PHASE 2 SITE INVESTIGATION - BUILDING 2

PROPOSED REPLACEMENT DWELLING (NEW BUILD)

Hill End Farm, Hill End Road, Mapplewell, Barnsley, S75 6DU

Report Ref: TH/Hill End/Bldng2/New Build/PHASE2/Mar2023/v01

11th March 2023

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Document Control

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1.0 INTRODUCTION

1.1 Terms of Reference

On the instructions of the Planning Consultant (Mr Tom Warren, Prism Agriculture Ltd) acting for the owner (Mr Needham), a full **PHASE II GROUND INVESTIGATION** was requested for a new build residential dwelling (to replace an existing property) on land situated at Hill End Farm, Hill End Road, Mapplewell, Barnsley S75 6DU.

This report supplements an initial ***Phase I - Potential Contaminated Land & Preliminary Risk Assessment (PRA)*** Report Ref: TH/Hill End/Bldng2/REP/PHASE1/02/Oct2022/v01 dated 5th October 2022 (carried out by Earth Tech Consulting Ltd) that was submitted to the LPA as part of a planning application to replace an existing redundant dwelling house with an equivalent new build property, and a ***Coal Mining Risk Assessment (CMRA)*** Report, also carried out by Earth Tech Consulting Ltd, Ref: TH/Hill End/Bldng2/Rep/CMRA/01/Oct2022/v01 dated 5th October 2022.

Planning Permission for the proposed development was granted by the LPA, and the subsequent requirement for a Phase 2 Site Investigation has arisen as a condition of the PP granted by Barnsley Metropolitan District Council dated 29.11.2022 (Ref: 2022/1165) and also because (a) the initial desk study identified a potential risk for shallow coal mining beneath the site, and (b) the subsequent CMRA submitted to the Coal Authority identified past coal mining activity in the vicinity of the site. Specifically, the LPA approval conditions state:

Condition 6.

No development shall commence (excluding the demolition of existing structures and site clearance) until:

a) a scheme of intrusive investigations has been carried out on site to establish the risks posed to the development by past shallow coal mining activity; and

b) any remediation works and/or mitigation measures to address land instability arising from coal mining legacy, as may be necessary, have been implemented on site in full in order to ensure that the site is made safe and stable for the development proposed.

The intrusive site investigations and remedial works shall be carried out in accordance with authoritative UK guidance.

REASON: In order to ensure the safety and stability of the development, in accordance with paragraphs 178 and 179 of the NPPF.

THIS REPORT CONSTITUTES THE FINAL PART OF THE ABOVE PROCESS AND IS A SUMMARY OF THE FINDINGS OF A SUITE OF ROTARY BOREHOLE DRILLING AS RECOMMENDED AND AFTER A COAL AUTHORITY PERMIT WAS OBSTAINED TO UNDERTAKE THE INVESTIGATION WORKS.

1.2 Previous Studies

The previous ***Phase I Contaminated Land Desk Study*** carried out by Earth Tech Consulting Ltd (Report Ref: TH/Hill End/Bldng2/REP/PHASE1/02/Oct2022/v01 dated 5th October 2022 recommended the following:

- A programme of exploratory holes across the site (Min 2Nr. Trial Holes + 1Nr. Rotary Cored BH) to provide an initial inspection of the near surface ground conditions for geotechnical and environmental purposes.
- Appropriate geotechnical and environmental soil analysis.
- A programme of ground gas monitoring and the inclusion of a basic ground gas risk assessment.

- Coal mining investigation works including a programme of rotary percussive water flush boreholes to investigate the depth, thickness and worked state of shallow coal seams beneath the site (subject to a Coal Authority Permit).

- Revision of the Conceptual Site Model.

Additionally, the ***Coal Mining Risk Assessment (CMRA)*** Report Ref: TH/Hill End/Bldng2/Rep/CMRA/01/Oct2022/v01 dated 5th October 2022 (also carried out by Earth Tech Consulting Ltd) identified a **MEDIUM** risk associated with the development from unrecorded shallow coal mine workings.

- Coal seams were considered to potentially underlie the site, possibly at a depth of < 20m (estimated based on dip and dip-direction of known coal seams at greater depth) and the CMRA recommended a suitable scheme of intrusive investigation to investigate involving rotary boreholes to 30m deep to better quantify the risk of shallow, historic mine workings.

These investigation works were also identified to clearly fall into the category where a formal Coal Authority Permit is required (see below).

[*Note! - these two specified requirements naturally overlap each other, and as such have been merged for the purposes of undertaking the Phase 2 Site Investigation for this proposal and for reporting the findings herein].

1.3 **The Parties**

Property	Building 2: Replacement Residential Dwelling – New Build - Hill End Farm, Mapplewell, Barnsley, S75 6DU
Client/Owner	Mr Needham
Planning Consultant	Prism Agriculture Ltd Mr Tom Warren
Geotechnical Consultants (CMRA & Phase II)	Earth-Tech Consulting Ltd Contact: Mr T. M. Hyett MSc CEng MIEI CGeol FGS MCIOB Direct E: timhyett@hotmail.co.uk Direct T: 07790 581478
Borehole Drilling Contractor (May 2022)	*ACE Drilling Services Ltd* *Mr Stuart Smallwood* *T: 07710 390021*
Soils Laboratory (chemical testing)	*Envirolab Ltd*

1.4 **Legislative Framework**

This report has been completed to fulfil the recommendations of the initial Phase I Desk Study, the supplemental Coal Mining Risk Assessment (CMRA) and the requirements of **Barnsley Planning Permission Ref: 2022/0683 (Condition 3 & 6 - above)** and in accordance with:

- *CLR11 'Model Procedures for the Management of Land Contamination';*
- *CIRIA Special Publication 102 - Remedial Treatment for Contaminated Land - Volume II: Decommissioning, Decontamination and Demolition (Jan 1995);*
- *Environment Agency (EA) Guidance on the Safe Development of Housing on Land affected by Contamination (Publication 66, dated 2008), and;*
- *EA Guidance on the Safe Development of Housing on Land affected by Contamination (Pub. 95, dated 2000).*

These procedures relate to 'past' contamination and assume that legislative controls such as H&S legislation and pollution prevention activities currently prevent potentially polluting activities on the site.

This report includes **HAZARD IDENTIFICATION** and environmental **RISK ASSESSMENT** in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a *'suitable for use approach'*. When considering the current use of land, Part IIA of the Environment Protection Act 1990 (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995, which came into force in England on 1 April 2000. The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A (2) as:

- "any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:

- Significant harm is being caused or there is a significant possibility of such harm being caused; or Pollution of controlled waters is being, or is likely to be, caused."

Harm is defined under section 78A of the Environmental Protection Act as meaning '*harm to the health of living organisms or other interference with the ecological systems of which they form part and, in the case of man, includes harm to his property*'. Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as '*the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter*'.

Types of harm are related to specific receptors in order to determine whether they can be regarded as '*significant harm*' or '*significant possibility of significant harm*', as defined in Clause 4 of the DEFRA publication '*Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance*'.

1.5 Aims and Objectives of this Phase II Site Investigation

To main aim of this report is to provide information on the site subject to the planning authority and identify the nature of any hazards and physical constraints that could affect the development proposals:

- To identify current and likely future receptors, potential sources of contamination and likely pathways and any features of immediate concern;
- To provide information on the geology, geochemistry, soil, hydrogeology and hydrology of the site subject to the planning application:
- To identify any residual risk of shallow coal mining, differing (or weak/collapsed) ground conditions; potential contamination; and past, present and future uses;
- To produce an initial **conceptual model** for the site as a whole;
- To provide information for the preliminary risk assessment;
- To identify areas where informed decisions are to be made using specialist assessment techniques or advisors, e.g. relating to implementation of Radon protective measures, or other ecological, unexploded ordnance (UXO), coal mining or archaeological considerations;
- To provide data to assist in the design of building foundations and to give an early indication of possible remedial requirements/options available to the developer;

The main objective of the investigation is to identify potential risks that may represent a constraint to the proposed development of the site that is subject to the planning application, and includes:

- Potential contamination of the site strata by historical and or current use;
- Potential problems associated with geological features such as faulting, mining and land instability;

This report also includes a detailed review of the available geological, historical and environmental information in order to establish the likely ground conditions at the site. The data collated in this study has been undertaken to allow the further development of the **conceptual model**, which represents the potential pollution linkages that have

been identified on the site.

1.6 Scope of this Phase II Site Investigation

The scope of work for this report comprises of the following:

- Review of the Groundsure Geo-Insight report;
- Review of the Coal Mining Risk Assessment;
- Review of published Geology;
- Detailed Intrusive Survey (By Deep Boreholes to 30m depth);
- Appropriate Contamination Testing;
- Appropriate Gas Monitoring.

1.7 Mandatory Guidance

- *DEVELOPMENT ON AND AFFECTED BY CONTAMINATION - Technical Guidance for Developers, Landowners and Consultants, YALPAG Version 10.3 – April 2019*
- *VERIFICATION REQUIREMENTS FOR GAS PROTECTION SYSTEMS - Technical Guidance for Developers, Landowners and Consultants - YALPAG Version 1.1 - December 2016*
- *VERIFICATION REQUIREMENTS FOR COVER SYSTEMS - Technical Guidance for Developers, Landowners and Consultants - YALPAG Version 3.4 – November 2017*
- *Cl: AIRE Research Bulleting RB17*
- *CIRIA Report C665 & British Standard BS 8485: 2007*
- *The Contaminated Land (England) Regulations 2000*
- *Contaminated Land (England)(Amendment) Regulations 2012*
- *The Environment Act 1995*
- *The Environmental Protection Act 1990*
- *Department for Environment, Food and Rural Affairs, April 2012.*
- *Environmental Protection Act 1990, Contaminated Land Statutory Guidance. The Stationery Office Ltd.*
- *Local authority guide to ground gas pub. by the Chartered Institute of Environmental Health (CIEH, 2008)*

1.8 Basis of Risk Assessment

This assessment has been undertaken with due regard to the *Environmental Protection Act 1990*, associated statutory guidance, *'Guidance for the Safe Development of Housing on Land Affected by Contamination', 'CLR 11 (Model Procedures for the Management of Land Contamination)'*, the *Contaminated Land Guidance Documents* issued by the *Environment Agency* and other legislation sources.

The method used follows a risk-based approach with the potential risk assessed using the **SOURCE-PATHWAY-RECEPTOR** pollution linkage concept as suggested in the 1990 Act.

1.9 Limitations and Exceptions of this report

This report was undertaken for the owner of the site (Mr Needham) and as such should not be entrusted to any third party without written permission. This report has been compiled from a variety of sources, within the time constraints of the program, which we believe to be trustworthy. The findings and opinions provided in this document are made in good faith and are based on data provided by third parties (*Groundsure, Environment Agency, The Coal Authority, and Regulatory Bodies*). The accuracy of map extracts cannot be guaranteed, and it should be recognised that different conditions on /adjacent to the site may have existed previously.

This report is prepared and written in the context of the purposes stated above and should not be used in a different context. The report should be read in its entirety, including all associated drawings and appendices. *Earth-Tech Consulting Ltd* cannot be held responsible for any misinterpretations arising from the misplaced use of extracts (or) extracts that are taken out of context.

2.0 REVIEW OF THE INITIAL PHASE 1 DESK STUDY

2.1 Site Location

The site is situated in a semi-rural position off Wentworth Road / Hill End Road in Mapplewell, a former mining village in the metropolitan borough of Barnsley in South Yorkshire, England. Historically part of the West Riding of Yorkshire,

Fig 1 – General Location and Aerial Photo of the Site in South Yorkshire: Hill End Farm, Mapplewell, S75 6DU

According to the Barnsley District Landscape Character Assessment (2002) the subject site lies within **D1: Settled Arable Slopes** designated category of the wider landscape on northeast Barnsley.

