

Phase 2 Site Investigation Report

Land off Edmunds Road, Worsbrough, Barnsley

Hadfield Developments



Report prepared by:
Ecus Ltd.
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW
0114 266 9292

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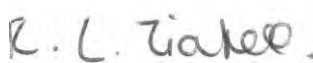
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Ecus Ltd

Report to: **Hadfield Developments
Oak Lodge
Redbrook Road
Barnsley
S75 2RS**

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Land off Edmunds Road, Worsbrough, Barnsley**

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Originated By: 
**R L Ziabek BSc (Hons) MSc FGS
Geo-environmental Engineer**

Date: 23rd April 2015

Approved By:



**A M Grant BSc (Hons) MSc CGeol
Team Manager: Geoscience**

Date: 23rd April 2015

Prepared by:
Ecus Ltd.
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW
0114 2669292

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Executive Summary

Location and Description:	<p>The site is situated off Edmunds Road, Worsbrough, Barnsley. The National Grid Reference for the site is 436200, 403580.</p> <p>The site is currently vacant and disused. The site covers an area of approximately 0.1 hectares.</p>
Site History:	Historical Ordnance Survey mapping indicates that the site was occupied by a gas works from before 1891 to the 1960s.
Proposed Form of Development:	It is proposed to construct four houses with private gardens on the site.
Ground Investigation:	Six trial pits and six windowless sampler boreholes were drilled on the site. Soil samples taken from the site were analysed for contaminants potentially associated with the previous use of the site. Ground gas monitoring wells were installed in 2no. boreholes.
Ground Conditions:	<p>Made Ground: Present across the site, to a maximum recorded depth of 2.85m bgl. Variable composition, including clay-rich and granular materials and locally oversized demolition waste materials.</p> <p>Intact Substructures: Intact brick and concrete vertical and horizontal substructures associated with the former gas works were identified at several locations.</p> <p>Subsoils: Comprise soft to stiff sandy gravelly clay.</p> <p>Groundwater: Perched groundwater inflow was observed within backfill to former substructures.</p>
Contamination Assessment:	Site-wide concentrations of arsenic, lead and several PAH compounds are greater than the adopted human health risk screening criteria within made ground.
Remediation Requirements:	<p>A clean soil capping layer is required within garden and soft landscaped areas to protect future residents from exposure to soil contamination. Vapour barriers are required within the ground floor construction of the houses and garages to prevent ingress of naphthalene vapours.</p> <p>Localised asbestos cement fragments should be removed from the ground surface in the western part of the site.</p> <p>The requirements for ground gas protection will be determined upon completion of the gas monitoring programme in June 2015.</p>
Concrete Protection:	Due to elevated sulphate concentrations and the presence of acidic soils, below-ground concrete should conform to Design Sulphate Class DS-2 and ACEC Class AC-5z.
Waste Soil Classification:	Due to concentrations of PAH and petroleum hydrocarbons, some made ground present on the site would be classified as hazardous waste, should off-site disposal be required.
Soakaways:	The use of soakaways for disposal of surface water is not considered suitable for the site, due to the presence of deep made ground and low permeability clay subsoils.

1 Introduction

1.1 Terms of Reference

- 1.1.1 Ecus Ltd (hereafter Ecus) was instructed by Hadfield Developments to undertake a Phase 2 Site Investigation at land off Edmunds Road, Worsbrough, Barnsley, South Yorkshire, hereafter referred to as 'the site'.
- 1.1.2 Figure A1, Appendix A shows the location of the site, which centres on National Grid Reference 436200, 403580.
- 1.1.3 A Desk Study and Preliminary Risk Assessment Report was previously produced for the site by Ecus Ltd (Report Reference AG/2096/081001/P1, dated October 2008). Reference should be made to this report for a detailed description of the site layout, its surroundings, historical development, geological and hydrogeological setting, etc.

1.2 Proposed Form of Development

- 1.2.1 It is proposed to redevelop the site with four residential houses with private gardens, as shown on Windle Cook Architects Drawing No. 15-185-C02, a copy of which is included within Appendix A.
- 1.2.2 This report has been written in relation to this site use; should the proposed site use change, the findings of the report may require revision.

1.3 Objectives of the Phase 2 Site Investigation

- 1.3.1 The assessment has been carried out in general accordance with the requirements of British Standards BS5930 (1990) – *Code of Practice for Site Investigations* and BS10175 (2011) – *Code of Practice for the Investigation of Potentially Contaminated Sites*.
- 1.3.2 The general objectives of the assessment are as follows:
- To provide factual data on ground conditions and soil and ground gas contamination;
 - To develop the preliminary conceptual model contained within the previous phase 1 site investigation report;
 - To determine the risk to the identified receptors from soil contamination;
 - To identify where remediation measures are required within the proposed development to reduce the risk of contamination to the receptors to an acceptable level, and / or give recommendations for further investigation work, if considered to be necessary.

1.4 Structure of the Report

- 1.4.1 A summary of the findings of the previous Phase 1 Site Investigation is included in Section 2 of this report. Details of the methods used in the intrusive site investigation are presented in Section 3, with the results presented in Section 4. Section 5 provides a revised conceptual model and risk assessment for the site. Section 6 includes commentary on waste soil classification and the feasibility of the use of soakaways on the site. Section 7 contains conclusions and recommendations. Supporting information is included in Appendices A - E.

