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CONSULTING ENGINEERS

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PHASE 1 AND PHASE 2 GEOTECHNICAL AND GEO-ENVIRONMENTAL SITE INVESTIGATION REPORT

LOW CUDWORTH GREEN, CUDWORTH BARNSLEY

FOR

RMH PROPERTIES LTD



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ISSUE 1

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Appendix 4 Geotechnical Test Results, PSL5883

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1.0 EXECUTIVE SUMMARY

1. The approximately 0.4 hectare site is located to the south of Low Cudworth Green in the south of Cudworth, around 3 miles north east of the centre of Barnsley.

2. The site is currently under construction, foundations for four properties have commenced along the northern boundary. Site won topsoil is stockpiled in the south eastern corner, with building supplies and machinery in the south western corner. The site is bound by a footpath to the west. To the north, east and south lies residential housing, the eastern boundary is marked by a brick retaining wall with the adjacent properties elevated by 1 to 2 m above site ground level.

3. The site has only ever been used as a farm, Poplar Farm, known to have been a turkey farm in the recent past. A well was present in the centre, until 1906.

4. The solid geology below the site comprises interbedded mudstone, sandstone and siltstone of the Pennine Middle Coal Measures. No superficial deposits underlie the site.

5. Precautions against the effects of shallow mining are not considered necessary.

6. Made ground is present across the site, with a typical thickness of 650 mm, overlying natural soft to firm sandy clay with weak mudstone encountered at depths of around 1.6 to 2.4 m. Coal was found on the eastern half of the site between 1.4 and 4.4 m, increasing in depth to the east. Groundwater seepage was noted in four of the eight trial pits between 1.0 and 2.4 m bgl.

7. Strip or trench fill foundations are deemed to be suitable for the proposed buildings. These should be founded within the natural clay, through the made ground, at a minimum depth of 900 mm. Foundations within clays, which are within influencing distance of present or past trees, will need to be deepened in accordance with NHBC Standards, Chapter 4.2. Heave precautions will be required where foundations are more than 1500 mm deep due to past or present trees.

8. Ground bearing floor slabs are not considered appropriate for the site. Either precast beam and block or reinforced suspended concrete slabs would be suitable considering the loose made ground.

9. Infiltration testing was not carried out. Soakaway drainage was not deemed viable considering the impermeable nature of clay, and onsite observations of poor surface water drainage.

10. No radon or ground gas precautions are required.

11. Elevated concentrations of PAH's, zinc and lead were recorded, in comparison to the human and phytotoxicity assessment values in the site won topsoil. Asbestos (chrysotile) clumps or fibres were also identified. The current topsoil has been deemed unsuitable for reuse, it is advised it is removed from site and clean appropriate topsoil is sourced.

12. Slightly elevated concentrations of two PAH's was recorded within the made ground. The values were marginally above the accepted human assessment values; this is not considered to pose a significant threat to human health with a sufficient depth of suitably clean capping material. This capping layer should be 450 mm in thickness and should comprise clean imported topsoil.

13. A design sulphate class of DS-2 and an ACEC class of AC-2 is considered appropriate for concrete in contact with any made ground.

14. The conclusions made in this report in relation to contamination are subject to agreement by the approving bodies, such as the Local Authority, and any warranty provider.

2.0 INTRODUCTION

2.1 Terms of Reference

This report presents the findings of a geotechnical and geo-environmental site investigation carried out by Eastwood & Partners (Consulting Engineers) Ltd for, and on the behalf of RMH Properties Ltd. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

2.2 Context

Eastwood & Partners do not know of any previous geotechnical or geo-environmental investigations to have been undertaken on the site in the past.

2.3 Aims and Objectives

The aims and objectives of this investigation were as follows:

- Assimilate Phase 1 data to derive an outline conceptual model identifying potential contaminants, pathways and receptors, as well as possible linkages between these;
- Obtain information enabling refinement and subsequent testing of the conceptual model;
- Carry out a tiered risk assessment to establish the likely risks to future receptors, involving the use of generic assessment criteria and where unacceptable risks are identified, site specific assessment criteria within a detailed quantitative risk assessment;
- Identify feasible remediation options if unacceptable risks are highlighted;
- Develop an appropriate remediation strategy where remediation is required; and
- Detail the ground conditions and their geotechnical properties enabling outline foundation proposals to be made.