2.2 Description

With respect to this specific approved development, the planning permission granted by Barnsley Metropolitan Borough Council (Ref: 2022/1165) dated 29.11.2022 is for the ***'Demolition of existing dwelling and erection of replacement dwelling with solar PV panels, air source heat pump, package treatment plant, and detached garage'*** on land located at and adjacent to No. 56 Hill End Road, Mapplewell, Barnsley, S75 6DX, as shown below:

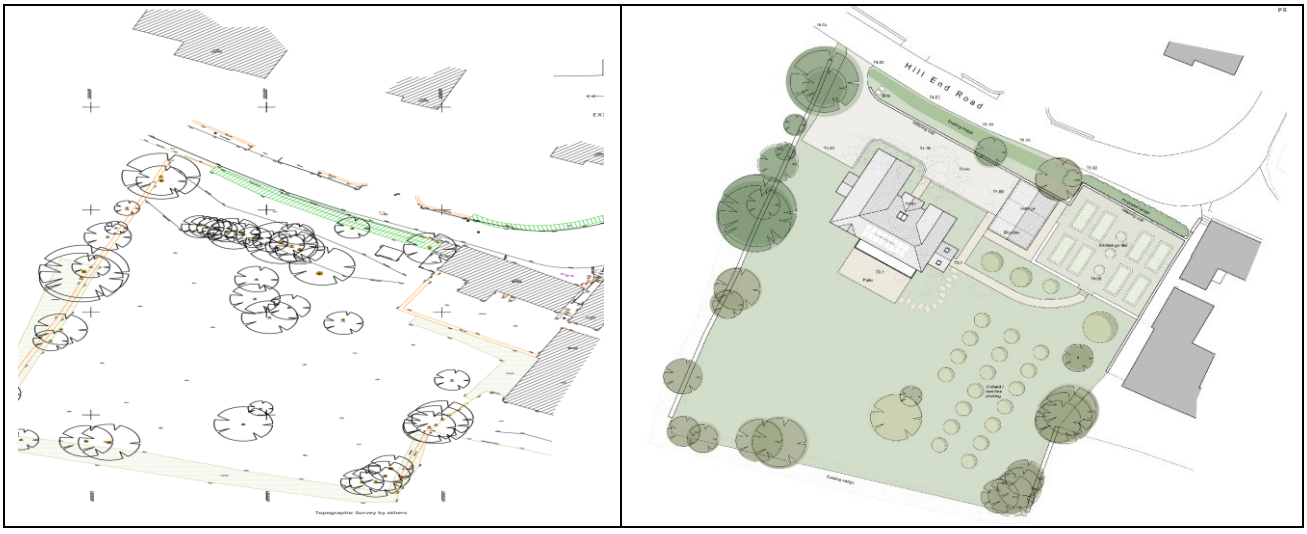

Fig 2 – Schematic showing existing building (No. 56) with LHS land parcel, and schematic showing approved Replacement Dwelling on LHS land parcel and existing building (No.56) demolished post or pre-development - Hill End Farm, Hill End Road, Mapplewell, S75 6DU.

As indicated from the historical mapping, the existing Farm buildings date back as far as the records exist (1892/93) when the surrounding area was (and continues to be) open agricultural fields where there is no indication from local knowledge, our research, or otherwise to suggest the site has had any other previous industrial or other usage.

2.3 Development Proposals

The development proposal consists of a new build dwelling house in the land parcel of No. 56 Hill End Road, Mapplewell, Barnsley, S75 6DX, and the demolition of the existing farmhouse (No. 56) post or pre-development as approved by Barnsley Metropolitan District Council on 29.11.2022(Ref: 2022/1165). The proposals are as per the current submitted drawings, including any approved amendments, but broadly the scheme is illustrated below:

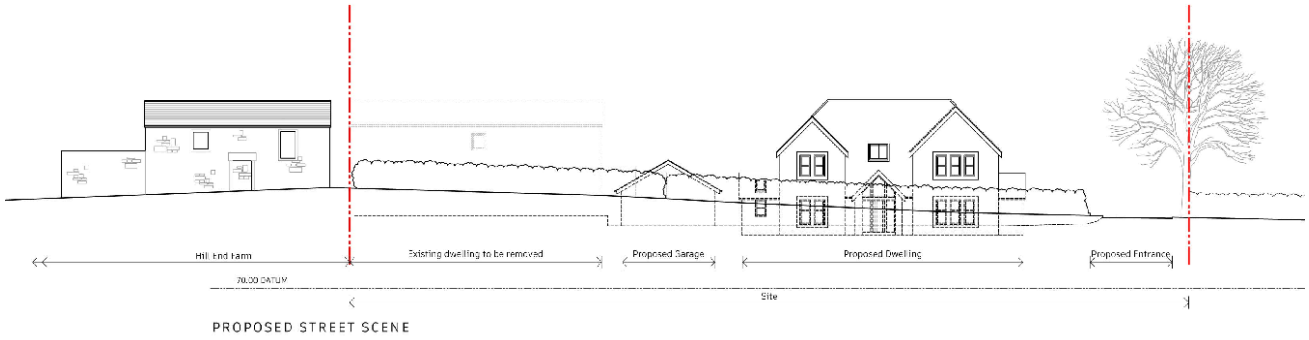

Fig 3 – Proposed Front Elevation

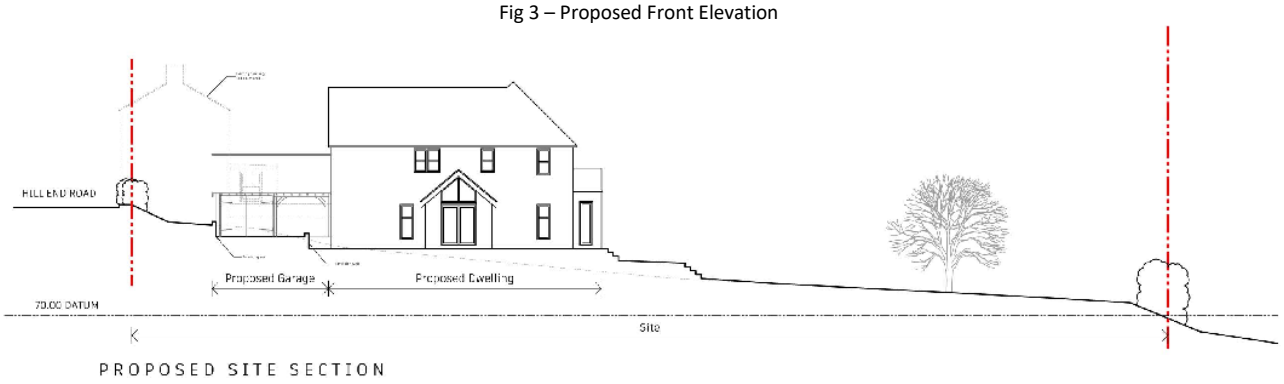

Fig 4 – Proposed Side Elevation

As per the approved scheme, the existing dwelling house (Building 2 - No.56) is to be demolished and is unoccupied and in a general state of dilapidation. The existing, older stone barn to the east of the collection of buildings (Building 1) has already been approved for conversion to residential under Class Q permitted development.

2.4 General History

Mapplewell as a village has long been associated with nearby Staincross and Darton – areas historically known for nail making – but areas that also experienced a significant amount of coal mining and ground excavation. Numerous former collieries are within the locality, the most notable being the North Gawber which emerged at a time coalmining was fast developing at the time when the nail making was on the decline.

The Phase 1 Report shows the site of the replacement dwelling lies within the curtilage of the former farm and has been agricultural in the past (as the name *Hill End Farm* suggests). The overall site was/is understood to have been used predominantly for agriculture over many years. There is no indication (from local knowledge, our research, our observations in the field or otherwise) to suggest the site has had any other significant previous industrial or other usage and the plot is surrounded by open fields which has been the case as far back as the records exist.

However, there is evidence of historic mining immediately adjacent to the site towards the east with shafts and the Dearne Side Colliery shown pre-dating the current historical maps. These sites were disused by 1891. The North Gawber Colliery is situated to the north and northwest, and emerged in the late 1800s but this closed completely by the early 1980s and is now fully restored and the site areas given up to development and local housing.

2.5 Summary of the Geology

From the Phase 1 Desk Study, the Walkover Survey and the examination of Geological Map Extracts from the BGS - British Geological Survey (specifically 1:10,000 scale geology data sheet Yorkshire 262SE (1932) the prevalent geological sequence is:

Superficial: Medium sandy loam TOPSOILS over intermittent layers of '*brown, soft to firm, sandy, silty CLAY*' (GLACIOLACUSTRINE DEPOSITS). No *Made Ground* is identified beneath the study area by research and/or observation.

Solid geology: Predominantly a rough sandstone and millstone grit formation, and the *Pennine Lower Coal Measures Formation (PLCM-MDSS)* of the Langsettian Sub-age, which is a mixture of mudstone, siltstone and sandstone containing coal measures and marine fossils. The sandstone within the area may have historically been quarried in locations off-site, and the location is well known to be dominated by historic coal mining activity in all directions. Possible presence of Rough Stone Sandstone and Millstone Grit, Mudstone, Siltstone and Sandstone.

2.6 Potential ON-SITE Features

- None of any significance (except in regard to shallow coal mining).

2.7 Potential OFF-SITE Features

- None of any significance (except in regard to shallow coal mining).

(Blacker Hill old quarry to north; old Shafts and Dearne Side Colliery to the east > 500m)

2.8 Summary of Past Usage

- The site has been agricultural and open fields since at least 1850.
- No industrial activity has been carried out on the site in its known history.
- There is a latent residual risk of shallow coal mining present.

2.9 Underground Mining Risks

The site and the immediate surrounding area are indicated on the Coal Authority Interactive Map Viewer to comprise a Development High Risk Area. A formal CMRA was carried out by Earth Tech Consulting Ltd on dated 5th October 2022 (Report Ref: TH/Hill End/Bldng2/Rep/CMRA/01/Oct2022/v01).

- The CMRA shows that the development plot of the replacement dwelling is in an area of possible shallow coal mine workings. The Consultants report also indicates that the WINTER coal seam outcrops approximately 13m south of the site and may be of workable thickness.

The shafts of North Gawber Colliery (BGS borehole records SE30NW9/C and SE30NW9/A located approximately 120m east of site) indicate local seam separations between the Kent's Thin, Kent's Thick/Mapplewell, Barnsley Rider and Barnsley seams of 21.12- 21.54m, 40.38m and 25.7m, respectively. These separations are significantly greater than those estimated from the indicative dip rates above. The rationalised plans NY190K and NY180K indicate the Kent's Thick and Kent's Thin seams to have local extraction thicknesses of 89cm and 61cm respectively and the North Gawber shafts

mentioned above indicate the Kent's Thin, Kent's Thick and Barnsley Rider seams to have thicknesses of 0.61-0.76m, 0.99-2.38m and 0.46m, respectively.

The British Geological Survey England and Wales Sheet 87 Barnsley (2008) sheet includes a Generalised Vertical Section (GVS), which gives the following indicative seam thicknesses for those seams between the Kent's Thin coal and Barnsley Coal: Kent's Thin (0-1.9m), Kent's Thick/Mapplewell (0.3-2.6m), thin unnamed coal, Barnsley Rider Coal (0-0.7m), thin unnamed coal, Warren House Coal (0-0.1m) and Barnsley Coal (0-3.9m). Abandonment plan NE1037 for local workings in the Kent's Thick seam records a 23.3m separation between Kent's Thin and Kent's Thick from borehole U1, however it is not clear where this borehole is located.

A section of the Kent's Thick seam on this plan shows coal 0.15m, seatearth 0.46m, coal 1.07m and seatearth of unknown thickness (total thickness of 1.68m excluding lower seatearth horizon). Based on the indicative seam separations mentioned above and the likely local thickness of these seams:

- It is possible that insufficient competent cover may exist above the WINTER seam.
- It is also possible that there may be insufficient competent cover above the Kent's Thick/Kent Thin/Mapplewell seam if the seam extraction thickness is at the greater end of the figures indicated and if the seam separation is at the lesser end of the figures indicated.
- It is likely that there will be sufficient competent cover above the Barnsley Rider Coal even if extracted at its maximum seam thickness.

Consequently, if shallow workings exist the competency of overlying rock seams should be proven through borehole drilling to a min 30m depth that will quantify the risk (if any) from unrecorded shallow workings in the Winter, Kent's Thin and Kent's Thick/Mapplewell seams.

2.10 Hydrogeology

The general study area is not influenced by any significant water sources, and groundwater can be reasonably assumed to be below the zone of influence of the existing foundations and/or below any new drainage connection trenches etc. There is no evidence of soils of high leaching potential, no evidence of abstractions or springs on current mapping, and no evidence of a perched water table and/or artesian pressure within the soil at shallow depth.

Evidence suggests a level water table at depth with a stable, consistent soil type comprising mainly COHESIVE SOIL (Clay) overlying BEDROCK of *Sandstone* (*Rough-Rock Sandstone)* and the *Pennine Lower Coal Measures* formation). Groundwater, whilst not observed in any significant quantity (or at all), if found to be present at deeper elevations (if applicable) can reliably be estimated from empirical data to be in the region of between pH 5.5 – 7.0 representing a *low risk* in terms of acidic ground and potential sulphate attack on existing concrete and cement mortars.