2 Summary of the Phase 1 Investigation

2.1 Site Description

- 2.1.1 The site currently comprises disused land, recently cleared of vegetation characterised by long grass and weeds. There is an access track leading from Edmunds Road along the northern part of the site.

2.2 Site History

- 2.2.1 A Gas Works is shown on the site since the earliest available map dated 1891. During the late 1960's the Gas Works was demolished with the site layout remaining vacant since that time. Throughout the period of the gasworks, there were minor modifications to the site layout.

2.3 Geology

- 2.3.1 The site is underlain directly by solid strata of the Pennine Middle Coal Measures.
2.3.2 No drift deposits are shown to affect the site.

2.4 Hydrogeology & Hydrology

- 2.4.1 The solid strata underlying the site are classified as a Secondary A Aquifer (formerly a Minor Aquifer).
2.4.2 The site is not located within a groundwater Source Protection Zone (SPZ).
2.4.3 There are no groundwater abstraction points within 1,000m of the site.
2.4.4 There is a single surface water abstraction point within 500m of the site. This is located 340m east of the site.
2.4.5 The River Dove is located 100m south of the site.

2.5 Landfill Sites

- 2.5.1 There is a historical landfill site located 185m to the north-west of the site.

2.6 Radon

- 2.6.1 No radon protection measures are required in the construction of new dwellings on the site.

2.7 Preliminary Conceptual Model and Risk Assessment

- 2.7.1 The preliminary conceptual model produced as part of the phase 1 site investigation is summarised in Tables 1 and 2 for organic and inorganic contaminants respectively.

- 2.7.2 The key for Tables 1 and 2 is as follows:

KEY: LOW – potential risks associated with the presence of the contaminant linkage are low and further assessment or remediation is not considered necessary.

MOD – potential risks associated with the presence of the contaminant linkage are moderate and further assessment or remediation should be considered.

HIGH – potential risks associated with the presence of the contaminant linkage are high and further assessment or remediation is considered necessary.

N/A – The contaminant has no potential to affect the receptor via this exposure pathway.

Table 1: Summary Preliminary Conceptual Model and Risk Assessment – Organic Contaminants

Receptors and pathways	Petroleum Hydrocarbons	PAH	BTEX, Phenol	Cyanides	Landfill Gases	Notes
Human Health On-site Dermal contact with soil. Intake via direct ingestion of soil and contaminated dusts indoors and outdoors. Ingestion of garden grown vegetables and attached soils Intake via inhalation of contaminated dusts outdoors and tracked indoors.	HIGH	HIGH	HIGH	HIGH	N/A	Direct contact of site residents with soil in garden areas is likely.
	MOD	HIGH	MOD	HIGH	N/A	
	HIGH	HIGH	HIGH	HIGH	N/A	
	HIGH	HIGH	HIGH	HIGH	N/A	
Intake via inhalation of soil vapours and ground gases indoors and outdoors. Explosion of methane, VOC and hydrocarbon vapours.	HIGH	HIGH	HIGH	LOW	HIGH	Soils contaminated by hydrocarbons may generate vapours that accumulate within confined structures above and below ground following development. A landfill is located within 250m of the site.
Underground water mains	HIGH	HIGH	HIGH	N/A	N/A	Some organic contaminants can permeate into plastic water mains.
Site Buildings Concrete foundations	LOW	N/A	LOW	N/A	N/A	Organic compounds can affect building materials only if they are present in very high concentrations.
Controlled Waters Migration to groundwater Migration to surface water	LOW	LOW	LOW	LOW	N/A	The site is underlain by clay soils and a Secondary aquifer. Migration to Controlled Waters is therefore considered unlikely.
	LOW	LOW	LOW	LOW	N/A	

Table 2: Summary Preliminary Conceptual Model and Risk Assessment – Inorganic Contaminants

Receptors and pathways	Heavy Metals	Sulphates	Asbestos	Acids/ Alkalis	Notes
Human Health On-site					
Dermal contact with soil.	HIGH	LOW	N/A	MOD	Direct contact of site residents with soil in garden areas is likely.
Intake via direct ingestion of soil and contaminated dusts indoors and outdoors.	HIGH	LOW	N/A	MOD	
Ingestion of garden grown vegetables and attached soils	HIGH	LOW	N/A	HIGH	
Intake via inhalation of contaminated dusts outdoors and tracked indoors.	HIGH	LOW	HIGH	N/A	
Intake via inhalation of soil vapours and ground gases indoors and outdoors.	LOW	N/A	N/A	N/A	Most inorganic contaminants have little or no potential to generate vapours or gases.
Underground water mains	N/A	N/A	N/A	N/A	Most inorganic contaminants have little potential to permeate water mains.
Site Buildings					
Concrete foundations	N/A	HIGH	N/A	HIGH	Acids and sulphates can degrade buried concrete structures including foundations and floor slabs.
Controlled Waters					
Migration to groundwater	LOW	LOW	N/A	LOW	The site is underlain by clay soils and a Secondary aquifer. Migration to Controlled Waters is therefore considered unlikely.
Migration to surface water	LOW	LOW	N/A	LOW	

3 The Phase 2 Site Investigation

3.1 Preparatory Works

- 3.1.1 A health and safety plan and method statement for the works was produced by Ecus, including risk assessments for the activities undertaken. Exploratory hole locations were cleared of live electrical cables with a cable avoiding tool (CAT scanner) immediately prior to excavation / drilling.

