10 Pavement Design

CBR values of 2% to 3% are likely to be achieved in undisturbed natural cohesive soils for pavement design purposes, unless proven otherwise by in-situ testing at sub-base level by a specialist geotechnical engineer. As a minimum, the subgrade should be proof rolled prior to construction.

Untreated Made Ground should be assumed to have a CBR value of less than 2.5%, unless proven otherwise. Highways Agency document HD25 'Interim Advice Note 73/06 Revision 1' (2009) states that where a subgrade has a CBR value lower than 2.5%, it is considered unsuitable support for a pavement foundation since it would tend to deform under construction traffic and must be improved.

The soils are considered to be frost susceptible due to the fines content and pavement construction should be a minimum thickness of 450mm to mitigate the risk.

7.11 Falling Head Test

One falling head test was carried out in WS01 at a depth of 3.0m bgl. During the drilling of the borehole, the borehole was filled with water to ground level and the depth of water within the borehole was recorded at regular intervals over a 60-minute period.

The test was conducted within natural cohesive Mudstone located beneath the central part of the proposed development area. The Made Ground deposits were cased off to 1.0m bgl to ensure that the drainage measured was representative of the strata targeted.

The water level dropped from ground level to 0.23m bgl over the 60 minute period and a soil infiltration rate of 6.31×10^{-8} m/s was determined within the underlying natural Mudstone. The use of SuDS drainage within the natural ground is therefore not considered to be feasible at the site based on the falling head test result.

The falling head test results are presented in *Appendix 14.*

7.12 Retaining Structures/Slope

A retaining wall is indicated to be present in the proposed development along the western wall which supports a proposed stairway/ramp that adjoins the existing pathways to a new doorway exit on the western wall.

The proposed retaining wall will be of a low level with a metal railing on top and so it is anticipated that a small scale Gabion or Masonry designed wall will be suitable for this proposed structure and these should be designed to resist earth pressures applied by soils.

For design parameters, the Angle of Internal Friction (ϕ') value of the retained soils will be dependent on the depth and engineering properties of the soils being retained, a *85kN/m²*has been selected for the natural Sandstone. No SPT N Value is available for the shallow Made Ground materials and a ϕ' of 25° should be assumed unless proven otherwise.

8.0 LAND QUALITY

8.1 Geo-Environmental Testing Results - Soils

Samples of Made Ground have been tested for a range of relevant Contaminants of Concern. In accordance with LCRM, a Generic Quantitative Risk Assessment (GQRA) has been undertaken to determine the significance of the concentrations as derived through Geo-Environmental analysis.

The GQRA process comprises the comparison of the actual concentrations measured on site with Generic Assessment Criteria (GACs) for the protection of human health.

The GACs used for the assessment of soil concentrations have been derived using the CLEA model. The GACs used and their ranking of importance are listed below:

- *Soil Guideline Values (SGVs) which demonstrate minimal risk.*
- *LQM/CIEH S4ULs which use the same toxicological data as the SGVs but different exposure criteria.*
- *C4SLs which demonstrate low risk.*

In deriving the GACs for use on Brownfield sites, we have assumed a 1% Soil Organic Matter unless the results indicate otherwise.

The proposed end-use for the site is a commercial development comprising an extension to the existing surgery building. We have therefore undertaken the GQRA on the basis that the proposed development site falls under the Commercial land-use scenario as defined in SR3 (EA, 2009b).

The strata or sources of contamination targeted by the laboratory testing scheduled is summarised in the table below:

Strata	Number of Samples Tested	Locations
Granular Made Ground (Population 1)	*4*	*WS02, WS03, HP01 to HP03*
Topsoil Made Ground (Population 2)	*4*	*WS01*

A summary of the Geo-Environmental Testing results is presented below and the GQRA Screening Values are presented in *Appendix 15*:

Metals				
Contaminant	Range (mg/kg)	Screening Values	Exceedances	Locations
Arsenic	*24 – 42*	*640*	-	-
Cadmium	*<0.2*	*230*	-	-
Chromium	*22 - 38*	*8600*	-	-
Hexavalent Chromium	*<1.8*	*49*	-	-
Copper	*73 – 350*	*68000*	-	-
Lead	*83 – 130*	*2300*	-	-
Mercury	*<0.3*	*26*	-	-
Nickel	*24 – 36*	*980*	-	-
Selenium	*<1.0*	*13000*	-	-
Zinc	*140 – 260*	*730000*	-	-