- No problems are envisaged with swelling or shrinkage of soil due to the movement of groundwater and the propagation of trees, vegetation and flora.

2.11 Landfill sites and waste management

- None of any Significance

2.12 Pollution controls and industrial land use

- None of any Significance

2.13 Radon

- No special measures Required.

2.14 **Potential for Ground Instability**

- There are no significant natural ground instability issues indicated in the vicinity of the site: namely weak or unstable rocks that could slip downhill on steep slopes (greater than c. 5 degrees) or into excavations ('Landslides (slope instability)') (LEVEL C).

- There is no evidence of *running sands*, and no specific need to check for *plasticity of clay soils* (PI).

- It is not likely that any *collapsible* (loessic) deposits will be encountered and the buildings' foundation loads are unlikely to exceed the *safe bearing capacity* of the soil during or after construction as observed.

3.0 PHASE II INTRUSIVE GROUND INVESTIGATION

3.1 **Introduction**

Based on our review of the *Phase I Desk Study Report* and the CMRA a contamination risk level of **VERY LOW** and a coal mining legacy risk of **MEDIUM** is considered appropriate for this development, based on the information provided, and from our own detailed assessment:

- No significant infilled ground was/is present on the site.

- Information available from the CA, BGS and Groundsure suggests that the site does have a potential risk of coal mining related geohazards and appropriate investigation methods should be adopted (i.e. rotary cored boreholes to 30m depth) with a CA permit.

- The existence of potentially unstable unrecorded shallow workings and/or mine entries (shafts) are unlikely within the site boundary **but cannot be entirely discounted**. During the construction phase, works should proceed cautiously recognising that unstable mine entries can always be present. Should any anomalous ground conditions be encountered then specialist advice should be sought.

- There is a very low potential for shallow or aggressive groundwater to be present below the site. If encountered, this could affect the soil bearing capacity and trench wall stability for traditional foundations.

3.2 **Further Risk Levels**

The historical maps show that the site is relatively unchanged in the past 100 years, and it has not been the subject of exhaustive (or any form of) redevelopment.

- A risk level of **VERY LOW** is considered appropriate with respect to potential ground contamination since there are limited sources of contamination expected on site which could impact receptors.

- A risk level of **LOW to MODERATE** is considered appropriate for the site with respect to potential harmful **Ground Gas** since legacy coal mining is a credible source (methane) of ground gas: however there is no evidence of extensive infilled ground (i.e. carbon dioxide and methane) and although the site is within a coal mining area, there are no records of mine gas emissions and the main, recorded worked coal seams in proximity are situated at deep elevations, indicating minimal pathways to the surface.

On this basis, it was considered appropriate to commission **3No. rotary boreholes to 30m deep** across the **whole site area** to identify any unstable zones, coal seams etc., **+ 1No. Trail Hole (TP1)** in direct proximity of the new build dwelling, all with a qualified watching brief to ensure that if made ground is also observed (with anthropogenic debris) or if visual/olfactory (malodorous) evidence of fuel/oil type contamination is identified, then **contamination screening** and more detailed laboratory testing and/or human health risk assessment can be undertaken as required.

- Soil sampling and **notional** laboratory chemical analysis is appropriate, typically for: *Asbestos in Soil, Arsenic, BTEX-Benzene, Cadmium, Chromium, Lead*.

- Due to the absence of a credible source of contamination from past usage there is no requirement to extend the chemical testing beyond conventional *speciated TPHs* and *PAH* at this stage.

3.3 Borehole Location Plan

Fig 3 – BH Location Plan - Hill End Farm, Mapplewell.

[*<u>Note!</u> – Borehole BH3 specifically relates to the land parcel identified for the position of the replacement (new build) dwelling), and Trail Pit TP1 is located 8m to the left of BH3 (but not shown on the above sketch)]

3.4 Coal Authority Permit

In October 2022 an application was made to the Coal Authority to carry out the proposed boreholes. This required the following supplementary information to be provided:

- Borehole Location Plan – (*see above*)
- A formal Coal Mining Risk Assessment (CMRA).
- Formal Drilling Risk Assessment & Method Statement (RAMS) – (*appended to the CMRA submitted to the CA*).

The Coal Authority granted the permit (**Permit No. 25809**) on 19 December 2022 as shown below:

The Coal Authority

Permit to Enter or Disturb Coal Authority Interests

Permit 25809

Name and Address of Permit Holder:	Site Location:
M Needham *55a Blacker Road* *Mapplewell* *Barnsley* *S75 6GS*	*Hill End Farm* *Hill End Road* *Mapplewell* *Barnsley* *S75 6DU*

This certificate hereby grants the above named Permit Holder a Permit to carry out:-

Ground investigation by three boreholes to 30m

within the Authority's interests at the identified site location above as shown on the Grant Permit Boundary (overleaf) for the period of **12 months** from the granted date shown below. *The granting of this Permit does not constitute advice given by the Authority in relation to the proposed operations. It is the Permit Holder's responsibility to obtain appropriate health, safety, environmental, technical and legal advice.*

Conditions:

- *Manned entry (i.e. into mine entries/workings) is strictly prohibited.*
- *Water flush*
- *Gas Monitoring CO, CH_4, CO_2, O_2, H_2S at borehole and rig*
- *Operators undertaking the work must be in possession of this certificate and the Permit boundary plan at the time of works*
- *Appropriate borehole sealing without delay and to withstand site level changes*

Signed: Paul Hobson Granted Date: ***19 December 2022***

For and on behalf of The Coal Authority

Nominated Representative: Paul Hobson, Permitting Manager;
The Coal Authority, Permitting Office, 200 Lichfield Lane, Mansfield, Notts, NG18 4RG
Tel: 01623 637450; E-Mail: permissions@coal.gov.uk

The Coal Authority

Granted Permit Boundary

Permit Ref: 25809

Permit Boundary:

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3.5 Coal Mining Consultants Report

In addition, as part of the initial *Phase I Desk Study* a Coal Mining Consultants Report (Ref: 51003166653001) was obtained from the Coal Authority in June 2022 and submitted to the LPA as an appendix to the CMRA. This report confirms:

- Mine entries are recorded within 150m of the development site. The development site sits within a historical mining area and therefore there is a residual risk of unrecorded mine entries to be present on site.
- All site operatives should be made aware of this potential risk and a watching brief should be maintained during site works.
- The development site sits upon the Pennine Middle Coal Measures Formation. The closest BGS borehole to the site, SE30NW547, located approximately 370m northwest of the site, records 10ft 8in (3.25m) of top soil and clay; however local ground deposits may vary. No faults, fissures or break lines are known to affect the development site.
- The Barnsley seam is known to be liable to spontaneous combustion.

- There are no recorded past gas emissions recorded in the surrounding area, however, coal seams and coal mine workings pose a potential gas risk which should be considered in any future investigations and development.

- There are no Recorded coal mining surface hazards.

At development sites with shallow coal workings, probable shallow coal mine workings, or pathway features such as mine entries and geological disturbances on or nearby the site, **the Coal Authority recommends that a more detailed gas risk assessment** to be undertaken in accordance with relevant guidance.

The Coal Authority Coal Mining Consultants report indicates extensive areas of opencast extraction immediately adjacent and surrounding the site (see below).

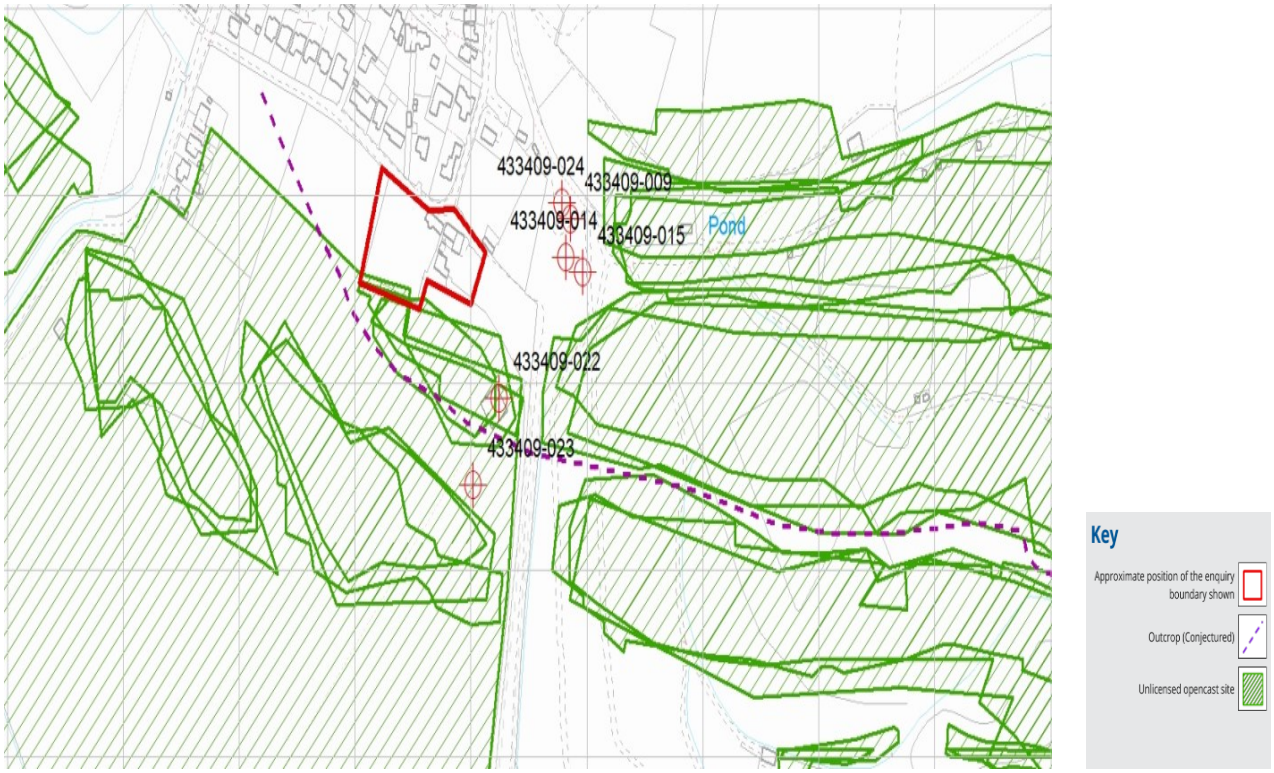


Fig 4 - Coal Authority Rationalised Plan 44 3209 (Opencast Workings) annotated as *'North Gawber Colliery Sites'*. Hill End Farm, Mapplewell. The rationalised plan indicates that these sites and others locally have been sourced from an Opencast Executive Consultation Plan.

The CA Consultants Report and above Rationalised Plan has been reviewed and whilst the site boundaries are recorded, and coal is recorded to have been worked, no further information or source plans are given. The areas do NOT extend to the curtilage of the property, and due to the nature of the development (i.e. a conversion of an existing barn) the risk to the proposed development from surface coal workings is considered to be low.

3.6 Borehole Drilling

The boreholes were drilled by an experienced drilling contractor (ACE Drilling Services Ltd) familiar with CA procedures between 10th January 2023 and 14th January 2023 in accordance with the stipulations of *Earth-Tech Consulting Ltd*; the RAMS provided to the Coal Authority, and the CA Permit No. 25809 as issued on 19th December 2022.

The fieldwork work was also supervised on a **full-time** basis by a Chartered Engineering Geologist provided by *Earth-Tech Consulting Ltd*.