3.2 Intrusive Investigation Works

Windowless Sampling

- 3.2.1 Windowless sampler boreholes were drilled at 6no. locations (WS01 to WS06) on 30th March 2015 to depths ranging between 4.0m and 7.0m below ground level (bgl) using an Archway Competitor Dart windowless sampling rig with disposable plastic sampling tubes.
- 3.2.2 Windowless sampling logs are presented in Appendix B, with the locations shown on Figure A2. The locations were generally chosen to be representative of ground conditions across the site, although were constrained by factors including the presence of underground structures. Borehole WS04 was drilled within the footprint of a former gas holder, as a trial pit (TP01) excavated there did not penetrate deep enough to measure the full depth of made ground.
- 3.2.3 The windowless sampling boreholes were drilled to a depth appropriate for the objectives of the investigation or where hard strata prevented further progress.
- 3.2.4 Upon completion, ground gas monitoring wells comprising 50mm diameter HDPE standpipes with flush covers were installed in boreholes WS02 and WS04. The other boreholes were backfilled with arisings.

Trial Pits

- 3.2.5 Trial pits were excavated at 6no. locations (TP01 to TP06) to depths ranging between 1.85m and 2.85m bgl on 30th March 2015 using a CAT 432E backhoe excavator with a 0.6m toothed bucket.
- 3.2.6 Trial pit logs are presented in Appendix B, with the locations shown on Figure A2. The trial pit locations were selected to be representative of ground conditions within features of the previous gas works as identified within the plan presented in the phase 1 site investigation report, as follows:
- TP01: Gas Holder;
 - TP02: Well (tar well / siphon adjacent to gas holder);
 - TP03 and TP03a: Retort House;
 - TP04: Purifier House.
- 3.2.7 In addition, trial pits TP05 and TP06 were excavated in the central part of the site to inspect ground conditions in proximity to proposed houses.
- 3.2.8 The trial pits were generally excavated to the maximum practicable reach of the machine or where hard strata prevented further progress.
- 3.2.9 Upon completion, the trial pits were backfilled with arisings.

On-site Logging and Assessment

- 3.2.10 Soil arisings from all boreholes and trial pits were logged on site by geo-environmental engineers employed by Ecus to British Standard BS5930 (1999).
- 3.2.11 Visual and olfactory examination of retrieved samples was carried out to identify evidence of contamination.

Soil Sampling

- 3.2.12 Small disturbed soil samples were recovered from the boreholes and trial pits for laboratory chemical analysis. The samples were selected from soil horizons at depths relevant to the objective of developing the preliminary conceptual model.
- 3.2.13 Selected soil samples were collected by hand and immediately packed into clean purpose-made containers supplied by the chemical testing laboratory. Clean disposable nitrile gloves were worn for each sample collection to prevent cross contamination between samples. The relevant sample containers were transported by courier to the laboratory for analysis.

3.3 Chemical Laboratory Analysis of Soil Samples

- 3.3.1 The chemical analysis suite and the number of samples analysed were chosen to meet the objectives of developing the preliminary conceptual model produced within the phase 1 site investigation report.
- 3.3.2 Chemical analysis was conducted by Scientific Analysis Laboratories Ltd (SAL), a UKAS and MCERTS accredited testing laboratory, on 14no. soil samples collected from the boreholes, as follows:
- Asbestos (quantitative analysis);
 - Heavy metals: arsenic, cadmium, chromium (total), chromium (hexavalent), copper, lead, mercury, nickel, selenium, zinc;
 - Speciated polycyclic aromatic hydrocarbons (PAH);
 - Speciated total petroleum hydrocarbons (TPH);
 - Concrete protection suite in accordance with BRE Special Digest 1 (BRE);
 - Fraction organic carbon (FOC);
 - Total cyanide;
 - Total phenols;
 - Water soluble sulphate (WSS);
 - pH.

- 3.3.3 The analytical methods used are listed in the laboratory report included in Appendix C. Table 3 summarises the samples that were subject to chemical laboratory analysis.

Table 3: Summary of Laboratory Chemical Soil Analysis

Borehole / Trial Pit	Depth (m)	Material	Analysis
WS02	0.3-0.5	MADE GROUND: Gravelly clay.	Heavy metals, PAH, WSS, pH, TPH, Phenols, Cyanide and BRE.
WS02	1.2	Gravelly sandy CLAY.	BRE.
WS03	0.2	MADE GROUND: Gravelly slightly sandy clay.	Heavy metals, PAH, WSS, pH, TPH, Phenols and Cyanide.
WS03	0.4	MADE GROUND: Gravelly sandy clay.	BRE and FOC.
WS04	0.2	MADE GROUND: Gravelly sand.	Heavy metals, PAH, WSS, pH, TPH, Phenols and Cyanide.
WS04	0.5	MADE GROUND: Gravelly sand.	Asbestos.
WS05	0.4	MADE GROUND: Clayey gravelly sand.	Heavy metals, PAH, WSS, pH, TPH, Phenols and Cyanide.
WS05	1.2	Very sandy CLAY.	BRE.
WS06	0.4	MADE GROUND: Slightly sandy slightly gravelly clay.	Asbestos.
TP01	0.3	MADE GROUND: Sandy gravelly clay.	Heavy metals, PAH, WSS, pH, TPH, FOC, Phenols and Cyanide.
TP02	0.3	MADE GROUND: Very sandy gravelly clay.	Heavy metals, PAH, WSS, pH, TPH, Phenols and Cyanide.
TP03	0.2	MADE GROUND: Slightly clayey slightly ashy very gravelly sand.	Asbestos.
TP03A	0.3	MADE GROUND: Slightly clayey slightly ashy very gravelly sand.	Heavy metals, PAH, WSS, pH, TPH, Asbestos, Phenols and Cyanide.
TP04	1.7	MADE GROUND: Sandy gravelly clay.	Heavy metals, PAH, WSS, pH, TPH, FOC, Phenols and Cyanide.