Polycyclic Aromatic Hydrocarbons (PAHs)				
Contaminant	Range (mg/kg)	Screening Values	Exceedances	Locations
Naphthalene	*0.69 – 3.20*	*190*	-	-
Acenaphthylene	*<0.05 – 0.14*	*83000*	-	-
Acenaphthene	*0.28 – 1.60*	*84000*	-	-
Fluorene	*0.16 – 1.10*	*63000*	-	-
Phenanthrene	*1.90 – 8.80*	*22000*	-	-
Anthracene	*0.32 – 1.60*	*520000*	-	-
Fluoranthene	*2.70 – 10.00*	*23000*	-	-
Pyrene	*2.50 – 8.50*	*54000*	-	-
Benzo(a)anthracene	*1.30 – 4.40*	*170*	-	-
Chrysene	*1.40 – 4.10*	*350*	-	-
Benzo(b)fluoranthene	*1.30– 4.10*	*44*	-	-
Benzo(k)fluoranthene	*0.65 – 1.40*	*1200*	-	-
Benzo(a)pyrene	*1.20 – 3.50*	*35*	-	-
Indeno(123cd)pyrene	*0.54 – 1.40*	*500*	-	-
Dibenzo(ah)anthracene	*0.14 – 0.40*	*3.5*	-	-
Benzo(ghi)perylene	*0.67 – 1.80*	*3900*	-	-
Others				
Organic Matter		*2.9 – 5.4%*		
Asbestos Screen				
Position	Depth (m bgl)	Result		
WS01	*0.15*	*None detected*		
WS02	*0.50*	*None detected*		
WS03	*0.50*	*Chrysotile Loose Fibres - <0.001%*		
HP01	*0.10*	*Crocidolite Loose Fibres - <0.001%*		
HP02	*0.15*	*None detected*		
HP03	*0.50*	*None detected*		

8.2 Generic Quantitative Risk Assessment - Soils

Made Ground has been encountered across the proposed development area to a maximum depth of 1.0m bgl and generally consisted of reworked topsoil or gravel over gravelly sand.

No visual or olfactory evidence of contamination was noted in the soils recovered.

Metals
Based on the site being developed commercially, no elevated concentrations of metals have been identified.

Speciated Polycyclic Aromatic Hydrocarbons (PAHs)
Using the commercial screening values, no elevated concentrations of speciated PAHs have been recorded.

Asbestos
Asbestos was detected in two samples of the granular Made Ground that were screened and comprised Chrysotile at <0.001% in WS03 at 0.5m bgl and Crocidolite at <0.001% in HP01 at 0.1m bgl.

No asbestos was detected in the other four samples of Made Ground that were screened.

8.3 Permanent Ground Gases

One gas monitoring visit has been undertaken to date and a further three are scheduled.

No concentrations of methane (CH_4) have been recorded in the boreholes, levels of carbon dioxide (CO_2) were recorded up to a maximum level of 1.7% v/v together with associated slightly depleted oxygen (O_2) concentrations (minimum of 19.1% v/v).

In addition, no positive gas flow rates have been detected during the monitoring visit.

The atmospheric pressure was 1013mb to 1014mb and the monitoring was completed during a period of steady barometric pressure.

Groundwater was not present within the standpipes.

Characterisation of the Gas Screening Value (GSV)

Based upon the results recorded to date, in accordance with CIRIA Report C665, the risk to the site from ground gases has been assessed by converting the results to gas screening values (GSVs), calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates. In addition, individual "hazardous gas flow rates" (Qhg) have been derived for each monitoring point. As no levels of methane have been recorded, a GSV for carbon dioxide only has been calculated.

GSV (l/hr) = max borehole flow rate (l/hr) x max gas concentration (%)

For this interim assessment, the maximum recorded concentration of carbon dioxide of 1.7% v/v has been used. No positive gas flow rates have been detected therefore, the limit of detection of the gas analyser of 0.1 l/hr has been used to calculate the GSV - this is worst case scenario.