3.7 Drillers Daily Log Sheets

Fig 5 – Pre-drilling Test Pit – Borehole BH1

Fig 6 – Pre-drilling Test Pit – Borehole BH1

Borehole – BH1

Drillers Daily Borehole Log

Ace Drilling Services

Office 6, Rear Walled Garden, Nostell Estate, Wakefield, West Yorkshire, WF4 1AB Office: (01924) 80202 Stuart@acedrillingservicesltd.com

Contract No.	TH/HE/008
Rig	Beretta T41-2
Driller	Pete Smallwood
Date	12.1.23

Site: Hill End Farm

Borehole No:	BH1
Borehole Dia:	5"
Type of Bit / Barrel:	PCD
Type of Flush:	Water

Casing used	
Size	PW
Depth to	3.5m

Water strikes	
Depth	
Inflow	
Water level	
Depth sealed off	

Hours on site	
From	
To	
Water level AM	
Water level PM	

Strata description		Depth		Drilling / Coring								Penetration Tests						
Colour	Strata	From	To	Type OH/C/DS/SPT	Sample No	Depth From	Depth To	Run Length	Core Recovered	Percentage of Recovery	Flush Colour	Flush Returns	75mm	75mm	75mm	75mm	75mm	Refusal
Grey	Concrete	0.00	0.10	OH		1.20	14.00				Grey	100%						
Grey	Man Made Fill	0.10	0.50	OH		14.00	18.00				None	0%						
Brown/Grey	Clay	0.50	2.00															
Brown	Siltstone	2.00	6.20															
Grey	Mudstone	6.20	11.50															
Black	Coal	11.50	12.10															
Grey	Mudstone	12.10	14.00															
	Competent Ground	14.00	18.00															

Consumables used	
Core Boxes	
Liner	
Gravel	
Bentonite	
Postcrete	
Install Cover	

Crew	
Driller	Pete Smallwood
2nd man	Ryan Stevens
3rd man	

Dayworks	Time From	Time To
Dig Pit - Excessive pit due to finiding potential service	8.00	9.30
Move to Position	9.30	9.45
Setup on Postion	9.45	10.45

Standing	Time From	Time To

Installation Size	Installation Type	Depth From	Depth To

Remarks: Loss of flush encountered at 14m. Competent ground proved down to 18m as instructed.

Borehole – BH2

Ace Drilling Services

Drillers Daily Borehole Log

Office 6, Rear Walled Garden, Nostell Estate, Wakefield, West Yorkshire, WF4 1AB Office: (01924) 80202
Stuart@acedrillingservicesltd.com

Contract No.	TH/HE/008	Site:	Hill End Farm
Rig	Beretta T41-2	Borehole No:	BH2
Driller	Pete Smallwood	Borehole Dia:	5"
Date	11.1.23	Type of Bit / Barrel:	PCD
		Type of Flush:	Water

Casing used		Strata description		Depth		Drilling / Coring									Penetration Tests						
		Colour	Strata	From	To	Type OH/C/DS/SPT	Sample No	Depth From	Depth To	Run Length	Core Recovered	Percentage of Recovery	Flush Colour	Flush Returns	75mm	75mm	75mm	75mm	75mm	75mm	Refusal
Size	PW	Grey	Man Made Fill	0.00	2.50	OH		1.20	16.00				Grey	80%							
Depth to	3m	Brown	Siltstone	2.50	6.00	OH		16.00	30.00				None	0%							
Water strikes		Grey	Mudstone	6.00	12.00																
		Black	Coal	12.00	12.50																
Depth		Grey	Mudstone	12.50	13.50																
Inflow		Grey	Sandstone	13.50	16.00																
Water level			Competent Ground	16.00	30.00																
Depth sealed off																					
Hours on site																					
From																					
To																					
Water level AM																					
Water level PM																					

Consumables used		Dayworks	Time From	Time To	Standing	Time From	Time To	Installation Size	Installation Type	Depth From	Depth To
Core Boxes											
Liner		Mob to Site							Bentonite	30.00	0.00
Gravel		Dig Pit	8.30	9.30							
Bentonite		Fill Bowser	12.00	12.30							
Postcrete		Fill Bowser	14.00	14.30							
Install Cover											
Crew											
Driller	Pete Smallwood										
2nd man	Ryan Stevens										
3rd man											

Remarks: Loss of flush encountered at 16m. Instructed to continue drilling to prove competent ground with no voids. No voids encountered.

Borehole – BH3

Ace Drilling Services

Drillers Daily Borehole Log

Office 6, Rear Walled Garden, Nostell Estate, Wakefield, West Yorkshire, WF4 1AB Office: (01924) 80202
Stuart@acedrillingservicesltd.com

Contract No.	TH/HE/008	Site:	Hill End Farm
Rig	Beretta T41-2	Borehole No:	BH3
Driller	Pete Smallwood	Borehole Dia:	5"
Date	13.1.23	Type of Bit / Barrel:	PCD
		Type of Flush:	Water

Casing used		Strata description		Depth		Drilling / Coring									Penetration Tests						
		Colour	Strata	From	To	Type OH/C/DS/SPT	Sample No	Depth From	Depth To	Run Length	Core Recovered	Percentage of Recovery	Flush Colour	Flush Returns	75mm	75mm	75mm	75mm	75mm	75mm	Refusal
Size	PW	Brown	Top Soil	0.00	0.50	OH		1.20	22.00				Grey	80%							
Depth to	1.5m	Brown/Grey	Clay	0.50	1.50	OH		22.00	30.00				None	0%							
Water strikes		Grey	Mudstone	1.50	7.00																
		Black	Coal	7.00	7.90																
Depth		Grey	Mudstone	7.90	8.80																
Inflow		Brown	Sandstone	8.80	11.70																
Water level		Grey	Mudstone	11.70	20.50																
Depth sealed off		Black	Coal	20.50	20.80																
Hours on site		Grey	Mudstone	20.80	21.50																
		Brown	Sandstone	21.50	22.00																
From			Competent Ground	22.00	30.00																
To																					
Water level AM																					
Water level PM																					

Consumables used		Dayworks	Time From	Time To	Standing	Time From	Time To	Installation Size	Installation Type	Depth From	Depth To
Core Boxes											
Liner		Move to Position	10.00	10.30							
Gravel		Dig Pit	10.30	11.30							
Bentonite		Setup on Postion	11.30	12.30							
Postcrete											
Install Cover											
Crew											
Driller	Pete Smallwood										
2nd man	Ryan Stevens										
3rd man											

Remarks: Loss of flush encountered at 22m. instructed to proceed by engineer to confirm competent ground.

3.8 Borehole Logs BH1, BH2, & BH3 and Trail Pit Log TP1

EARTH-TECH CONSULTING LIMITED	Rotary Borehole Record	BH01	Sheet 1 of 1
Project Ref: **TH/SBR/BESSEMER/02**	Client: **Mr Needham**	Date: **12.01.2023**	
Location: **Hill End Farm, Hill End Road, Mapplewell, Barnsley, S75 6DU**	Plant Used: **Berreta T41 rotary rig**	Borehole Position: (see plan Dwng No.)	

Geology Description	Depth (m)	Legend	TRC (%)	SCR(%)	RQD(%)	Sample / Insitu Test Information: Type	Depth	Remarks
Concrete Slab + Made Fill (hardcore) to 0.5m... 0.5m to 2.0m Predominantly firm to stiff brown locally orangish-brown slightly sandy silty CLAY with gravel of fine to coarse sandstone - gravels are angular to coarse sandstone	0.0							
	2.0							
2.0m to 6.20m: Weak to medium strong locally grey fine to medium grained SILTSTONE (PLCM-MDSS)								
	4.0							
	6.0							
6.20m to 11.50m: Medium strong locally grey fine to medium grained SANDSTONE with many localized bands of siltstone / mudstone (PLCM-MDSS)								
	8.0							
	10.0							
	12.0							
11.50m to 12.10m Coal Seam (600mm thick – unworked)								
12.10m to 14.0m Weak to medium strong locally grey fine to medium grained MUDSTONE (PLCM-MDSS)	14.0							
14.0m to 30.0m – Solid formation - Medium strong locally grey fine to medium grained MUDSTONE with many localized bands of sandstone / siltstone (PLCM-MDSS)	16.0							
	18.0							
	20.0							
	22.0							
	24.0							
	26.0							
	28.0							
	30.0							

Hole Diameter by Depth			Drilling Flush Details			Water Strike		
Depth (m)	Diameter (mm)	Casing (mm)	Depth(m)	Type	Return (%)	Strike Depth (m)	Depths Sealed (m)	Remarks
				water	100%			

Earth-Tech Consulting Ltd
Yorkshire Office
T: 07790 581478
E: timhyett@hotmail.co.uk

Remarks:
1. No voids or fractures / no loss of flush
2. No groundwater

Drilled By: **ACE Drilling Svs Ltd** | Logged By: **TH** | Checked By: **KH**

EARTH-TECH CONSULTING LIMITED	Rotary Borehole Record	BH02	Sheet 1 of 1
Project Ref: **TH/SBR/BESSEMER/02**	Client: **Mr Needham**	Date: **11.01.2023**	
Location: **Hill End Farm, Hill End Road, Mapplewell, Barnsley, S75 6DU**	Plant Used: **Berreta T41 rotary rig**	Borehole Position: (see plan Dwng No.)	

Geology Description	Depth (m)	Legend	TRC (%)	SCR(%)	RQD(%)	Sample / Insitu Test Information: Type	Depth	Remarks
Made Fill (hardcore) to 0.9m... 0.9m to 2.5m Predominantly firm to stiff brown locally orangish-brown slightly sandy silty CLAY with gravel of fine to coarse sandstone - gravels are angular to coarse sandstone	0.0							
	2.0							
2.5m to 6.00m: Weak to medium strong locally grey fine to medium grained SILTSTONE (PLCM-MDSS)	4.0							
	6.0							
6.0m to 12.0m: Medium strong locally grey fine to medium grained SANDSTONE with many localized bands of siltstone / mudstone (PLCM-MDSS)								
	8.0							
	10.0							
	12.0							
12.0m to 12.50m Coal Seam (500mm thick – unworked)								
12.50m to 13.50m MUDSTONE to SANDSTONE 13.50m TO 16.0m	14.0							
	16.0							
14.0m to 30.0m – Solid formation - Medium strong locally grey fine to medium grained MUDSTONE with many localized bands of sandstone / siltstone (PLCM-MDSS)	18.0							
	20.0							
	22.0							
	24.0							
	26.0							
	28.0							
	30.0							

Hole Diameter by Depth			Drilling Flush Details			Water Strike		
Depth (m)	Diameter (mm)	Casing (mm)	Depth(m)	Type	Return (%)	Strike Depth (m)	Depths Sealed (m)	Remarks
				water	100%			

Earth-Tech Consulting Ltd
Yorkshire Office
T: 07790 581478
E: timhyett@hotmail.co.uk

Remarks:
1. No voids or fractures / no loss of flush
2. No groundwater

Drilled By: **ACE Drilling Svs Ltd** | Logged By: **TH** | Checked By: **KH**

EARTH-TECH CONSULTING LIMITED	**Rotary Borehole Record**					**BH03**		Sheet 1 of 1
Project Ref: **TH/SBR/BESSEMER/02**	Client: **Mr Needham**					Date: **13.01.2023**		
Location: **Hill End Farm, Hill End Road, Mapplewell, Barnsley, S75 6DU**	Plant Used: **Berreta T41 rotary rig**					Borehole Position: (see plan Dwng No.)		
Geology Description	Depth (m)	Legend	TRC (%)	SCR(%)	RQD(%)	Sample / Insitu Test Information		
						Type	Depth	Remarks
0.00m to 1.50m Firm to stiff brown locally orangish-brown slightly sandy silty CLAY with gravel of fine to coarse sandstone - gravels are angular to coarse sandstone	0.0							
1.5m to7.00m: Weak to medium strong locally grey fine to medium grained SILTSTONE (PLCM-MDSS)	2.0							
	4.0							
	6.0							
7.00m to 7.9m Coal Seam (900mm thick – unworked)	8.0							
7.90m to 20.50m – Solid formation - Medium strong locally grey fine to medium grained MUDSTONE with many localized bands of sandstone / siltstone (PLCM-MDSS)	10.0							
	12.0							
	14.0							
	16.0							
	18.0							
20.50m to 20.80m Coal Seam (300mm thick – unworked)	20.0							
20.80m to 30.0m – Solid formation - Medium strong locally grey fine to medium grained MUDSTONE with many localized bands of sandstone / siltstone (PLCM-MDSS)	22.0							
	24.0							
	26.0							
	28.0							
	30.0							

Hole Diameter by Depth			Drilling Flush Details			Water Strike		
Depth (m)	Diameter (mm)	Casing (mm)	Depth(m)	Type	Return (%)	Strike Depth (m)	Depths Sealed (m)	Remarks
				water	100%			

Earth-Tech Consulting Ltd Yorkshire Office T: 07790 581478 E: timhyett@hotmail.co.uk	EARTH-TECH	Remarks: 3. No voids or fractures / no loss of flush 4. No groundwater
Drilled By: **ACE Drilling Svs Ltd**	Logged By: **TH**	Checked By: **KH**

The strata levels on the site were reasonably consistent between each borehole, with the rockhead broadly level being encountered fairly near to the surface. This should be borne in mind when reviewing the Borehole Logs and considering foundation details etc.

- The boreholes identified rockhead at between 2.0m and 2.50m BGL, with overlying deposits comprising predominantly *firm to stiff brown locally orangish-brown slightly sandy silty CLAY with gravel of fine to coarse sandstone - gravels are angular to coarse sandstone*. No significant Made Ground was encountered, and even in the hard standing areas this was nominal, being imported stone fill.