3.4 Gas and Groundwater Monitoring

- 3.4.1 Gas and groundwater monitoring is to be carried out on a total of nine occasions following the intrusive investigation.
- 3.4.2 The gas composition (methane (%v/v CH₄ and %LEL (lower explosive limit)), carbon dioxide (CO₂), oxygen (O₂), carbon monoxide (CO) and hydrogen sulphide (H₂S)) within each monitoring well is monitored using a calibrated Gas Data GSM 430 portable landfill gas analyser. The anemometer function within the analyser is used to monitor the flow rate of gas emitted. The gas monitor and a portable digital barometer are used to record the atmospheric pressure at the time of monitoring.
- 3.4.3 Measurements of groundwater depth from ground level are also undertaken during gas monitoring visits. The measurements are taken using an electronic dipmeter which sounds when the probe is in contact with the groundwater in the well.

The results of the ground gas monitoring, together with a ground gas risk assessment, are to be issued separately upon completion of the ground gas monitoring programme in early June 2015.

4 Findings of the Phase 2 Site Investigation

4.1 Ground Conditions

- 4.1.1 For a detailed description of the ground conditions encountered, refer to the borehole and trial pit logs included within Appendix B. A summary is given below.

Made Ground

- 4.1.2 Made ground was found in all boreholes and trial pits excavated on the site, to measured depths ranging between 0.7m and 2.65m bgl. Trial pit TP01 identified made ground to the full depth of excavation (2.85m bgl).
- 4.1.3 Made ground on the site was found to be highly variable, comprising both clay-rich and granular materials, although granular materials were more common.
- 4.1.4 The clay-rich material generally comprised soft to firm sandy gravelly clay, with the gravel component varying in composition, variously including fragments of concrete, sandstone, asphalt, brick, slag, pottery, coal, quartz, glass, timber and slate.
- 4.1.5 The granular made ground identified comprised mainly loose to medium dense gravelly sand / sandy gravel, with the gravel component varying in composition, variously including fragments of sandstone, brick, slag, ash, clinker, concrete, coal, and quartz. Cobble- and boulder-sized fragments of sandstone and brickwork were also present within trial pits TP03 and TP03A.
- 4.1.6 Within trial pit TP03, the granular made ground contained much oversized demolition waste material, comprising boulders of sandstone, brick and concrete and iron girders.

Intact Substructures

- 4.1.7 Photographs showing intact substructures are included within Appendix B.
- 4.1.8 A hard obstruction, possibly the base of the former gas hold, was encountered within trial pit TP01 at 2.6m bgl, however, the obstruction was obscured by groundwater inflow into the trial pit. It should be noted that borehole WS04, which was drilled within the footprint of the former gas holder, did not encounter a hard obstruction at the base of made ground, but instead found natural subsoil at 2.65m bgl.
- 4.1.9 Trial pit TP02 was excavated at the location of a 'Well' shown on the layout plan for the former gas works. The well construction comprised sandstone blocks, with a solid base present at 3.5m bgl. An intact vertical iron pipe was also present within the well, to the base.
- 4.1.10 Trial pit TP03 was excavated at the location of the Retort House shown on the layout plan for the former gas works. An intact concrete floor was present at 1.85m bgl, with intact brick retort oven or furnace walls present in the southern and western sides of the trial pit.
- 4.1.11 Intact brick walls were also encountered within trial pits TP03A, TP04 and TP05.

Natural Subsoils

- 4.1.12 All boreholes and trial pits TP02, TP03A, TP04, TP05 and TP06 encountered natural subsoils beneath the made ground, generally comprising soft to firm sandy clay or soft to stiff sandy gravelly clay with gravel of sandstone. This material is interpreted as representing the upper weathered horizons of the Pennine Middle Coal Measures that is known to underlie the site. It is possible that the softer material represents a drift deposit that is not shown on the geological map.

Rock

- 4.1.13 Rockhead was not encountered during this investigation.

4.2 Groundwater Observations

- 4.2.1 Groundwater inflow was observed within trial pits TP01 and TP04, at depths of 2.6m and 1.6m bgl respectively.
- 4.2.2 Wet soil arisings, taken to be indicative of groundwater seepage, were observed during drilling of boreholes WS01 and WS03, at depths of 4.2m and 3.4m respectively.
- 4.2.3 The depths to groundwater recorded during subsequent monitoring are summarised in Table 4.

Table 4: Summary of Groundwater Levels within Monitoring Wells

Monitoring Well	Depth to Groundwater (m bgl)		
	07/04/2015	14/04/2015	21/04/15
WS02	2.64	2.59	2.48
WS04	DRY	DRY	DRY

4.3 Visual and Olfactory Observations of Contamination

Surface Asbestos Containing Materials

- 4.3.1 Fragments of suspected asbestos cement were observed on the ground surface at the western end of the site, in proximity to borehole WS04 as shown on Figure A2, Appendix A.