2.4 Scope of Investigation

This document is split into two sections. These constitute the findings of the Phase 1 and Phase 2 investigations, consecutively.

2.4.1 Phase 1

The Phase 1 investigation involved a review of information extracted from published documentation as well as that obtained from a site reconnaissance. Information regarding the current and former land uses both on and surrounding the site, as well as the environmental sensitivity of the site

location as determined by factors including geology, hydrogeology and hydrology have been examined.

Information analysed in this section of the report has been obtained from a variety of sources and included the following:

- A Landmark Envirocheck;
- A Coal Authority Mining Report;
- British Geological Survey Maps;
- The British Geological Survey website; and
- A site walkover.

The results of the Phase 1 investigation were used to derive an outline conceptual model from which a preliminary risk assessment was made.

2.4.2 Phase 2

This part of the investigation consisted of intrusive works and laboratory analysis. The findings were used to test the conceptual model and produce a final risk assessment. The intrusive works comprised trial pits and rotary boreholes to enable:

- Examination of the upper few metres of ground;
- In situ description of soils, enabling any localised lateral and vertical changes in soil conditions to be logged;
- Assessment of any contamination identified using visual and olfactory methods;
- Collection of soil samples for geotechnical and chemical testing; and
- Determination of the depth, thickness and condition of possible shallow coal seams beneath the site.

2.5 Limitations of Investigation

This report is based on the assumption that the site will be developed with low rise housing of conventional construction with private gardens, and that site levels will not alter significantly. If this is not the case, then the advice given in this report may not be appropriate. At the time of the site visit, three of the new plots were under construction, with foundations having been cast and the

substructure blockwork being in place on one. We understand that the Local Authority building inspector had witnessed the excavations prior to casting the concrete.

Where assessments of site areas affected in particular ways are given, these are approximate. All information, comments and opinions given in this report are based on the ground conditions encountered during the site work, on the results of laboratory testing carried out as part of the investigation and information gained from a geological, historical and environmental desk study. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata and water conditions between or below investigation points. It should be noted that groundwater levels vary due to seasonal or other effects, and may at times differ from those measured during the investigation.

This report considers the ground and groundwater and does not cover any buildings or their fabric, or the constituents of any existing hardstanding materials. Generally, testing has only been carried out for contaminants identified as potentially present with no assessment made of biological contamination. Risks to ecological receptors, such as bats, have not been considered.

3.0 THE SITE

3.1 Description

The site is located to the south of Low Cudworth Green, in the south of Cudworth, around 3 miles north east of the centre of Barnsley. It is centred on Grid Reference 438930, 408240 and has an area of approximately 0.4 hectares. The site is roughly rectangular in shape. The topography is mostly level with a gentle gradient sloping towards the south western corner of the site.

Construction of the residential development has commenced on site, one house is nearing completion in the north western corner, which comprised the renovation of an existing two storey farm house, with foundations having commenced on three further houses along the northern edge. The southern half of the site is comprised of several stockpiles, two comprised of site won topsoil and at least two of refuse requiring removal. Building materials and machinery are stored along the western boundary. A small area of macadam hardstanding, approximately 10 m by 5 m, remains at the entrance to the site from Low Cudworth Green.

The site is bound to the west by the end of Low Cudworth Green and a paved footpath with temporary metal herras fencing in place. The north, east and south of the site is surrounded by residential properties. The northern boundary is lined by a stone wall, the south with wooden fencing and the east by a brick retaining wall. The adjacent properties to the east of site are situated approximately 1 to 2 m above the current site elevation. At least seven mature and semi-mature fir trees line the south eastern boundary.

The Exploratory Hole Location Plan, drawing 41954/001A in Appendix 1, shows the features described.

3.2 History

Historical Ordnance Survey maps within the Envirocheck have been reviewed to assess the previous use of the site and surrounding area. Copies of the maps are presented in Appendix 2.

3.2.1 The Site

The earliest Ordnance Survey map available is from 1893 and shows the site to comprise several larger buildings in the western half, and open land with woodland cover in the east. A well is noted in the centre of the property adjacent to a small pond.

The 1906 map does not show the well to be present on site any longer.