- Natural bedrock was found to be consistent, comprising *medium strong* (25MPa to 50MPa) rocks of the Pennine Lower Coal Measures - PLCM-MDSS. No voids were encountered; 1No. coal seam was encountered in BH1 and BH2, and 2No. coal seams were encountered in BH3 (Drilled in the field area to the West, and at a lower elevation). The coal had been unworked. No significant loss of water flush was experienced. Rock strength was broadly seen to increase progressively with depth.

From our inspection of the exposed geology from trial holes carried out to check for services prior to drilling, and from the rotary drilling itself there were **NO VOIDS** and **NO LOSS OF WATER FLUSH** that might otherwise suggest weak or collapsed zones associated with shallow coal workings.

01	TRIAL PIT No. TP1	
Project	Hill End Farm, Hill End Road, Mapplewell, Barnsley, S75 6DU	
Location	Offset 8m to the west of BH3 in proximity of the proposed dwelling.	

Depth (m) From	Depth (m) To	Strata Description
0.00	0.15	*Natural, brown slightly to medium sandy, slightly gravelly loam (TOPSOIL) semi-fibrous over gravelly landscaped Ground (Undivided) unclassified (LSGR-UKNOWN. Gravel is angular coarse sandstone, (with slight humose or peaty signature), single grain structure.*
0.15	1.25	*Firm to stiff brown locally orangish-brown slightly sandy silty CLAY with occasional gravels of fine to coarse sandstone – gravels are angular to coarse sandstone / mudstone (GLACIOLAUCUSTRIAN DEPOSITS)*
1.25	1.3	*End of Trial Pit (Bedrock): highly weathered, weak to medium strong locally grey fine to medium grained SILTSTONE (PLCM-MDSS)*

P and V values where given refer to the unconfined compressive strength in Kn/m² measured with a hand penetrometer (P) or hand vane (V)

Groundwater	*No ground water*	**Machine**	*5t mini-excavator*
Side Stability	*Stable*	**Weather**	*Fair, dry*
Sampling	*None*	**Other**	*-*
Pit dimensions	*2m long x 0.6m wide*		

Prepared By	TH	**Logged**	TH	**Date**	10.03.2023	**Job Ref:**	TH/Hill End/TP/X001

PHOTOGRAPHIC LOG (S)

[*Note – *soil descriptions & classification based on visual examination in accordance with the requirements of BS EN ISO 14688-1:2002 Geotechnical Investigation and Testing - Identification and Classification of Soil - Part 1, BS EN ISO 14688-2:2004, Part 2, and including where appropriate BS EN ISO 14689-1:2003 Geotechnical Investigation and Testing - Identification and Classification of Rock - Part 1*].

3.9 General Observations

There was also no unusual colouration or odours to any of the superficial soils and no evidence to suggest the site had any previous potentially contaminative or industrial use. There were no visual or olfactory indicators to suggest the presence of hazardous contaminants in particularly high (or any) significant concentrations, and no levels of methane or carbon dioxide were recorded using basic hand-held gas monitors during the drilling. Other observations were:

- Vegetation across the site is varied but there are no established trees or significant vegetation features that might be adversely affected by the proposed works, nor is the vegetation in proximity to the house plots likely to affect the works as proposed. There are no problems envisaged with swelling or shrinkage of soil due to the movement of groundwater and the propagation of trees, vegetation, flora and fauna.

- Groundwater, whilst not observed in any significant quantity, is likely to fluctuate in pockets, or at deeper elevations, however where encountered it can be estimated from empirical data to be in the region of between pH 5.5 – 7.0 representing a *low risk* in terms of acidic ground and potential sulphate attack on existing concrete and cement mortars.

4.0 CONTAMINATION ASSESMENT

4.1 Soil Sampling

It is generally accepted (and stated in CIRIA C659) that the overall objective for any intrusive investigation (by Trial Hole or Rotary Borehole) of a potentially contaminated site is:

> *'To provide information on actual and potential contamination and ground engineering characteristics to permit an assessment of environmental and physical risks and allow decisions to be made on the needs for and nature of any remedial work necessary for enabling a safe development.'* (Barry et al, 2001).

CIRIA C659 also states the site-specific objectives of an investigation should therefore be determined on the basis of:

i. the conceptual site model developed by the Phase I desk study and walkover survey
ii. the implications of anticipated conditions for the use (or proposed future use) of the site
iii. the potential hazards and risks (including health and safety risk) which could arise from the site conditions.

In addition, the factsheet from Public Health England (PHE) '*Use of Potentially Contaminated Residential Land, Gardens and Allotments'*: February 2019 PHE Gateway number: GW-183 states, inter alia;

> *'Sites with the potential to be contaminated are areas of historic industrial use that have been used for waste disposal, military or mining purposes, or had an accidental or deliberate release of chemicals in the past. A report carried out in 2014 for DEFRA indicated that between 2000 and 2013, most* [garden and allotment] *sites found to have a reasonable possibility of impacting public health were driven by chemicals such as arsenic, lead, nickel, chromium and the polycyclic aromatic hydrocarbons (PAHs) especially benzo[a]pyrene, all found in soil or water...'*

Based on the above, and on the fact that there was very limited amount of Made Ground encountered it was decided that 3No. soil samples (1 from each Borehole) would be adequate, and it was considered appropriate to only test for the chemicals that have a reasonable possibility of impacting public health, hence the laboratory testing focussed on the near surface infilled soils (only).

4.2 Objectives of the Laboratory Testing

The main aim of the laboratory testing is to evaluate the levels of chemicals present in the soil in order to determine if there is a significant risk to human health and/or the environment, with a view of determining what (if any) remedial measures are required or recommended.

The approach adopted in **estimating** and **evaluating risk** follows the recognized steps shown below (*courtesy of NHBC*):

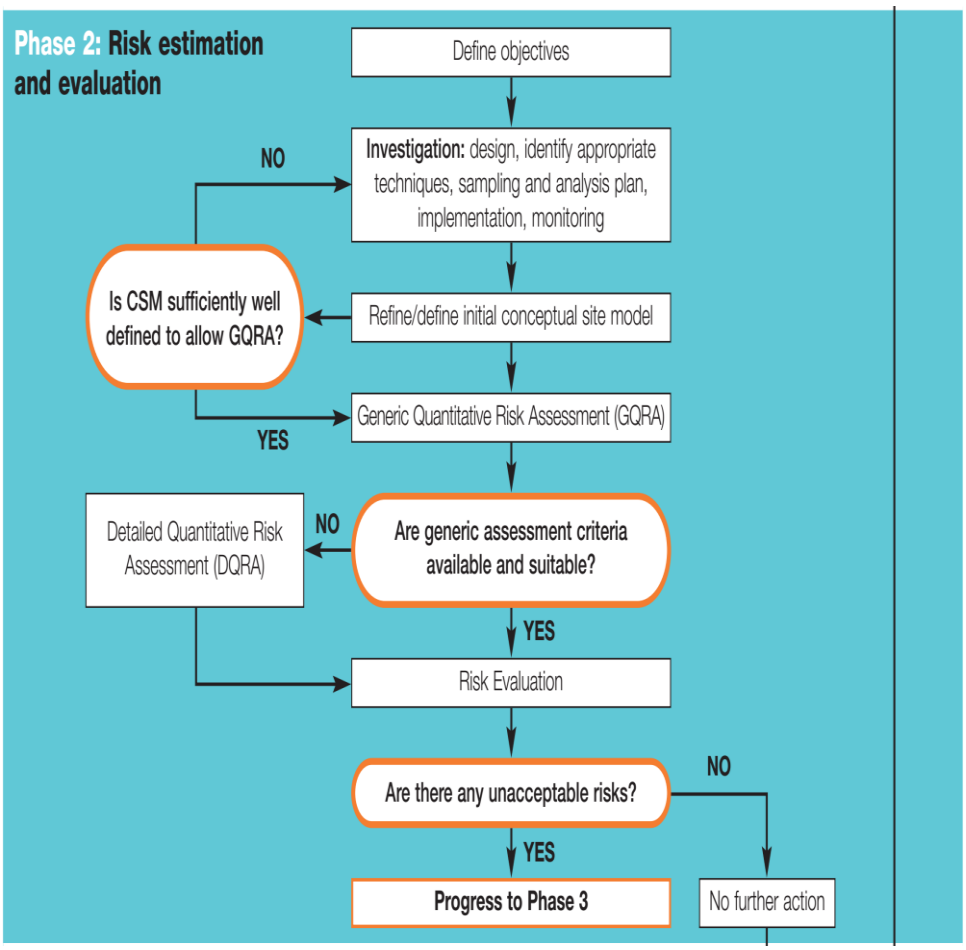


Table from NHBC 'Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008 Vol.1

4.3 Contamination Testing - Context

A key distinction between the previous guidance (i.e. using *Soil Guideline Values* (SGVs)) and the C4SLs is the level of risk that they describe. The Environment Agency (EA) consider that; 'SGVs are guidelines on the level of long-term human exposure to individual chemicals in soils that, unless stated otherwise, are tolerable or pose a minimal risk to human health'. C4SLs, therefore, should not be used as a legal trigger for the determination of land under Part 2A.

As such, the approach taken in this report follows the **2014 CL:AIRE (Contaminated Land: Application in Real Environments)** guidance published in the reference document '*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*' which lists the following C4SLs;

Analyte	Residential (with home grown produce) (mg/kg)	Residential (without home grown produce) (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)	PoS (mg/kg)
Arsenic	37	40	49	640	79
Benzene	0.87	3.3	0.18	98	140
Benzo(a)Pyrene	5.0	5.3	5.7	77	10
Cadmium	22	150	3.9	410	880
Chromium (vi)	21	21	170	49	21
Lead	200	310	80	2300	630

4.4 Laboratory Test Results – February 2023

Envirolab Job Number: 23/02277

Client Project Name: Hill End, Barnsley, S75

Client Project Ref: Earth Tech

Lab Sample ID	23/02277/1	23/02277/2	23/02277/3					Units	Limit of Detection	Method ref
Client Sample No	1	2	3							
Client Sample ID	BH1	BH2	BH3							
Depth to Top	0.50	0.50	0.90							
Depth To Bottom										
Date Sampled	13-Jan-23	13-Jan-23	13-Jan-23							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	5AE	6AE	6ABE							
% Stones >10mm$_A$	<0.1	11.7	8.5					% w/w	0.1	A-T-044
Arsenic$_D$[M#]	6	12	11					mg/kg	1	A-T-024s
Cadmium$_D$[M#]	0.6	0.6	0.6					mg/kg	0.5	A-T-024s
Chromium$_D$[M#]	22	24	26					mg/kg	1	A-T-024s
Lead$_D$[M#]	20	25	45					mg/kg	1	A-T-024s

Envirolab Job Number: 23/02277

Client Project Name: Hill End, Barnsley, S75

Client Project Ref: Earth Tech

Lab Sample ID	23/02277/1	23/02277/2	23/02277/3					Units	Limit of Detection	Method ref
Client Sample No	1	2	3							
Client Sample ID	BH1	BH2	BH3							
Depth to Top	0.50	0.50	0.90							
Depth To Bottom										
Date Sampled	13-Jan-23	13-Jan-23	13-Jan-23							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	5AE	6AE	6ABE							
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_D$[#]	NAD	NAD	NAD							A-T-045
Asbestos ACM - Suitable for Water Absorption Test?$_D$	N/A	N/A	N/A							A-T-045

envirolab

Envirolab Job Number: 23/02277

Client Project Name: Hill End, Barnsley, S75

Client Project Ref: Earth Tech

Lab Sample ID	23/02277/1	23/02277/2	23/02277/3					Units	Limit of Detection	Method ref
Client Sample No	1	2	3							
Client Sample ID	BH1	BH2	BH3							
Depth to Top	0.50	0.50	0.90							
Depth To Bottom										
Date Sampled	13-Jan-23	13-Jan-23	13-Jan-23							
Sample Type	Soil	Soil	Soil							
Sample Matrix Code	5AE	6AE	6ABE							
PAH-16MS										
Acenaphthene$_A^{M\#}$	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02	<0.02					mg/kg	0.02	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	0.06	0.09					mg/kg	0.04	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	0.06	0.08					mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	0.11	0.12					mg/kg	0.05	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05	<0.05					mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	<0.07					mg/kg	0.07	A-T-019s
Chrysene$_A^{M\#}$	<0.06	0.09	0.11					mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04					mg/kg	0.04	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	0.14	0.17					mg/kg	0.08	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01	<0.01					mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	0.03	0.04					mg/kg	0.03	A-T-019s
Naphthalene $_A^{M\#}$	<0.03	0.05	0.04					mg/kg	0.03	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	0.12	0.13					mg/kg	0.03	A-T-019s
Pyrene$_A^{M\#}$	<0.07	0.12	0.15					mg/kg	0.07	A-T-019s
Total PAH-16MS$_A^{M\#}$	<0.08	0.78	0.93					mg/kg	0.01	A-T-019s

4.5 BGS Estimated Background Soil Chemistry (by research – within 50m)

From research (the Geo-Insight Report) the *Estimated Background Soil Chemistry* within 50m of the study area boundary confirms the following:

Location	Arsenic	Bioaccessible Arsenic	Lead	Bioaccessible Lead	Cadmium	Chromium	Nickel
On site	15 - 25 mg/kg	No data	200 - 300 mg/kg	120 - 240 mg/kg	1.8 mg/kg	120 - 180 mg/kg	30 - 45 mg/kg
On site	15 - 25 mg/kg	No data	200 - 300 mg/kg	120 - 240 mg/kg	1.8 mg/kg	120 - 180 mg/kg	30 - 45 mg/kg

4.6 BGS Estimated Urban Soil Chemistry (within 50m)

From research (the Geo-Insight Report) the *Estimated Urban Soil Chemistry* within 50m of the study area boundary suggests the following:

Records within 50m	0

Estimated topsoil chemistry of Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Tin and Zinc and bioaccessible Arsenic and Lead in 23 urban centres across Great Britain. These estimates are derived from interpolation of the measured urban topsoil data referred to above and provide information across each city between the measured sample locations (4 per km^2).