Soil and Groundwater

- 4.3.2 Potentially contaminating materials comprising gravel-sized fragments of ash, clinker and rare slag were identified within the made ground in the majority of the exploratory holes, including within the uppermost layer of made ground in some exploratory holes.
- 4.3.3 Blue-coloured materials, indicative of contamination by cyanide-bearing gasworks purifier waste, were encountered within the made ground within trial pits TP02 (from 0.25m bgl) and TP06 (from 0 – 0.9m bgl).
- 4.3.4 Made ground with sulphurous odours were encountered within made ground in trial pit TP01 (0.8 – 1.2m and 2.0 – 2.85m bgl) and borehole WS04 (0.1 – 1.4m bgl).
- 4.3.5 Coal tar contamination was noted within the made ground in trial pit TP03A.
- 4.3.6 A lead pipe was encountered within trial pit TP02 (0.7m), which appeared to contain traces of tar and / or hydrocarbons.
- 4.3.7 Perched groundwater within the made ground identified within trial pit TP04 was noted to be oily.

4.4 Summary of Chemical Soil Laboratory Analysis Results

- 4.4.1 Chemical soil laboratory analysis and data sheets for soil samples are presented in Appendix C. Table 5 provides a summary of the chemical soil analysis results.

Table 5: Summary of Soil Chemical Analysis Results.

Analyte	No. of Samples	Minimum Value	Maximum Value
Arsenic	8	11	130
Cadmium	8	<1	3
Chromium (total)	8	11	56
Chromium (hexavalent)	8	<1	<1
Copper	8	23	230
Lead	8	50	810
Mercury	8	<1	3
Nickel	8	10	39
Selenium	8	<3	<3
Zinc	8	51	620

Analyte	No. of Samples	Minimum Value	Maximum Value
pH (units)	11	4	7.6
Sulphate (water soluble) (g/l SO ₄)	12	<0.01	1.5
Sulphate (acid soluble) (%)	4	0.04	2.9
Sulphur (total) (%)	4	0.02	0.87
Asbestos	4	Not detected	<0.001% Chrysotile
Fraction of Organic Carbon (decimal)	3	0.013	0.099
Total cyanide	8	120	3,500
Total phenol	8	0.3	72
Polycyclic Aromatic Hydrocarbons (PAH)			
Naphthalene	8	1.9	22
Acenaphthylene	8	0.7	20
Acenaphthene	8	0.26	12
Fluorene	8	0.8	41
Phenanthrene	8	6.7	280
Anthracene	8	2.1	81
Fluoranthene	8	7.9	290
Pyrene	8	6.5	240
Benzo(a)anthracene	8	3.7	190
Chrysene	8	2.7	160
Benzo(b)fluoranthene	8	3.9	240
Benzo(k)fluoranthene	8	1.8	130
Benzo(a)pyrene	8	2.8	130
Indeno(1,2,3-cd)pyrene	8	1.4	100
Dibenzo(a,h)anthracene	8	0.56	33
Benzo(g,h,i)perylene	8	1.1	110
Total PAH	8	46	1,700
Total Petroleum Hydrocarbons (TPH) – Aliphatic Carbon Chains			
C5-C6	8	<0.010	<0.040
C6-C8	8	<0.010	0.026
C8-C10	8	<0.010	0.23
C10-C12	8	<1	<10
C12-C16	8	<1	21
C16-C21	8	<1	15
C21-C35	8	2	21
Total Petroleum Hydrocarbons (TPH) – Aromatic Carbon Chains			
C6-C7	8	<0.010	<0.040
C7-C8	8	<0.010	0.01
C8-C10	8	<0.010	1.6
C10-C12	8	<1	60
C12-C16	8	7	380
C16-C21	8	33	1200
C21-C35	8	63	1800
BTEX Compounds and VOCs			
Benzene (µg/kg)	8	<1	10
Toluene (µg/kg)	8	<1	9
Ethylbenzene (µg/kg)	8	<1	12
m/p- Xylene (µg/kg)	8	<1	160
o-Xylene (µg/kg)	8	<1	100
Methyl tert-Butyl Ether (µg/kg)	8	<1	<4

NB: Values are concentrations in mg/kg unless otherwise stated.

5 Revised Conceptual Model and Risk Assessment

5.1 Introduction

- 5.1.1 The preliminary conceptual model and risk assessment summarised in Section 2 of this report identified potential receptors to contaminants that may be present on the site following redevelopment. The actual risks to each of these receptors have been assessed based on observed site data and are detailed in this section of the report.