By 1962 the area has been named as Poplar House Farm and a footpath is shown to cross the south eastern corner of the site.

During 1970 to 1984 the number of buildings on site increases to cover the south eastern corner of the site.

Another building is shown on the 1993 map in the north eastern corner.

Aerial photography from 2017 shows at least three buildings in the eastern half of the site to have been demolished. The remaining buildings have since been removed with the exception of the farm house in the north west, which has undergone renovation. The buildings were understood to have been sheds/barns to house turkeys.

3.2.2 The Surrounding Area

The earliest map, dated 1854, shows the surrounding area to comprise predominantly open land. Directly to the north lies the village of Lower Cudworth. A railway track, with Cudworth station, is shown to trend north west to south east across the map, located approximately 500 m to the south west of the site. Two sandstone quarries are shown, the first around 250 m to the north and the second, labelled Knowles Quarry, about 800 m to the north west. A well is located approximately 100 m to the west of the site boundary and a pump around 150 m to the north.

By 1906 to 1907 both quarries are still present but seem to be disused. The villages of Lower and Upper Cudworth appear to start merging due to the expansion of Upper Cudworth to the south along Barnsley Road. The well and pump are no longer shown, a reservoir is now visible about 500 m to the west.

The reservoir to the west is not shown on the 1955 map, indicating its removal and potential back fill.

Housing has been built to the immediate west of the site and around 100 to 150 m to the south by 1974. A school is now shown about 260 m to the east of the site boundary and an area of open cast workings is noted approximately 1000 m to the south east.

By 2000, housing is shown to surround the property on all sides. The railway line to the south east is now labelled as dismantled, sections of embankments still remain.

No other significant developments or changes take place to the present day.

3.3 Geology

The British Geological Survey (BGS) map SE 30 NE (1: 10,000 scale) shows the site to be underlain by interbedded mudstone, sandstone and siltstone of the Pennine Middle Coal Measures. A band of sandstone is shown to cross the western end of the site trending roughly north to south. The strata are shown to be dipping at about 4° to the east.

No superficial deposits are indicated to be present.

No other faults or lines of weakness are shown to overlie the site.

3.4 Hydrogeology

The Envirocheck states the site is underlain by a Secondary A Aquifer, comprising permeable layers suitable to supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The site is not located within a Groundwater Source Protection Zone.

3.5 Hydrology

According to the Envirocheck the nearest surface water feature is 315 m to the north west, this is thought to be Small Bridge Dike which is located adjacent to Ring Farm.

3.6 Mining

The geological map shows Sharlston Top Coal to be the shallowest expected seam lying beneath the site. It is conjectured to outcrop approximately 40 m to the west of the site boundary, assuming the strata to dip at 4°, it is anticipated to lie about 3.5 m below the site. Records from the geological map show the seam to have a thickness between 0.69 to 1.07 m. The geological memoirs for the area are based on an older, now superseded map, Sheet 275 NW of the 6 inch : 1 mile mapping series, and therefore do not refer to the Sharlston Top Coal. They do refer to a seam locally known as the Cudworth Coal, however, which appears to be a term applied to several seams that are present in this area. Workings were locally undertaken in some of these seams, and therefore could possibly have been undertaken within the seam now named the Sharlston Top Coal.

The second shallowest coal of seam expected beneath the site is the Sharlston Low Coal. The seam is conjectured to outcrop around 450 m to the south west of the site and is estimated to be around 31.5 m below the site ground level, based on a strata dip of 4°. The seam is known to have been worked in this area, and old workings are recorded around the outcrop in the area just south west of the site. Records state the seam thickness varies between 0.3 to 0.48 m in this area, indicating that a sufficient thickness of competent rock lies between the base of the seam and the ground level if this seam has been worked in the past.

The Envirocheck states the site is within an area at risk from coal mining activities. A Coal Authority Report has been obtained and can be found in the Appendix. The report states the site is within a surface area that could be affected by underground mining in eight seams of coal between 250 and

660 m below ground level, last worked in 1986. Any movement in the ground associated with the mining of these seams should now have ceased.

The Coal Authority also believe there to be coal close to the surface which could have been worked at some time in the past. This shallow coal is likely to be the Sharlston Top Coal and the Sharlston Low Coal estimated to be 3.5 m and 31.5 m beneath the site respectively.