The estimated values from the Groundsure Report provide the likely background concentration of the potentially harmful elements *Arsenic, Cadmium, Chromium, Lead and Nickel* in topsoil and upper subsoils. The values are estimated primarily from rural topsoil data collected at a sample density of approximately 1 per 2 km². In areas where rural soil samples are not available, estimation is based on stream sediment data collected from small streams at a sampling density of 1 per 2.5 km²; this is the case for most of Scotland, Wales and southern England. The stream sediment data are converted to soil-equivalent concentrations prior to the estimation.

4.7 Results Summary

Both the *background soil chemistry* (i.e. by research); the *indicative soil chemistry* (i.e. from observations on site) and the *laboratory testing* indicate levels of contaminants within the accepted range contained in the guidance in 2014 CL:AIRE (Contaminated Land: Application in Real Environments) '*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*' based on the six C4SLs.

- **All determinants for Contaminants fell BELOW the commercial guidance levels within the Made Ground and Subsoils.**

4.8 Further Observations

From the Phase I Desk Study it is evident that the site does not have any former industrial use. When soil samples were assessed on site, there were no visual indicators to suggest the presence of hazardous contaminants in high (or any) concentrations, both in the superficial soils and or at depth - and there was no evidence of shallow workings or coal seams. There was no physical evidence of high (or any) concentration of *oils, lubricants, sulphates, asbestos (chrysotile, amosite, tremolite, actinolite or ferroactinolite), radon gas, methane, high concentrations of carbon monoxide, hydrogen sulphide* or *carbon dioxide*. It was also observed that:

a. Regarding fuel/oils, there was no visual or olfactory signature in the soils inspected;

b. Regarding asbestos, there was no physical and/or anecdotal evidence, either from the presence of detritus from the construction of past building(s), or visual evidence of unlicensed tipping etc., in the trial holes. [*Note – *the buildings on the adjoining site do appear to date from the period when asbestos was used extensively as a building material in England and Wales i.e. 1950s through to the 1980s. It should also be noted that noted that blue (crocidolite) and brown (amosite) asbestos were banned by law in 1985, and the manufacture and supply of all asbestos was banned by the end of 1999. Under current legislation, existing asbestos articles can continue in use until they reach the end of their service life*].

c. Regarding *Polycyclic Aromatic Hydrocarbons* (PAHs), the selection of laboratory testing gave due consideration of the following:

   - **Previous use of the site** - there was/is no history of urban environmental pollution, heavy industrial uses, etc. In terms of possible past rural agriculture, the soils would be unlikely to have been affected by pesticides, sewage sludge and livestock manures associated with horticulture hence the likelihood of inputs of heavy metals and metalloids from these sources is extremely low.

   - **Atmospheric deposition** - the site is reasonably enclosed, and is set back from the main high street of a small rural village so the likelihood of significant contaminants in emissions from motor vehicles,

domestic and industrial burning of fossil fuels, industry (e.g. metal smelters, foundries), incinerators and dust from nearby contaminated sites was/is unlikely.

- **Historic use of contaminated fill for site levelling** - the topography of the site is generally flat, and there was no indication that excessive soil, rubble or mineral material in significant quantities from external sources, including materials from other sites and/or locations has been used to raise the level of the land and/or fill in localised depressions.

- **Bonfires** - there was no visual or olfactory indications that there had been any previous fires used to burn wood and other combustible materials which could give rise to relatively high concentrations of contaminants in the residual ash. In semi-rural sites it is not uncommon for residual ash to have been spread on the soil, but this usually only gives rise to contamination hotspots. None were identified, and hence the likelihood of significant quantities of Pb and Cr from paints, As, Cu and Cr from wood preservatives, and Cd from plastics etc., was/is highly unlikely.

- **Runoff from metal surfaces** – on some semi-rural sites this can sometimes cause elevated concentrations of Zn and Cd in water dripping from galvanized roofs and stored galvanized sheeting, galvanized fencing and guttering, and Pb from roofing. However, no galvanized elements were present.

- **Use of ash/mineral waste for making paths** – there was/is no evidence to indicate that any waste materials, such as incinerator ash, coal ash and metalliferous mine waste have been used to make free-draining paths, or that phytotoxic bearing contaminants have been used to create weed-free areas.

- **Burial of metal-containing wastes** – there was/is no evidence to indicate that there has been any previous disposal by burial of any waste materials, such as old electric cables, batteries and paint scrapings, which can sometimes be a measurable source of Pb, Cu and Zn.

- **Composts and fertilizers** – although there may be possible agricultural connections with the past use of the site it is unlikely to have been subjected to extensive (if any) cultivation using composts, fertilizers and sewage sludges, which can sometimes contain a range of trace metal and organic contaminants including: Cd and Zn in phosphatic fertilizers. No visual or olfactory evidence was observed in the trial holes and/or the boreholes, nor was there any evidence to suggests the occasional past practice (sometimes observed on garden/allotment sites) to compost waste and/or by-products from local industries, such as leather (Cr), felt (Hg) and carpet fabric, which can add considerable amounts of metals to the soils.

- **Pesticides** - due to the vacant previous usage of the site it is unlikely to have been subjected to extensive (if any) use of pesticides containing Pb, As, Cu, Hg and Zn - these compounds are more likely to be found in areas where annual crops are cultivated on a sizeable scale.

4.9 GROUND GAS and HAZARDOUS VAPOURS

It is well known that certain unnatural features, such as historic coal workings, disused quarries and landfill sites have the possibility of generating ground gases which have the potential to present a risk to human harm. **Methane** is the dominant constituent of most ground gas and can form an explosive mixture in air at concentrations of between 5% and 15%, thus 5% methane in air is known as the *Lower Explosive Limit* (LEL). Concentrations less than this do not normally ignite. Carbon dioxide can also be a potential problem, especially where it occurs > 1.5%.

The Phase I Desk Study identified that there was a potential source of methane or carbon dioxide beneath or in proximity to the site in the form of **Coal Seams** and/or **Shallow Mine Workings**. However, no workings were encountered but natural coal was identified in the borehole drilling. Gas monitoring was used during the drilling (personnel were equipped with *MSA Altair 4X Gas Monitors* as per the requirements of the Coal Authority Permit) and no emissions of Ground Gas were noted in the fieldwork.

Nonetheless, in accordance with the recommendations in the Phase I Desk Study and the CMRA, standpipe piezometer tubes were installed in BH1 and BH3 and a structured phase of Ground Gas monitoring was carried out for a duration of 6 weeks from 7th January 2023 to 18th February 2023 using a ***Geotechnical Instruments GA5000*** which is used to monitor landfill gas extraction systems and is designed to meet all current demands for landfill & Brownfield site monitoring protocols set by government legislation in Europe and the UK. It measures % CH_4, CO_2 and O_2 and barometric pressure.

GA5000 gas analyser

Fig 7 – Earth Tech's *Geotechnical Instruments GA5000* sampling system used at Hill End Farm, Hill End Road, Mapplewell, S75 6DU

Monitoring Installation & Depth of Response Zone

BH1 and BH3 were fitted with the necessary equipment to allow ground gas monitoring to be carried out over the course of 6 to 8 week period. Gas monitoring standpipe zones were set at the position of the Coal Seams +/- 2m in each case.

Migration / Pathways

The principal gas migration / transport pathways are thought to be lateral and/or vertical migration within the natural soils. No significant preferential pathways have been identified in any of the previous studies.

Receptors

Principal receptors of ground gas migration (if present on the site) and potential for accumulation include the future property / barn conversion; the workforce and the future occupants of the property.

Ground Gas Monitoring Data

Based upon a **low source potential** and high/medium sensitivity end use, a ground gas monitoring programme comprising 6 visits over an 8 week period was undertaken. The borehole positions selected for monitoring are shown on the Drawing presented above and the results are summarised in the table below:

GAS MONITORING RECORDS – HILL END FARM, HILL END ROAD, MAPPLEWELL, S75 6DU								
Location	**Date**	**CH4**	**CO2**	**O2**	**Flow**	**Barometric Pressure**	**Water Level**	**Standpipe Depth**
BH1	07.01.2023	0.0	0.8	20.1	0.0	1022	n/a	11.0m
	14.01.2023	0.0	0.6	20.0	0.1	999	n/a	11.0m
	28.01.2023	0.0	1.1	19.4	0.1	989	n/a	11.0m
	04.02.2023	0.1	1.2	27.6	0.0	979	n/a	11.0m
	11.02.2023	0.0	0.4	16.8	0.1	989	n/a	11.0m
	18.02.2023	0.1	1.0	18.3	0.1	1006	n/a	11.0m
BH2	07.01.2023	0.0	0.1	20.1	0.0	1022	n/a	8.0m and 20m
	14.01.2023	0.1	1.1	19.5	0.0	999	n/a	8.0m and 20m
	28.01.2023	0.0	0.2	20.1	0.0	988	n/a	8.0m and 20m
	04.02.2023	0.1	0.1	19.9	0.1	979	n/a	8.0m and 20m
	11.02.2023	0.0	1.0	17.3	0.0	989	n/a	8.0m and 20m
	18.02.2023	0.0	0.3	20.2	0.0	1005	n/a	8.0m and 20m
	07.01.2023	0.0	1.1	16.5	0.1	1022	n/a	8.0m and 20m

Strata within Response Zone

All the boreholes consisted residual bedrock within the response zone(s) and the piezo tubes were set at the coal seam levels identified in the BH Logs (+/- 2m).

Gas Concentrations

The six gas monitoring visits were carried out over a period between 7th January 2023 to 18th February 2023. The table above summarises the gas monitoring results obtained. The monitoring events covered atmospheric pressure conditions of between 979mb and 1022mb and included periods of steady and rising pressure.

With respect to Ground Gas, the results indicate **very low to negligible** methane (0.1 max), with concentrations of carbon dioxide ranging between 0.1% and 1.2% in association with oxygen levels of between 16.5% and 20.2%. It should be appreciated that on non-contaminated sites there is generally about 19% by volume of oxygen, associated with low levels of carbon dioxide. In addition, a maximum flow rate of 0.1 litres per hour was recorded, and this has been used in the preliminary calculations to derive an indication of the level of risk.

The principal driving force for initiating the movement of gas in the ground is a change in barometric pressure. The most onerous gas condition on a site is usually observed on days of low or falling barometric pressure, preferably below 1000mb. It has been noted in the guidance that measurements undertaken solely during high pressure conditions may be of lesser value. At Hill End Farm the readings undertaken were at atmospheric pressures of < 1000mb with the exception of two visits, but on these days it was marginally above the recommended value, and the results are not considered to be impaired by these minor exceedances.

Risk Assessment

In order to establish the gas screening value (GSV) for carbon dioxide or methane, the maximum gas concentration (expressed as a decimal) is multiplied by the borehole flow rate (l/hr).