5.2 Risks to Site End Users – Selection of Human Health Risk Screening Criteria

Category 4 Screening Levels

- 5.2.1 The Department for Environment, Food and Rural Affairs (Defra) published Category 4 Screening Levels^{1,2} (C4SLs) in 2014. These were developed to be used in the inspection of potentially contaminated land under Part 2A of the Environmental Protection Act (hereafter referred to as 'Part 2A') to define land that is suitable for use and definitely not contaminated land.
- 5.2.2 However, Defra has explicitly stated that the C4SL values are suitable for use for soil contamination assessments within the development planning regime; the Policy Companion Document published by Defra to be read alongside the main document states that:
- "The Part 2A regime and the planning regime are inter-linked such that the National Planning Policy Framework states that "after development, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990" and that "Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner." The Part 2A Statutory Guidance and accompanying Impact Assessment were developed on the basis that Category 4 Screening Levels could be used under the planning regime, as they would be in Part 2A investigations directly".*
- 5.2.3 Hence a site where all shallow soils contain concentrations of contaminants that are equal to or less than the applicable C4SLs is suitable for use, as defined within the National Planning Policy Framework (NPPF). Therefore, the C4SLs are appropriate for use as a human health risk screening tool in this assessment. However, where the concentration of a contaminant is greater than the C4SL value, this is not necessarily indicative that there is an unacceptable risk or that remediation is required; other lines of evidence should also be taken into consideration.
- 5.2.4 The land use assumptions for the residential, allotments and commercial land use scenarios within the C4SL assessment system are based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) model^{3,4,5}, with amendments to the exposure assumptions within the standard land use models and exchanging the health criteria values (HCVs) used to calculate the previously published soil guideline values (SGVs) for updated low levels of toxicological concern (LLTC).

¹ CL:AIRE, 2013, *Development of Category 4 Screening Levels for Assessment of Land affected by Contamination*. Defra, London.

² Defra, 2014. *Development of Category 4 Screening Levels for Assessment of Land affected by Contamination – Policy Companion Document*. Defra, London.

³ Environment Agency, 2009. Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil*.

⁴ Environment Agency, 2009. Science Report SC050021/SR4: *CLEA Software (Version 1.05) Handbook*.

⁵ Environment Agency, 2009. Science Report SC050021/SR3: *Updated technical background to the CLEA model*.

- 5.2.5 At the time of writing, C4SL values have been published for arsenic, benzene, benzo(a)pyrene, cadmium, hexavalent chromium and lead.

Suitable 4 Use Levels

- 5.2.6 Land Quality Management Ltd (LQM) and the Chartered Institute of Environmental Health (CIEH) published Suitable 4 Use Levels (S4ULs) in 2015⁶. These have been calculated based on the same assumptions on exposure as those used to calculate the C4SL values, and LLTC values that are of an equivalent level of protection as the C4SLs.
- 5.2.7 Accordingly, the S4UL have been used as human health risk screening criteria in this assessment for those heavy metals, phenols, PAH compounds and petroleum hydrocarbon fractions not covered by the C4SLs.

Asbestos

- 5.2.8 For the assessment of the risk from asbestos in soils, guidance contained within CIRIA Report C733⁷ has been taken into consideration, although it should be noted that this does not include any UK-based soil guideline values for the assessment of risk from asbestos in soils.

5.3 Risks to Site End Users – Conceptual Exposure Model

- 5.3.1 The preliminary conceptual model indicates that there are several potential exposure pathways by which site users may be exposed to concentrations of contaminants in soil. These exposure pathways, coupled with information about the future use of the site (exposure frequency, age class of users etc.), combine to form a conceptual exposure model for each of the contaminants identified as being potentially significant.
- 5.3.2 Category 4 Screening Levels and S4ULs have been produced for the following standardised land use scenarios:
- Residential (with and without home-grown produce);
 - Allotments;
 - Commercial;
 - Public open space near to housing;
 - Public open space distant from housing.
- 5.3.3 In the CLEA model, the residential land use with home-grown produce scenario is assumed to consist of a small two-storey terraced house built on a ground-bearing floor slab with access to a private garden consisting of lawn, flowerbeds and a small fruit and vegetable patch. The standard critical receptor is assumed to be a young female child (aged zero to six years old) with a duration of exposure of six years.
- 5.3.4 The proposed land use following redevelopment is for houses with private gardens. Therefore, C4SL and S4UL values for the 'residential with home-grown produce' land use scenario has been chosen as the initial risk screening criteria for the site.
- 5.3.5 Defra's published C4SL values have been calculated assuming a soil organic matter (SOM) concentration of 6%. The soil organic matter (SOM) from shallow soil samples analysed varies between 2% and 17%, with an average value of 12%; therefore, the C4SL values are considered applicable to the site.

⁶ Nathanail, C.P., et al., 2015. *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press, Nottingham.

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⁷ Nathanail, P., et al., 2014. CIRIA Report C733, *Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks*. CIRIA, London.

5.3.6 The S4UL values for 6% SOM have been used in this assessment

5.4 Initial Risk Screening Assessment

- 5.4.1 The C4SL and S4UL values for each contaminant of concern is summarised within Table 6. The maximum recorded concentration for each contaminant is also stated. There is a satisfactorily representative dataset for the site for the contaminants of potential concern, and therefore, where the maximum concentration of a contaminant is less than the C4SL / S4UL, it can be stated with a satisfactory degree of confidence that the risk from potential contaminant linkages between that contaminant within existing site soils and the health of the identified critical receptor is low.
- 5.4.2 Conversely, where the maximum concentration of a contaminant is greater than the C4SL / S4UL (highlighted in bold type), further assessment is required. Where the maximum recorded concentration of a contaminant was less than the laboratory's limit of detection within Table 5, it is considered that this would not represent a risk by inspection, and is not included in Table 6.