According to the Coal Authority report there are no known mine entries within, or within 20 m, of the site boundary. There could be unrecorded entries which the Coal Authority is unaware of, however.

The site is not within the boundary of an opencast site from which coal has been removed by opencast methods and there are no outstanding license requests within 800 m of the property boundary.

The site is not in an area where the Coal Authority has granted, or is considering granting any licenses, to remove or work coal by underground mining methods. The site is not within an area which is likely to be affected by any future underground mining. However, reserves of coal exist in the area which could be worked at some time in the future. This is considered unlikely due to the decline of the UK coal industry.

One damage notice or claim for alleged mining subsidence damage was made for the north western corner of the property in June 1996, however the claim was rejected. There have been a further three claims within 50 m, to the north and west of the property boundary. The exact locations of these claims can be seen in the Enquiry boundary map at the end of the appended report.

The property is in an area where notices to withdraw support have been given, in 1962, 1977 and 1981. This are not expected to affect the site.

Based on the information gathered it is considered the site may be at risk of shallow coal mining. An intrusive investigation is advised to establish the depth and potential workings in the Sharlston Top Coal seam and whether any remedial measures, such as grouting will be required. The borehole investigation has been undertaken as part of the Phase 2 intrusive works which are reported on in Section 6.0 and 7.0 of this report.

3.7 Ground Gas

According to the Envirocheck the site is not in an area in which radon protective measures would be required.

Limited previous development has occurred across the site, comprising agricultural buildings, which have now been demolished. It is not expected that any significant depth of made ground will be present on the site.

Shallow coal workings are potentially present beneath the site and therefore mine gas may pose a risk to the site.

The Envirocheck indicates there are no current or historical landfill sites within 250 m of the site. There is one area of non-water related infilled land 229 m to the north west of the site boundary, thought to be the location of a former sandstone quarry. The backfill material for the quarry is unknown; however residential properties are located between the quarry and proposed site suggesting it to be of relatively low risk to the public.

An area of infilled land relating to water is noted on site, this is thought to be related to the well which was observed on the 1893 historical map of the area. The next available historical map, 1906, no longer shows the well to be present. This is not expected to present a significant risk of gas generation.

3.8 Pollution Incidents to Controlled Waters

The Envirocheck indicates there are no pollution incidents to controlled water within 250 m of the site.

3.9 Discharge Consents

According to the Envirocheck there are no discharge consents within 250 m of the site.

3.10 Flooding

The Envirocheck shows the site is not within a flood plain and it is only considered to have a limited risk of groundwater flooding. Areas in the western half of the site are shown to be at low risk of flooding from surface water.

3.11 Soil Geochemistry

The Envirocheck estimates the following concentrations of arsenic, cadmium, chromium, nickel and lead to be present in the natural soil at the site:

Contaminant	Estimated Concentration (mg/kg)	Assessment Value (mg/kg)
Arsenic	15 to 25	37
Cadmium	<1.8	11
Chromium	>180	910
Lead	<100	200
Nickel	30 to 45	180

There is a possibility for the levels of chromium to be naturally elevated within the soils at the site, however the remainder of the contaminant concentration levels are not expected to be elevated within the natural ground.

4.0 OUTLINE CONCEPTUAL MODEL

Both the topsoil and natural ground are not expected to be particularly contaminated; however there is the potential for naturally elevated chromium levels to be present.

The following table details the possible sources and associated contaminants of concern, pathways and receptors, highlighted by the Phase 1 investigation as potentially present.

Source	Potential Contaminants	Pathway	Receptor
• Existing made ground and topsoil	• Heavy metals/metalloids and PAH's Petroleum hydrocarbons	• Ingestion, inhalation, direct contact • Migration through ground	• Future residents and visitors to the site • Site construction workers • Groundwater Aquifer
		• Root uptake	• Plants
		• Direct contact	• Water supply pipes
	• Asbestos	• Inhalation of fibres	• Future residents and visitors to the site • Site construction workers
• Made ground and natural ground.	• Sulphates	• Direct contact	• Subsurface concrete
• Natural ground	• Chromium	• Ingestion, inhalation, direct contact • Migration through ground	• Future residents and visitors to site • Site construction workers
		• Root uptake	• Plants
• Shallow mine workings	• Mines gases	• Upward migration	• Future residents and visitors to site • Buildings

5.0 GROUND INVESTIGATION

5.1 Site Works

Eastwood & Partners visited site on 9 and 15 November 2017 and excavated eight trial pits and drilled six rotary boreholes, TP1 to TP8 and BH1 to BH6, to determine the underlying ground conditions. The trial pits reached depths of between 2.3 and 2.8 m below ground level (bgl). The bores were extended to depths of between 20 and 30 m bgl. All of the exploratory holes were positioned to give good site coverage.