Carbon Dioxide GSV = 0.017 (1.7%) x 0.1 = 0.0017 l/hr

In order to assess the ground gas regime beneath the site and the need to incorporate ground gas precautions, guidance was taken from CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings'. Based on the site being developed for a commercial end use, the Wilson and Card method has been used to carry out the assessment.

When considering the results in accordance with CIRIA C665 (Section A Development and Table 8.5 – Modified Wilson and Card Classification) it can be seen that the GSV values for carbon dioxide are below the assessment GSV of 0.07 l/hr and falls within Characteristic Situation 1 therefore, gas protection measures are not required.

Characteristic Situation 1

The proposed development is classified as a Building Type C in accordance with BS 8485:2015 and the site falls in CS1 in accordance with Table 2 of the above guidance and no gas protection measures are required.

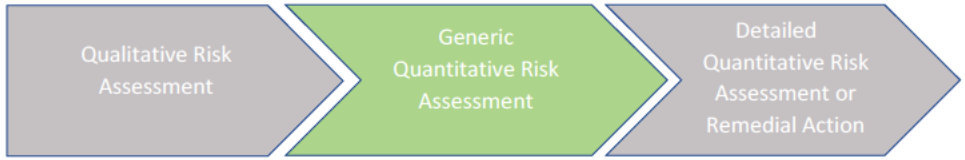
The above recommendations will be confirmed on completion of the monitoring. However, as a minimum, any gas protection measures included in the existing surgery building should be carried on through into the proposed extension.

Radon
The site is located in an area requiring Basic Radon protective measures.

8.4 Revised Pollution Linkage Assessment

A revised pollution linkage assessment has been undertaken based on the findings of the Ground Investigation and testing to identify any realistic pollution linkages in order to quantify the risks to human health and controlled waters. An Illustrative Revised CSM is presented on Plan *GRO-22384-P06*.

Human Health Pollution Linkage Assessment



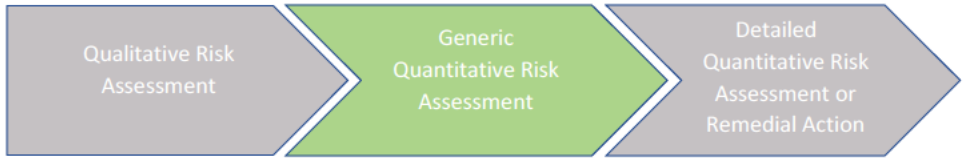
- The table below represents the second stage in the land quality risk assessment process - **the Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Generic Quantitative Risk Assessment*	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Unlikely to Low Likelihood	Medium	Moderate to Low	*Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site.* *The site is currently used as an office/surgery building and is surrounded by car parking areas and soft landscaping.* *Made Ground is present beneath the site to a maximum depth of 1.0m bgl. Geo-environmental testing indicates that there are no elevated concentrations of metals or PAHs based on the site having a commercial end use. However, asbestos was detected in two samples of the granular Made Ground soils at trace concentrations of <0.001% and the combined hazard, exposure and receptor ranking is Low using the JWIG receptor tool.* *It is proposed to construct an extension to the west of the existing surgery building.*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
						Where the site is covered with hardsurfacing, there is not considered to be a viable pollution linkage. However, a possible pollution linkage exists in any areas of soft landscaping as asbestos has been detected in the granular Made Ground soils.
PL2	Contaminated Soils	Inhalation of vapour.	Unlikely	Medium to Severe	Low	*This pollution linkage refers to volatile vapours migrating into confined spaces within the proposed development. A source of volatiles has not been identified and a pollution linkage has not been identified.*
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	*Pollution Linkage 3 relates to contamination on the subject site affecting adjacent site users. Mobile contamination has not been identified beneath the site, a plausible pollution linkage has not been determined.*
PL4	Contaminated Soils	Attacking potable water supply pipe.	Unlikely	Medium	Low	*Pollution Linkage 4 refers to the possible contaminants permeating potable water pipes and consumption by the future site end users of the tainted water supply. Made ground is present beneath the site to a maximum depth of 1.0m bgl however, no organic contamination has been identified.* *It is likely that existing water supply pipes will be used to feed the extension, therefore a pollution linkage has not been identified.*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Likely	Medium to Severe	Moderate to High	*Made Ground is present beneath the site to a maximum depth of 1.0m bgl. Preliminary gas monitoring has indicated that the site is classified as CS1 and gas protection measures are unlikely to be required. As a minimum, any gas precautions within the existing building will need to be continued through into the proposed extension.* *This will be confirmed upon the completion of the gas monitoring programme.* *However, the site is within an area requiring basic radon precautions within foundations.*