Table 6: Screening Assessment of Risk to Human Health following Redevelopment

Contaminant	Max. conc. (mg/kg)	S4UL (mg/kg)	C4SL	Is the Maximum Concentration Greater than the Risk Screening Criteria? Is Further Assessment Necessary?
Arsenic	130	-	37	YES
Cadmium	3	-	22	No
Chromium (total)	56	910	-	
Copper	230	2,400	-	
Lead	810	-	200	YES
Mercury	3	40	-	No
Nickel	39	180	-	
Zinc	620	3,700	-	
Phenols	72	380*	-	
Polycyclic Aromatic Hydrocarbon (PAH) Compounds				
Naphthalene	22	13	-	YES
Acenaphthylene	20	920	-	No
Acenaphthene	12	1,100	-	
Fluorene	41	860	-	
Phenanthrene	280	440	-	
Anthracene	81	11,000	-	
Fluoranthene	290	890	-	
Pyrene	240	2,000	-	
Benzo(a)anthracene	190	13	-	YES
Chrysene	160	27	-	
Benzo(b)fluoranthene	240	3.7	-	
Benzo(k)fluoranthene	130	100	-	
Benzo(a)pyrene	130	-	5	
Indeno(1,2,3-cd)pyrene	100	41	-	
Dibenzo(a,h)anthracene	33	0.3	-	No
Benzo(g,h,i)perylene	110	350	-	
Petroleum Hydrocarbon Chain Bands				
C6-C8 Aliphatic	0.026	530	-	No
C8-C10 Aliphatic	0.23	150	-	
C12-C16 Aliphatic	21	142	-	
C16-C21 Aliphatic	15	110,000	-	
C21-C35 Aliphatic	21	110,000	-	
C7-C8 Aromatic	0.01	660	-	
C8-C10 Aromatic	1.6	190	-	
C10-C12 Aromatic	60	380	-	
C12-C16 Aromatic	380	660	-	
C16-C21 Aromatic	1,200	930	-	YES
C21-C35 Aromatic	1,800	1,700	-	
BTEX Compounds				
Benzene	0.01	-	0.87	No
Toluene	0.06	660	-	
Ethylbenzene	0.012	260	-	
m/p-Xylene	0.16	310	-	
o-Xylene	0.100	330	-	

*As per Errata dated 02/02/15.

5.4.3 Table 6 shows that the maximum concentrations of arsenic, lead, 8no. PAH compounds and aromatic petroleum hydrocarbons with carbon chain lengths of C16-

C21 and C21-C35 are greater than the adopted human health risk screening criteria and therefore further assessment of these contaminants is required.

- 5.4.4 The maximum concentrations of all other contaminants analysed for are less than the adopted human health risk screening criteria; the risk from exposure to these contaminants in soil following redevelopment is therefore considered to be low.
- 5.4.5 There are currently no UK-based human health risk assessment values for cyanide in soils. However, the concentrations recorded on the site are considered to be elevated and could contribute to the overall risk to human health from exposure to soil contamination on the site.

Further Assessment of Contaminants of Potential Concern

- 5.4.6 Statistical analysis of the concentrations of the contaminants of potential concern listed above has been undertaken in accordance with the guidance published by the Chartered Institute of Environmental Health and CL:AIRE⁸ using the software tool ESI Contaminated Land Statistics Calculator.
- 5.4.7 Where there is 95% confidence or greater that the true mean concentration of the contaminant within site soils is less than the adopted screening value, it can be said that that contaminant does not pose an unacceptable chronic risk to human health.
- 5.4.8 Where the upper confidence limit (UCL; equivalent to the US₉₅ within the withdrawn Contaminated Land Report CLR7) is greater than the adopted screening value, there may be an unacceptable health risk from the contaminant involved, and further risk assessment or remediation may be required prior to redevelopment.
- 5.4.9 Table 7 summarises the UCL values at 95% confidence level for the contaminants of potential concern identified within Table 6 and states whether or not the UCL exceeds the C4SL / S4UL.

Table 7: Comparison of Contaminant UCL Values to C4SL / S4UL Values

Contaminant	C4SL / S4UL (mg/kg)	UCL at 95% Confidence Level (mg/kg)	Is the UCL Value Greater than the C4SL / S4UL?
Arsenic	37	99	YES
Lead	200	560	
Naphthalene	13	21	
Benzo(a)anthracene	13	130	
Chrysene	27	102	
Benzo(b)fluoranthene	3.7	139	
Benzo(k)fluoranthene	100	107	
Benzo(a)pyrene	5	87	
Indeno(1,2,3-cd)pyrene	41	53	
Dibenzo(a,h)anthracene	0.3	18	
C16-C21 Aromatic Hydrocarbons	930	899	No
C21-C35 Aromatic Hydrocarbons	1,700	1,364	

- 5.4.10 The summary sheet from the Contaminated Land Statistics Calculator software is included within Appendix D.

⁸ CIEH and CL:AIRE, 2008. *Guidance on Comparing Soil Contamination Data with a Critical Concentration*.

- 5.4.11 Table 7 shows that the UCL value for all potential contaminants of concern exceed the adopted human health risk assessment criteria, except the two aromatic petroleum hydrocarbon chains.
- 5.4.12 There is therefore a considered to be an unacceptable site-wide risk to human health from soil contamination following redevelopment. Accordingly, remediation measures will be necessary; recommendations are given in the final section of this report.