Copies of the trial pit and borehole logs are presented in Appendix 3, and their positions are plotted on the Exploratory Hole Location Plan, drawing number 41954/001A, in Appendix 1.

5.2 Laboratory Testing

Two samples of natural clay were sent to Professional Soils Laboratory for geotechnical testing. The geotechnical test results are presented in Appendix 4 and discussed further in Section 7.

Four samples of made ground, four of topsoil and three of natural ground were dispatched for chemical testing. Soil samples were taken in 500 g plastic tubs and 250 ml Amber jars. All samples were analysed at Chemtest Limited, using MCERTs accredited methodologies where available. The chemical test results are presented in Appendix 5 and discussed further in Sections 8 and 9.

6.0 GROUND CONDITIONS

6.1 Surface Covering

Made ground is present across the site. It is comprised of slightly sandy slightly gravelly clay with an average thickness of around 650 mm.

Site won topsoil was present as two large stockpiles in the south eastern corner of the site, having been previously stripped.

6.2 Natural Ground

Natural ground was encountered below the made ground within all of the exploratory holes and generally comprised firm sandy clay over stiff clay. The firm sandy clay was encountered between 0.55 and 1.5 m bgl, except in TP1 and TP7 which instead contained a coal seam at 0.9 m to 1.8 m and 1.8 to 2.4 m bgl respectively. Within the firm and stiff clay occasional coal pockets or veining were observed in TP3, TP4, TP6 and TP8. Trial pit TP7 encountered clayey sand and gravel between 0.45 and 1.2 m overlying gravely clay which was also present in TP6 to a similar depth.

The stiff clay present in all exploratory holes (except TP7) was encountered between 1.3 and 2.3 m bgl, becoming progressively stiffer with depth. In four holes, TP2, TP6, TP7 and TP8, at the base material became very weathered, weak clayey mudstone recovered as medium angular gravel, encountered between 1.6 and 2.4 m bgl.

The rotary boreholes generally found made ground or clay in the first 600 mm. This was found to be underlain by brown mudstone to around 3.3 m, following this a coal seam with an average thickness of 0.9 m present beneath the eastern half of the site (BH1, BH2, BH4 and BH5). Grey mudstone was then found to around 10 m with grey sandstone below.

6.3 Coal

The boreholes encountered solid coal at depths between 1.4 and 4.4 m bgl in BH1, BH2, BH4 and BH5. The depth of the seam was found to increase to the east of the site. No voids or evidence of extraction was found when drilling, therefore it is considered the site is not at risk of shallow coal mining and no further work is required.

6.4 Groundwater

Seepages were noted within four of the trial pits (TP3, TP5, TP7, and TP8) on site at depths of between 1.0 and 2.4 m bgl. A steady flow of water into TP6 was noted between the sand and gravel made ground and the natural clay. This was determined to be surface water drainage from the remainder of the site.

7.0 GEOTECHNICAL APPRAISAL

7.1 General

The proposed development is to comprise residential housing of conventional construction with associated soft landscaped areas.

Made ground is present at the surface across the site, with a typical thickness of 0.65 m, overlying natural sandy clay with occasional coal pockets or veins. Below this, stiff clay is present above weak clayey mudstone bedrock.

One coal horizon was encountered in exploratory boreholes BH1, BH2, BH4 and BH5, where a solid coal seam was encountered at depths of between 1.40 and 4.40 m bgl. No evidence of workings was found and therefore no further work is required.

Groundwater seepages were noted in four trial pits between 1.0 and 2.4 m depth.