- In this case a max of 0.1% methane was recorded along with 1.2% (0.012) carbon dioxide, in association with a maximum flow rate of 0.1 l/hr.

- This results in a **GSV of 0.01 (l/hr)** for Methane and a **GSV of 0.0012** (l/hr) for Carbon Dioxide.

Consulting Table 1 of BS8485: 2015, *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* shown below this indicates that the site would presently be characterized as:

CHARACTERISTIC SITUATION (CS) 1 – VERY LOW

Table 1.

Characteristic gas situation	Hazard potential	Site characteristic hazardous gas flow rate, Q_{hgs} $l h^{-1}$	Additional factors
1	Very low	<0.07	Typically ≤1% methane concentration and ≤5% carbon dioxide concentration (otherwise consider an increased characteristic gas regime)
2	Low	≥ 0.07, <0.7	Typical measured flow rate <70 l/h (otherwise consider an increased characteristic gas regime)
3	Moderate	≥ 0.7, <3.5	
4	Moderate to high	≥ 3.5, <15	
5	High	≥ 15, <70	
6	Very high	≥70	

[*NOTE - *the site characteristic hazardous gas flow rate is synonymous with the "gas screening value" in CIRIA C665 and NHBC Report no.: 10627-R01 (04*)].

From the above, **CS Level 1** indicates that currently the site is considered to present a **very low risk** of harm to end users and site operatives, and **NO SPECIAL PRECAUTIONARY MEASURES** would be required.

Having ascertained the characteristic gas situation, the accepted procedure is to use a suitable point scoring mechanism to match the application (i.e. the type of building) with the gas protection system solution. A guidance value for the required gas protection in the range 0 to 6 should be obtained from Table 2 of BS8485: 2015 shown below (OR) or alternatively by reference to the equivalent **NHBC Traffic Light Risk Factor** taken from NHBC Report no.: 10627-R01 (04) for low-rise residential housing.

For domestic housing (only), and within the context of the equivalent NHBC traffic light risk factor, Table 2 of BS8485: 2015 can be expressed as follows:

Table 2.

Characteristic gas situation	NHBC traffic light Very low	Required gas protection			
		Non-managed property, e.g. private housing	Public building	Commercial buildings	Industrial buildings
1 2 3	Green Amber 1 Amber 2	0 3 4	0 3 3	0 2 2	0 1 [C] 2
4 5 6	Red	6 [D]	5 [D] 6 [E]	4 5 7	3 4 6

It should be noted that the NHBC supports the revised British Standard Code of Practice (BS8485:2015 +A:2019), which provides a standardized UK approach that can be used to demonstrate compliance with Building Regulations.

The NHBC Traffic Light guidance approach can still be used where the development proposals are based on the 'typical house' used in the modelling for the traffic light classification system. A typical house is defined by the NHBC as a house (up to three storey) with <100m² footprint and minimum 150mm depth clear ventilated void achieving sub-slab ventilation of one complete air exchange per day. As can be seen from the above, a **GREEN** trigger is apportioned to the site at Hill End Farm and no gas protection measures are required.

- From a 6 to 8 week on-site analysis, no significant levels of methane or carbon monoxide were detected.
- This confirms the site to be a **LOW HAZARD POTENTIAL** site.
- There is no immediate requirement to undertake a further detailed phase of ground gas monitoring.

4.10 Residual Risk - Hazardous Vapours

There is a *Very Low* risk of ground gases from anthropogenic sources within any areas where there may be infilled ground, and the field work has now confirmed that there are **no shallow coal seams present beneath the site**. The drilling works has confirmed that, in this location, the bedrock has not been worked - there was no loss of water flush and no voids encountered, indicating otherwise stable solid geology. No levels of gas were recorded during either the drilling fieldwork (or) the Gas Monitoring phase.

[*Note! - *There is always residual risk that infilled ground could generate unacceptable levels of ground gas, and the development proposal is for a Class Q Barn Conversion, and the site is not located in a radon area – However, it is still recommended that the developer considers installing synthetic membranes and/or liquid membranes, ideally to Characteristic Situation CS2 as best practice. Damp proofing membranes will be required to meet Building Regulations in any event, and the Radon Regulations are currently under review by the HSE, so where practicable it would be prudent to upgrade the DPC membrane to CS2 equivalent*].

5.0 CONCEPTUAL SITE MODEL

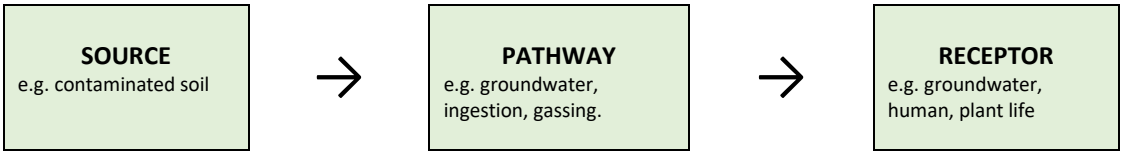
5.1 Basis of the Model

A quantitative health and environmental risk assessment forms part of this report: the process of risk assessment follows the guidance contained in **Part 2A of the Environment Protection Act 1990**, which defines contaminated land as:

> *'any land which appears to the local authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that there is a significant possibility of significant harm being caused, or that significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused'.*

The risk assessment uses a '*Source-Pathway-Receptor*' methodology for assessing whether a source of contamination could potentially lead to harmful consequences. This means that there needs to be a pollutant linkage from source to receptor for harm to be caused, this linkage consisting of: a source of pollution; a pathway for the pollutant to move along; a receptor that is affected by the pollutant. The current potential risks to the site arising from various source-pathway-receptor linkages are assessed below.

A risk may be considered significant if all three of the stages are present and therefore providing a pollution linkage. The various sources, pathways and receptors are considered separately. The assessment is based on the future use, which is understood to be predominantly residential.



5.2 **Human Health (Pathways 1-5, Receptors A–C)**

- ***Uptake of contaminants*** by food plants grown in contaminated soil - Uptake will depend on concentration in soil, its chemical form, soil pH, plant species and prominence in diet.
- ***Ingestion and inhalation*** - Substances may be ingested directly by young children playing on contaminated soil, by eating plants which have absorbed metals or are contaminated with soil or dust. Ingestion may also occur via contaminated water supplies. Metals, some organic materials and radioactive substances may be inhaled from dusts and soils.
- ***Skin contact*** - Soil containing tars, oils and corrosive substances may cause irritation to the skin through direct contact. Some substances (e.g. phenols) may be absorbed into the body through the skin or through cuts and abrasions.
- ***Irradiation*** - As well as being inhaled and absorbed through the skin, radioactive materials emitting gamma rays can cause a radiation response.
- ***Fire and explosion*** - Materials such as coal, coke particles, oil, tar, pitch, rubber, plastic and domestic waste are all combustible. Both underground fires and biodegradation of organic materials may produce toxic or flammable gases. Methane and other gases may explode if allowed to accumulate in confined spaces.

5.3 **Buildings (Pathways 7 and 8)**

- ***Fire and explosion*** - Underground fires may cause ground subsidence and cause structural damage. Accumulations of flammable gases in confined space leads to a risk of explosion.

- ***Chemical attack on building materials and services*** - Sulphates may attack concrete structures. Acids, oils and tarry substances may accelerate corrosion of metals or attack plastics, rubber and other polymeric materials used in pipework and service conduits or as jointing seals and protective coatings to concrete and metals.

- ***Physical*** - Blast-furnace and steel-making slag (and some natural materials) may expand. Degradation of fills may cause settlement and voids in buried tanks and drums may collapse as corrosion occurs or under loading.

5.4 **Natural Environment (Pathway 6, Receptors D-E)**

- ***Phytotoxicity*** (prevention/inhibition of plant growth) - Some metals essential for plant growth at low levels are phytotoxic at higher concentrations. Methane and other gases may give rise to phytotoxic effects.
- ***Contamination of water resources*** - Soil has a limited capacity to absorb, degrade or attenuate the effects of pollutants. When this is exceeded, polluting substances may enter into surface and groundwaters.
- ***Ecotoxological effects*** - Contaminants in soil may affect microbial, animal and plant populations. Ecosystems or individual species on the site, in surface waters or areas affected by migration from the site may be affected.

5.5 **Assessment Methodology**

For any potential contaminant source identified, professional judgement is required to assess the probability of a pollution linkage occurring and to quantify the possible consequences of that linkage. Based on the probability and likely consequences, the overall risk (significance) can then be established. This is based on a standard risk assessment model:

Hazard (H) is something with a potential to cause *harm*.
Severity (S) is the *magnitude* of the harm the hazard could cause.
Probability (P) is the *likelihood* the hazard will occur.
Risk (R) is the likelihood of the hazard (x) the severity of the harm it could cause.

Risk Rating (RR) = Severity (S) x Probability(P)

Probability (P)

Probability of Risk	1. Remote 2. Possible 3. Probable	Unlikely but conceivable May occur, could well occur May occur several times, occurs frequently

Severity (S)

	1. Negligible	*Human Health:* no chance of injury *Environment:* no chance of harm to the environment *Project:* no impact on construction works
	2. Minor	*Human Health:* minor harm with short term effects *Environment:* nuisance and minor disturbance to flora and fauna *Project:* minor changes required to achieve construction objectives with low costs and/or delivery implications
	3. Moderate	*Human Health:* major injury or disability or ill-health with long term effects *Environment:* potentially fatal to flora and fauna for days / weeks *Project:* major changes required to achieve construction objectives with significant costs and/or delivery implications
	4. Severe	*Human Health:* permanent disability / death *Environment:* detrimental to local eco-systems for months / years *Project:* catastrophic impact on construction objectives

Risk Rating (RR)

PROBABILITY	MINOR	SEVERE	EXTREME
Remote	1	2	3
Possible	2	4	6
Probable	3	6	9

1	VERY LOW	*Risk is negligible – no action required*
1-2	LOW	*Risk is controlled as far as is reasonably practicable, no further control measures necessary*
3-4	MODERATE	*Risk should be evaluated and controlled as far as is reasonably practicable*
6-9	HIGH	*Hazard should be avoided – Ground remedial measures required*

Source	Potential Pollutant	Pathways	Receptor	Risk
Possible past minor spillages of materials. Possible contaminants from previous agriculture & farming.	Oils, fuels, greases, hydraulic fluids, metals, Creosote(s), oil, tar, pitch. Anthropogenic debris, e.g. ash, clinker	1-5	A. Present users (owner)	**RR=1 Very Low Risk** involved with pre-construction phase as some disturbance is required – farming & agriculture associated works have ceased.
			B. Groundworkers.	**RR=1 Very Low Risk** – none observed in lab testing – minor residual risk associated with excavation work - personnel still to adopt robust RAMS and suitable precautions together with adequate washing facilities (which is an absolute obligation under CDM2015).
			C. Future workers, visitors and members of the public.	**RR=1 Low Risk** possible presence of exposing areas of *Infilled Ground* associated with the works

				for foundations, drainage and associated infrastructure.
		2	D. Controlled waters.	**RR=2 Low Risk.**
			E. Ecosystems	**RR=2 Low Risk.**
		2	F. Building Materials and Services.	**RR=2 Low Risk** provided no extraordinary construction materials /methods proposed.
Possible contaminants from previous structures	Asbestos	7	C. Future workers, visitors and members of the public.	**RR=0 Very Low Risk** – none observed
Underground workings, cavities, mines, landfills.	Mine, landfill and ground gases, Radon, VOCs	3	A - F	**RR=1 Low Risk** – none observed during drilling field (or) over a structured 6 to 8 week monitoring phase using a *Geotechnical Instruments GA5000* sampling system.
Surface Workings	Past tipping, uncontrolled wastes, anthropogenic debris, e.g. ash, clinker	1	D - E	**RR=3 Low Risk**
Waste Materials	Past tipping, uncontrolled wastes			**RR=2 Low Risk.** No identifiable wastes obser5ved and requiring to be removed from site

6.0 CONCLUSIONS

6.1 Soil and Groundwater Contamination

Groundwater was not observed in the trial holes carried out ahead of the BH drilling (or) in the BHs themselves. As such, broadly speaking, groundwater can be expected to be below the zone of influence of existing foundations and below any potential new drainage connections etc. There is no significant risk of encountering soils with high leaching potential; no evidence of abstractions or springs on current mapping, and no evidence of a perched water table and/or artesian pressure within the soil at shallow depth.