Controlled Waters Pollution Linkage Assessment



- The table below represents the second stage in the land quality risk assessment process – **Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Unlikely	Medium	Low	*Made Ground deposits are present across the site to a maximum depth of 1.0m bgl, no mobile contamination has been encountered.* *Geological maps indicate that the site is underlain by the Emley Rock Sandstone Formation in the north and the Pennine Lower Coal Measures deposits are beneath the remaining areas. The bedrock is classified as a Secondary A Aquifer.* *The site is not within 500m of a SPZ and there are no potable water abstractions within 2000m of the site.* *The Ground Investigation indicates the site is underlain by residually weathered Mudstone which will have restricted the downward migration of any potential contamination.* *As a source of mobile contamination has not been identified, a pollution linkage is not considered to exist.*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	*Pollution Linkage 7 refers to the impaction of Carlinghow Brook 183m north east of the site from contaminated soils and groundwater.* *A source of mobile contamination has not been encountered and a plausible pollution linkage does not exist.*

8.5 Outline Remedial Strategy

Soils

The geo-environmental testing has not highlighted any elevated concentrations of CoC in the Made Ground beneath the site. Asbestos fibres were detected in two samples of the Made Ground taken from WS03 and HP01 and have been quantified at trace concentrations of less than 0.001%.

Where the site is underlain by hardsurfacing, this will effectively act as a cover system and remediation will not be required.

However, where any minimal areas of soft landscaping will be present within the final development, a cover system will be required comprising 600mm of clean topsoil/subsoil underlain by a contamination demarcation barrier.

Any imported soils will need to be tested to ensure they are suitably clean for the proposed commercial end use and the thickness of the cover system should be validated.

Controlled Waters

Mobile contamination has not been encountered and remediation in relation to controlled waters not required.

Ground Gases

Initial ground gas monitoring indicates that the site is within the CS1 and gas protection measures will not be necessary. This will be confirmed on completion of the monitoring. The site is in an area requiring Radon protection measures.

Watching Brief and Regulatory Compliance

A watching brief should be in place during ground works and construction. If previously unidentified contamination is encountered, work should cease in that area and Groundtech Consulting contacted for advice.

Regulatory compliance should be obtained pre-commencement to avoid delays during the construction phase which will have cost implications.

8.6 Asbestos in Soils

Chrysotile and Crocidolite asbestos fibres were detected in two of the six samples of Made Ground that were screened at a trace concentration of less than 0.001%. The asbestos was present in the granular Made Ground deposits.

Where possible, it is advised that any Made Ground soils containing asbestos are left in the ground undisturbed.

Where soils will be disturbed as part of the ground works, in accordance with the Joint Industry Working Group (JIWG) decision support tool for CAR2012 work categories, the combined hazard and exposure ranking is *Low*. The work is classified as non-licenced and CAR does not apply. However, it is recommended that EN149 type FFP3 disposable masks are worn, dust suppression takes place and localised/basic personal decontamination facilities are produced.

The JIWG tables are presented in *Appendix 16*. This should be used as an aid to classify risk and recommend the level of protection required, the final decision on how asbestos within the soils should be managed should be made by the contractor.

8.7 Health and Safety - Construction and Ground Workers

During the reclamation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. The risk to construction and ground workers is assessed in the table below:

PL Ref	Potential Source	Pollution Linkage	Likelihood	Severity	Level of Risk
PL8	*Made Ground*	*Ingestion, direct contact, inhalation of dusts.*	*Unlikely*	*Medium*	***Low***
PL8	*Asbestos*	*Ingestion, direct contact, inhalation of dusts.*	*Unlikely to Low Likelihood*	*Medium*	***Moderate to Low***

No elevated concentrations of contaminants have been recorded in the Made Ground soils, trace concentrations were detected in two of the granular Made Ground samples. It is recommended that ground workers wear gloves when handling soils and hand washing facilities should be made available. The risk should be communicated in site inductions and information boards.