Geotechnical testing was carried out on two samples of natural clay (from TP4 and TP5). Copies of the test certificates are included in Appendix 4. The following results were recorded:

Location	Depth (m)	Material Description	Modified Plasticity Index (%)*	Volume Change Potential*
TP4	1.20	Brown slightly gravelly slightly sandy CLAY	31	Medium
TP5	1.20	Brown sandy CLAY	19	Low

* In accordance with NHBC Chapter 4.2 standards

A worst case scenario is considered appropriate, therefore the natural clay should be assumed to be of medium volume change potential. It is therefore recommended that the clay is assumed to be of medium shrinkability.

7.2 Foundations

A safe bearing capacity of 150 kN/m^2 is considered to be appropriate for the natural sandy clay, based on our observations.

For the low rise housing scheme proposed, the most suitable foundations are considered to be strip or trench fill footings. These should be taken through any made ground and into the natural clay at a minimum depth of 900 mm. Around the edges of the site where trees are present the footings should be deepened in accordance with NHBC Chapter 4.2 guidance. Heave precautions will be required where foundations are more than 1500 mm deep due to past or present trees.

Should coal be exposed in the base of the foundation, the trench should be deepened until competent natural clay is exposed. The coal should be blinded with a lean mix of concrete in the sides of the trenches to prevent any possibility of spontaneous combustion.

7.3 Ground Slabs

A ground bearing slab is not expected to be suitable due to the thickness and un-compacted nature of the made ground. Precast beam and block or reinforced suspended concrete slabs should be used.

If footings require heave precautions due to trees, a precast concrete floor with a 250 mm ventilated void will be required.

7.4 Superstructure Precautions

No additional superstructure precautions are considered to be required based on the ground conditions encountered.

7.5 Excavation Problems

The stability of trenches may be poor in the loose made ground which was encountered in the first 0.9 m.

Temporary support will be required in accordance with current Health & Safety Regulations wherever access is required to trenches deeper than 1.2 m or less where there is risk of collapse.

The well which was situated in the centre of the property has been backfilled according to the current landowner, it should not be of significant concern as it is situated under the access road in the future site plan.

7.6 Roads

The ground encountered in the upper 600 mm generally comprises made ground, or made ground over soft to firm sandy clay. A CBR value of 2% may be able to be achieved. It is recommended that full scale CBR tests are undertaken along roadways prior to construction so that accurate values can be obtained to satisfy the Local Authority. We also recommend that a contingency for removing and infilling local soft spots is allowed.

7.7 Surface Water Drainage

The natural ground appeared to comprise impermeable clay across the site. Poor surface drainage was apparent when excavating TP6 which is located at the lowest elevation of the site. Surface water was flowing between the base of the made ground and above the clay. Soakaways are

therefore not expected to be viable for the proposed development. An alternative form of drainage, such as a piped connection to the local sewerage network or to an appropriate outfall, will therefore be required.

8.0 REFINEMENT OF OUTLINE CONCEPTUAL MODEL

8.1 Source Characterisation

An outline conceptual model, detailing the possible sources and associated contaminants of concern, potential pathways and receptors identified in the Phase 1 report, is set out in Section 4.

This section of the report documents the works undertaken to obtain information to test and refine this model enabling a risk assessment to be produced and, where significant risks are expected, remediation recommendations.

8.2 Ground Gas

Deep made ground (i.e. more than 2 m) was not encountered on site. Therefore, no ground gas measures are considered to be required. Evidence of shallow workings in the coal was not encountered, therefore mine gas is not considered to pose a risk.

8.3 Unexpected Contamination

Visual or olfactory evidence of additional significant contamination was not recorded in any of the exploratory holes.

8.4 Chemical Testing

Four samples of made ground, four samples of topsoil and three samples of natural ground were dispatched for chemical testing. Each of the samples was analysed for the suite of contaminants listed in the table below:

Contaminant Type	Actual Contaminants
Metals/Metalloids	Arsenic, cadmium, chromium, lead, mercury, nickel, selenium, copper and zinc
pH	pH
PAHs	Speciated PAH
Sulphates*	Water soluble sulphate, acid soluble sulphate and sulphur

*Natural and made ground only

In addition to the above tests, two samples of made ground were tested for Total Petroleum Hydrocarbons (TPH) and all of the topsoil and made ground samples were screened for asbestos fibres.

8.5 Assessment Criteria

The proposed development of the site is for residential properties with associated soft landscaping. Tables detailing the relevant assessment concentrations used are included in Appendix 5.