- There is no evidence of any significant soil contamination sources (heavy industry, fuel stations, etc.).
- There was no visual or olfactory evidence of significant quantities of possible anthropogenic debris, i.e. ash, clinker etc., and no visual/olfactory (malodorous) evidence to suggest potential land contamination.
- There was no unusual colouration or odours to any of the soils encountered and sampled during all the trial hole and BH excavations; no evidence to suggest the site had any previous heavy industrial use, and no visual indicators to suggest the presence of hazardous contaminants in significant (or any) quantities.

6.2 Ground Gases and Hazardous Vapour

No ground gasses were recorded during the investigation. The desk study did identify possible evidence of shallow coal mine workings but the field work did not identify any indications of disturbance, voids and/or cavities relating to past coal mining legacy. Coal seams were identified but these were thin, natural and had not been worked. The solid geology was found at circa 2m depth across the whole site and was very stable - therefore there is no requirement to consider any ground stabilisation such as grouting etc., with a ***very low*** to ***extremely low*** residual risk that ground gases could still be generated at some time in the future, by natural sources.

- No Ground Gas Membranes are required, and the property is NOT located in a Radon Area.

However, it is recommended that as the development is a new build, the DPC membranes should be uprated to radon equivalent as best practice and to mitigate any future or residual risk. (basic radon protection membranes are compatible with, and the equivalent to, *Characteristic Situation CS2* gas protection standards). These are the same membranes / methods used to protect against other ground gases such as methane or carbon dioxide on sites categorized as *Low Hazard Potential* (after *Wilson et al., 2007*; *Boyle and Witherington, 2007*).

6.3 Foundation Criteria

Normal strip footings should be suitable for the new building, unless there are any unusual or complex design elements associated with the building that require more expansive support(s). Rockhead was encountered at c. 1.5m BGL in BH3, positioned immediately next to the site of the new dwelling, and this will be measurably less after topsoil stripping etc., so it would be prudent to **take strip foundation depths to rockhead** where practicable:

All foundation excavations should be inspected to ensure that no supporting structures are situated upon any infilled ground, soft clays or other weak soils that would be incapable of safely sustaining the applied raft foundation loads.

Typical foundation design is shown below for a worst case where rockhead is not encountered. For firm clay (overlying the bedrock) the typical Soil Parameters (from Index Testing) are assumed as:

Estimated UCS	25MPa
Bulk Density	2100 Kg/m³
Unit Weight (γ)	20.6 Kn/ m³
Angle of Internal friction	0 degrees
Cohesion	0 Kn/m²

Bearing Capacity Factors (Shallow Foundations) - (BS 8004: 1986)

Nc - 47
Nq - 35
Nγ - 40
Approximate Foundation width B – 0.6m
Approximate Foundation depth D – 0.75m

Approximation / Check on Bearing Capacity in Rock (after Terzaghi)

(i) Ultimate Bearing Capacity (Qf) is given by;

$Qf = C.Nc + \gamma DN\gamma + 0.5B\gamma Nq$

Qf = 20.6x0.6x40 + 0.5x0.5x20.6x35

Qf = 494.4 + 180.25 =675Kn/m²

Where;

(ii) The Safe Bearing Capacity (Qs) is given by;

Qs = Qf/FOS where FOS =3

Qs = Qf/3

(or)

Qs = 675/3 = 225Kn/m²

>> 3 x UCS and >> than the proposed loading for a traditional two storey domestic dwelling- therefore O.K

6.4 **Building Near Trees**

Wherever any buildings are located near existing or proposed planting of new trees, their foundations must be positioned below the potential root growth zone.

Reference should therefore be made to the *NHBC Standards Chapter 4.2 'Building Near Trees'*, which gives guidance on foundation criteria, depths and construction. All services will also have to be similarly protected.

6.5 **Radon Gas**

The site is not within an area where Basic Radon Protection Measures are required for new properties.

However, the Radon Regulations are currently under revision with the HSE, and given that the new dwelling will require sheet DPC membranes in any event, **it is recommended that the developer considers up-rating these to basic radon protection levels** - as best practice.

There were no elevated levels of ground, mine or landfill gases found on site during the investigation phase, but in any event, the use of approved radon and moisture-resistant membrane installed according to best practice will provide additional mitigations for the new building, and in practice this is easy and inexpensive.

If suspended concrete beam and block ground floors are adopted further guidance should be sought by the Contractor but as a minimum it is recommended that a double layer of Visqueen 1200 gauge or an equivalent approved DPC/radon barrier is laid over the concrete blocks and covered by a concrete screed. Any void spaces beneath ground floors should be well ventilated both internally and externally with closely spaced air-bricks. Sleeper walls should either be of honeycomb structure or contain sufficient openings to ensure adequate air movement and ventilation. All air-bricks included in the structure(s) should be placed at the top of the void space to prevent them from becoming blocked by vegetation, and should be lined or cased through cavity walls.

Where possible, all services, drains and pipe work should enter the buildings from above ground level. Where this is not possible, they should be sealed at the points of entry, in order to prevent any unexpected residual ground gases entering the buildings via backfilled trenches. It is usual to properly seal all services where they pass through the impermeable DPC/radon membrane(s).

British Standard *BS8485: 2015 'Code of practice for the design of protective measures from methane and carbon dioxide ground gases for new buildings'*, and Building Research Establishment Report BR414 'Protective Measures for Housing on Gas Contaminated Land', together with the *CIRIA Report 149 'Protecting Development from Methane'* and *BR211 (2015) 'Radon: Guidance on Protective Measures for New Buildings'* all give construction advice for preventing gases entering buildings, the principles of which are incorporated in the above recommendations. Advice is also given in respect of sealing services where they pass through impermeable membranes.

All works should be carried out in accordance with The Building Regulations 2010 England: *Approved Document C - Site preparation and resistance to contaminants and moisture* (2004 edition incorporating 2010 and 2013 amendments), and BRE Report *BR211 (2015) Radon: Protective measures for new buildings*. The installation and verification of the membrane should also be in accordance with *YALPAG 'Verification Requirements for Gas Protection Systems' Version 1.1, December 2016*.

6.6 **Existing Drains and Services**

Wherever any redundant drains and other services channels are found to underlie new building foundations, they should be dug out and replaced by lean mix concrete or compacted hardcore to an appropriate standard. Any longer or deeper

drainage runs can be grouted using a suitable cementitious grout, but care should be taken to ensure that no grout enters any live drains, sewers or culverts.

6.7 Road / Pavement Construction

The driveway to the new dwelling will be based on a subgrade of firm to stiff clay, overlying weathered siltstone/mudstone bedrock. By observation and index testing from disturbed/undisturbed soil samples this suggests typical in-situ CBRs of 2% to 2½%.

- It is recommended that a design CBR of 2% be adopted for the access drive to the property. This will allow for a reasonable construction thickness on top of the subgrade, as well as for any isolated weaker areas.

The design of trafficked pavements should always take account of the ground conditions and likely traffic loads during the life of the development. Designs meeting the requirements in the following table will normally be acceptable. At sites where particular poor ground conditions are encountered or where it is anticipated that there will be a particularly high frequency of commercial vehicle or abnormal load movements, further analysis is accordance with the '*Design Manual for Roads and Bridges*' will be required to demonstrate adequacy of the design.

A preliminary design check can be prepared using an 'Equilibrium CBR' value based on the appropriate type of sub-grade material as set out in the table below. However, if this method of CBR estimation is used, testing by an approved laboratory should be carried out prior to construction in order to verify the CBR value used for design.

Equilibrium CBR Value to be used for Design Purposes		
Type of Soil	**Plasticity Index**	**Equilibrium CBR (%)**
Heavy Clay	50 or greater	Less than 2
Heavy Clay	40 to 49	2
Heavy Clay	30 to 39	2
Silty Clay	20 to 29	3
Sandy Clay	10 to 19	4
Silt	Less than 10	1
Sand (Poorly graded)	Non-plastic	20
Sand (well graded)	Non-plastic	40
Gravel (poorly graded)	Non-plastic	40
Sandy Gravel (well graded)	Non-plastic	60

Table 1 -Equilibrium CBR Values based on Manual for Roads and Bridges

A granular road/pavement foundation comprising sub-base or a combination of sub-base and a capping layer can be provided in accordance with the table below.

Pavement Foundation Design					
CBR (%)	**Capping (mm)**	**+**	**Sub-Base (mm)**	**OR**	**Sub-Base (mm)**
Less than 2	600	+	150		--
2	450	+	150		--
3	350	+	150	OR	300
4	300	+	150	OR	275
5 to 15	250	+	150	OR	225
> than 15	--	+	--		150

Table 2 - Typical pavement design based on Equilibrium CBR Values (Manual for Roads and Bridges)

Sub-grades that have CBR values significantly less than 2% and deform under construction traffic may be unsuitable to support the pavement, even for a domestic driveway. In this case, special measures will be required. No material within 450mm of the finished road surface should be frost susceptible.

Prior to the application of any sub-base, all subgrades must be checked by proof rolling to ensure that an adequate CBR exists. Where any loose granular or soft clayey areas remain, these must be either dug out and replaced by compacted material or an additional 150mm of sub-base added. This will be especially important wherever trench works for drains, sewers and other services have been carried out. Old foundations (if present) should be removed to a depth of 1m below subgrade level to prevent hard spots occurring. It will also be necessary to prevent the deterioration of the subgrade from the effects of wet weather and site traffic.

6.8 Excavations and Groundwater

Soft ground plant should prove suitable for most of the trench/foundation excavations. For all deep excavations in excess of 1.2m where vertical sides are necessary, trench supports should be provided as the soils will not be self-supporting for any appreciable length of time. It would also be prudent (as best excavation practices) to monitor excavations for the presence of explosive or asphyxiating gases in any 'confined space' situation.

No significant groundwater seepages were noted in the near surface excavations. However, it should be remembered that trapped groundwater can be released from areas of Made Ground when they are excavated. In addition, seasonal variation in groundwater levels will occur and groundwater will be shallower during the winter months.

6.9 Contamination

Laboratory testing has recorded no significant contaminants and as such no special precautions are necessary.

6.10 Cement and Buried Concrete

The soils have generally been assessed as containing negligible (or very low) levels of soluble sulphates. Therefore, in accordance with the *Building Research Establishment Special Digest No. 1 'Concrete in Aggressive Ground'*, a normal Portland cement in accordance with Group DS-1 Specifications should be acceptable for all buried concrete, mortar, and pre-cast concrete pipes.

6.11 Further Monitoring and Inspection

Should any geotechnical or geo-environmental problems arise on site or if ground conditions are different from those that are predicted, this should be referred to Earth-Tech Consulting Ltd for further guidance.

6.12 Recommendations

1. No further action is required regarding Ground Gas and Contaminated Land risk (based on the approach contained in Table 1 of the NHBC Publication '*Guidance for the Safe Development of Housing on Land Affected by Contamination*' R&D66: 2008 Vol.1).

2. Although not a strict requirement, it is recommended that *Basic Radon Protective* measures are adopted where practicable. The Radon Regulations are currently under review by the HSE and sealed sheet (or) liquid membranes are available and inexpensive which are equivalent to *Characteristic Situation CS2*) in line with the guidance contained in *CL: AIRE Research Bulletin RB17 'A Pragmatic Approach to Ground Gas Risk Assessment'*.

   This will serve to mitigate any residual risk of natural ground gases being generated from beneath the site, were this to manifest at any time in the future. Utilising Radon Barrier membranes (or) CS2 gas membranes beneath the proposed houses is cost-effective and proportionate although the radon risk is *very low*.

3. The geology as identified by the BHs suggests that **traditional strip footings** ideally to rockhead represent the optimum foundation design - this should be adopted by the *Engineer/Architect*.

6.13 Basis of Assessment

This assessment is a **Phase II Intrusive Site Investigation** intended to confirm the site is suitable for the intended use and to confirm that no further action is required. This report may be submitted in support of either a planning application or discharge of conditions or for the purposes of due diligence on the part of the owner. I can confirm to Barnsley Metropolitan Borough Council Planning Department (and any other third party), that the geological conditions on the site are adequate for carrying out the development as proposed in the drawings, plans and submissions prepared by the architects.

I confirm that under para. 2.E.2 of Appendix 2E of *Planning Policy Guidance Note 14 (PPG14) – Development on Unstable Land, DoE, 1990* I am suitably qualified to make these statements, and I understand that my overriding duty is to present independent and impartial expert analysis, and I believe I have complied with that duty. The facts I have stated in this report are true and the opinions I have expressed are correct and they are entirely my own, based upon the evidence I have been shown and my own observations.

Signed

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Tim Hyett LLM MSc CEng MIEI CGeol FGS MCIOB
Consultant Chartered Engineering Geologist
Earth-Tech Consulting Ltd
11th March 2023