General guidance on these matters is given in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land". In summary, the following measures are suggested to provide a minimum level of protection:

- *All ground workers should be issued with the relevant protective clothing, footwear and gloves. These protective items should not be removed from the site and personnel should be instructed as to why and how they are to be used.*
- *Hand-washing and boot-washing facilities should be provided.*
- *Care should be taken to minimise the potential for off-site migration of contamination by the provision of dust suppression control and wheel cleaning equipment during the construction works.*
- *Good practices relating to personal hygiene should be adopted on the site.*
- *The contractor shall satisfy the Health and Safety Executive with regard to any other matters concerning the health, safety and welfare of persons on the site.*

8.8 Waste Classification by Assessment

We have reviewed the testing results and inputted them into the HazWasteOnline model which allows users to code and classify waste as defined in the EWC (European Waste Catalogue 2002) based on EC Regulation 1272/2008 on the Classification, labelling and packaging of substances and mixtures (CLP) and latest Environment Agency guidance (WM3 "Guidance on the classification and assessment of waste (1st edition 2015)-Technical Guidance").

This is a useful tool as waste producers have the legal responsibility to classify any waste they produce.

Six samples were tested to assess whether they contained any contaminants in the hazardous range when screened against assessment criteria within WM3. The results are in the Waste Classification Report presented in *Appendix 17.*

Based on the Waste Classification Report, the Made Ground has been classified as *Non-Hazardous* for waste disposal purposes.

Asbestos was detected at a maximum concentration of <0.001% which is below the hazardous threshold concentration of 0.1% and will not affect the classification of the material.

Total testing was not undertaken on the natural soils and are assumed to be *Non-Hazardous*.

8.9 Waste Acceptance Criteria (WAC) Results

The Landfill Directive (Directive 1999/31/EC on the landfilling of waste) led to the establishment of a methodology for classifying wastes. Wastes can only be accepted at a landfill if they meet the relevant Waste Acceptance Criteria (WAC) for that type of landfill. There are three different WAC, these are for:

- *Inert waste*
- *Non-Hazardous waste*
- *Hazardous waste*

Wastes should first be classified based on their total concentrations as detailed in the previous section. WAC testing is then required if the end disposal route is a landfill.

Waste Acceptance Criteria (WAC) testing was outside the scope of this investigation and the guidance given below is general.

The possibility of automatic inert classification of the natural soils should be explored in accordance with Section 4.3 of the EA guidance document. The Council Decision includes a list of wastes in Section 2.1.1 of the document that are assumed to be inert and therefore acceptable at a landfill for inert waste without testing, this is the case if:

- *They are single stream waste of a single waste type (although different waste types from the list may be accepted together if they are from a single source)*
  and
- *There is no suspicion of material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify contamination and they do not contain other their disposal in other classes of landfill.*

If any organic contaminated material is encountered during the construction phase, it is possible that this may be classified as hazardous, and testing should be undertaken at that time.

Materials should be segregated and where necessary sufficient time is allowed to further classify the material properly, including discussion with landfill sites and waste transfer stations to find the best disposal route. It is recommended that where possible, the soils could be recycled at a suitable local waste treatment plant or transfer station rather than a landfill disposal route.

The reuse of soils on the site this should be done in accordance with the CL:AIRE "Development Industry Code of Practice for the Definition of Waste" (CL:AIRE CoP). Any re-use scheme should be designed to minimise disposal costs.

After a cut and fill balance plan/volume calculation has been carried out, a U1 and T5 exemption could be registered. This will allow the use of the following soils without a waste permit or under Dow CoP MMP:

- *1,000 tonnes (c.600m^3) of non-hazardous soil.*
- *5,000 tonnes (c.3,000m^3) of natural sand and gravels.*
- *50,000 tonnes (c.25,000m^3) of bituminous material to be used in roadways.*
- *5,000 tonnes (c.3,000m^3) of crushed concrete / stone.*

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Further investigation to assess risk from shallow coal mine workings comprising rotary boreholes .
Obtain BGS Site-Specific Radon Report.
Completion of gas monitoring programme.
Issue gas assessment.
Demolition asbestos survey.
Detailed Remedial Specification.
Detailed foundation design.
Confirmation of the recommendations made within this report with the regulators.

10.0 RELEVANT INDUSTRY REFERENCES

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