8.6 Chemical Test Results

8.6.1 Topsoil

Additional testing was conducted to determine a site specific Total Organic Carbon (TOC) value for the topsoil. From this an average Soil Organic Matter (SOM) of 6.9% was calculated, therefore Assessment criteria derived using 6% SOM has been used in this assessment.

Two samples of topsoil (Topsoil B and D) recorded concentrations below their respective assessment values.

Topsoil A, recorded elevated levels of Benzo[b]fluoranthene (9.0 mg/kg), Benzo[a]pyrene (6.8 mg/kg) and Dibenz(a, h)anthracene (0.47 mg/kg) compared to the human health assessment values. Modified means were calculated across the samples of topsoil, the results of which still exceeded the assessment criteria.

Determinand	Assessment Value 6% SOM (mg/kg)	Topsoil A Value (mg/kg)	Modified Mean (mg/kg)
Benzo[b]fluoranthene	3.7	9.0	7.95
Benzo[a]pyrene	3.0	6.8	5.94
Dibenz(a, h)anthracene	0.3	0.47	0.41

Topsoil C, recorded elevated levels of lead (210 mg/kg) compared to the respective human health assessment value of 200 mg/kg. The modified mean, incorporating all samples, reduced the level to 201 mg/kg resulting in the concentration only being marginally above the acceptable limit. Elevated levels of zinc were also recorded (400 mg/kg) in comparison to the phytotoxicity assessment values (300 mg/kg).

No asbestos was identified in topsoil samples A, B and D. Chrysotile fibres / clumps were identified in Topsoil sample C, A quantification of the sample established 0.001% total asbestos.

8.6.2 Made Ground

None of the made ground samples recorded elevated concentrations of heavy metals.

The sample from TP3 at 0.1 m returned elevated concentrations of Benzo[b]fluoranthene, 3.7 mg/kg compared to the respective assessment value of 2.6 mg/kg. TP3 also returned slightly elevated concentrations (2.3 mg/kg) of Benzo[a]pyrene in association with the assessment value of 2.2 mg/kg. The modified means for both determinands were still above the human health assessment values.

No asbestos was detected in any of the made ground samples.

Neither of two samples (TP3 and TP8) screened for Total Petroleum Hydrocarbons (TPH's) detected any raised concentrations in comparison to the assessment values.

8.6.3 Natural Ground

None of the samples of natural ground recorded elevated concentrations above their respective assessment values.

8.6.4 Sulphates

The site has been taken as a Brownfield location in relation to the Aggressive Chemical Environment for concrete classifications and groundwater is assumed to be mobile.

Made Ground

Across the four samples of made ground tested, a maximum total potential sulphate concentration of 0.57% is recorded, compare to the upper limit of 0.6% for DS-2.

A maximum water soluble sulphate concentration of 650 mg/l was recorded, compared to the upper limit of Design Sulphate Class 2 1500 mg/l.

The pH varied between 7.4 and 8.0.

Natural Ground

Across the three samples of natural ground tested, a maximum total potential sulphate concentration of 0.043% is recorded, compared to the upper limit of 0.24% for class DS-1.

A maximum water soluble sulphate concentration of 82 mg/l was recorded, compared to the upper limit of Design Sulphate Class 1 of 500 mg/l.

The pH varied between 6.7 and 7.2.

8.7 Significant Pollutant Linkages

Source	Pathway	Receptor
Asbestos in the topsoil	Inhalation of fibres	Future residents and visitors to the site Site construction workers
Elevated levels of lead, zinc and PAH's in the topsoil	Ingestion, inhalation, direct contact Migration through ground	Future residents and visitors to the site Site construction workers Vegetation
Elevated levels of PAH's in the made ground	Ingestion, inhalation, direct contact Migration through ground	Future residents and visitors to the site Site construction workers Secondary A Aquifer
Sulphates in the made ground	Direct contact	Subsurface concrete

9.0 RISK ASSESSMENT

9.1 Human Health: Future Site Users

Topsoil

Two samples (Topsoil A and C) of the site won topsoil recorded elevated concentrations of Benzo[b]fluoranthene, Benzo[a]pyrene, Dibenz(a, h)anthracene and the presence of asbestos (Chrysotile)fibres / clumps. Therefore, the site topsoil is considered to be unsuitable for reuse.

Extensive additional sampling and testing of the stockpiled topsoil could be undertaken to further establish the suitability of the topsoil, however, this is not guaranteed to provide a positive result, and therefore the most viable method of progressing is likely to be to remove the existing topsoil material from site and to replace it with clean imported material.

Made Ground

The existing made ground contains some mildly elevated levels of PAH compounds. However, the levels are not elevated significantly and therefore the material does not need to be removed from site, and a simple capping system can be applied to mitigate the potential risks to future site users,

It is considered that a 450 mm capping layer of imported topsoil placed over the made ground will be sufficient.

9.2 Human Health: During Construction

Ground workers employed during the construction phase of the development are most at risk of harm due to them having direct contact with the affected soils. However, the contact is generally of short duration, and all competent ground workers will be aware of the potential risks associated with the topsoil and made ground soils. Therefore, the overall risk to the health of construction workers is considered to be low.

All ground workers employed on the site should be made aware that elevated concentrations of contaminants and low levels of asbestos fibres may be present. Normal site procedures, such as the wearing of gloves when handling soils and the washing of hands prior to eating, should be implemented at all times. It is recommended that ground workers wear asbestos rated dust masks when handling the existing topsoil, which has recorded low levels of asbestos fibre within the material

Any unusual, brightly coloured, ashy or odorous material or material suspected of containing asbestos encountered during construction should be brought to the attention of the site staff and investigated.

9.3 Plants

Topsoil sample C recorded elevated levels of zinc which could be harmful to future plant growth; the modified mean of the topsoil samples (372 mg/kg) was still elevated compared to the phytotoxicity assessment value. As other elevated contaminants were recorded in the topsoil samples which could be hazardous to human health the existing topsoil is not considered to be suitable for reuse across the development. Imported topsoil is recommended to be placed in a 450 mm thick capping layer across all gardens and soft landscaping areas, This will also act as a growing medium for plants.

9.4 Ground Gas

No ground gas measures are considered to be required.

No radon protection is required.

9.5 Construction Materials

Based on the chemical test results, a design sulphate class of DS-2 and an ACEC class of AC-2 is considered appropriate for concrete in contact with the made ground.

The results of the chemical testing may need to be forwarded to the water company so appropriate water supply pipes can be selected.

9.6 Controlled Waters

Widespread significant contamination was not encountered, and there are no particularly sensitive receptors nearby. No significant risks are expected to be posed to controlled waters.

9.7 Unexpected Contamination

There is the possibility that areas more significantly contaminated than identified to date may be present. Any unusual, brightly coloured, ashy or odorous material or material suspected of containing asbestos encountered during the construction phase should be brought to the attention of the site staff and investigated.

9.8 Disposal of Material

If material needs to be removed, it should to be taken to a suitably licensed landfill or waste treatment facility. The costs of disposal and landfill tax can be substantial. The disposal of material should therefore be seen as a last resort with options such as treatment and reuse either on-site or off-site considered where possible.

The category of landfill which can accept the waste (inert, non-hazardous or hazardous) would need to be determined and will also have a significant effect on the costs. Additional testing may be required by the landfill operator and the acceptance of material is generally at their discretion.

Appendix 1

‘Exploratory Hole Location Plan’, Drawing Number 41954/001A



INFORMATION WITHIN THIS DRAWING IS NOT NECESSARILY PRODUCED TO SCALE.
ALWAYS USE FIGURED DIMENSIONS AND CO-ORDINATES - IF IN DOUBT, ASK.

KEY:

- Site Boundary
- Approximate location trial pit excavated by Eastwood and Partners on 09.11.17.
- Approximate location of rotary borehole drilled by Eastwood and Partners on 15.11.17.

REV	DESCRIPTION	SIG	CHK	DATE
A	First Issue.			

RMH PROPERTIES LTD

LOW CUDWORTH, BARNSLEY

EXPLORATORY HOLE LOCATION PLAN

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SCALE WHEN PLOTTED AT A3	DRAWING STATUS
1:1000	INFORMATION

DRAWN	CHECKED	DATE	DRAWING NUMBER	REV
JRB	NG	14.12.17	41954/001	A