5.5 Risk Assessment for Asbestos in Soils

Background

- 5.5.1 This assessment has been undertaken taking into consideration the recent research contained within CIRIA Report C733.
- 5.5.2 Asbestos is widespread within the environment in the UK; around 6 million tonnes was imported between the late Nineteenth Century and 1999, when it was banned⁹. The peak year for asbestos imports into the UK was 1972. Asbestos was used within more than 3,000 products including in many building materials, and is believed to be present to some degree in around half of homes in the UK.
- 5.5.3 The ubiquity of asbestos in the environment results in widespread low concentrations of asbestos in air, with estimates summarised in the Health Protection Agency document referenced above ranging between 0.0001 fibres / millilitre of air (f/ml) and 0.001f/ml in outdoor air in residential areas, resulting in the typical inhalation of 15 million asbestos fibres over a 70-year lifespan.
- 5.5.4 Asbestos in soil is potentially harmful only when loose fibres are released into the air when disturbed, and then inhaled.
- 5.5.5 It is thought that the age at which people are first exposed to asbestos is a factor in the risk of contracting asbestos-related diseases, and therefore children are relatively more vulnerable to exposure to asbestos (including within soils) than adults.
- 5.5.6 The risk to human health from exposure to soils contaminated by soils cannot be assessed using the CLEA model, which is the primary method of estimating human exposure to soil contamination in the UK.
- 5.5.7 There are currently no alternative UK-published guideline values, normal background concentrations or C4SL / S4UL values for asbestos in soils. Similarly, there is no UK-published methodology for quantitatively estimating the concentrations of asbestos fibres released into air from disturbance of asbestos-contaminated soils, including within the document recently published by CIRIA.
- 5.5.8 The typical concentrations of asbestos in soils in the UK are not known; the Defra NBC project identified that there is insufficient data from previous soil surveys to calculate this¹⁰. However, it is stated that naturally occurring asbestos deposits in the UK are unlikely to contribute significantly to normal background concentrations of asbestos in soil.

Concentration of Asbestos in Site Soils

- 5.5.9 Of the 4no. samples of made ground taken from the site that were subjected to quantitative asbestos analysis, 2no. were found to contain asbestos (chrysotile as loose fibres), in concentrations <0.001% by weight, which is the laboratory's limit of quantification, within each sample.

⁹ Smith, K.R. and Saunders, P.J., 2007. *The Public Health Significance of Asbestos Exposures from Large Scale Fires*. Health Protection Agency, Didcot.

¹⁰ Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B, 2011. *Normal background concentrations of contaminants in the soils of England. Available data and data exploration*. British Geological Survey, Keyworth.

Potential for Asbestos Fibres to be released into Air

- 5.5.10 The site is to be redeveloped for residential use with private gardens. Although it is likely that there will generally be a relatively low proportion of the site surfaced with bare soil, there is some potential for asbestos fibres to be released from the soil during disturbance of dry soils, e.g., by digging to cultivate vegetables.
- 5.5.11 The Institute of Occupational Medicine (IOM) previously undertook laboratory experiments¹¹ to measure the amount of loose asbestos fibres released to air from disturbance of soil contaminated with asbestos fibres.
- 5.5.12 The variable factors used in the experiments were the soil type (clay, sand and intermediate), soil moisture content (0%, 5%, 10%, 20%, 30%, 40% and 50%), and asbestos fibre concentration (0.001%, 0.01%, 0.1% and 1%) in the soil and the type of asbestos in the soil (chrysotile, amosite and crocidolite).
- 5.5.13 Experiments with a range of combinations of the above variables were undertaken. The experiment used mechanical means to vigorously disturb the soil samples to deliberately create a dust cloud in a fashion that would be unlikely to occur in reality on the site.
- 5.5.14 It was found that each of these variables influenced the concentration of asbestos fibres in a dust cloud in the air formed from disturbance of asbestos-contaminated soil, but that the initial concentration of asbestos in the soil was the most influential factor (i.e., the more asbestos that was in the soil, the more was transferred to air), followed by the soil moisture content (i.e., the drier the soil, the more asbestos fibres were transferred to air).
- 5.5.15 It was also found that crocidolite and amosite were more readily transferred to air than chrysotile.
- 5.5.16 The CIRIA document describes a study undertaken in the Netherlands that synthesised the results of 30 laboratory and field experiments undertaken that measured the release of asbestos fibres into air from soils with known asbestos concentrations. Within the CIRIA document, these data are communicated using a chart with logarithmic scales (Figure 9.1) showing the measured concentrations of airborne fibres against the concentrations of asbestos in the soil that was disturbed. There are two trend lines for the data; the trend line for laboratory data shows a higher rate of fibre release from soil than that for field data.
- 5.5.17 From Figure 9.1, soil containing 0.001% (i.e., 10mg/kg) free asbestos fibres would be expected to release asbestos fibres during vigorous disturbance to create an airborne concentration of approximately 0.00003 fibres/ml based on the trend line for field data and approximately 0.0007 fibres/ml based on the trend line for the laboratory experiment data.
- 5.5.18 This is illustrated in Appendix A, which contains an annotated extract of Figure 9.1 from the CIRIA guidance document.

Significance of Potential Asbestos Concentrations in Air

- 5.5.19 At the upper end of the estimate of asbestos fibre release to air from vigorous disturbance of shallow soils described above (i.e., the graph trend line based on laboratory experiment data), the potential temporary asbestos fibre concentration in air is within the range of background concentrations of asbestos in outdoor air described by the HPA (see Paragraph 5.5.3, above).
- 5.5.20 At the lower end of the estimate of asbestos fibre release to air from vigorous disturbance of shallow soils (i.e., the graph trend line based on field experiment data), the potential temporary asbestos fibre concentration in air is lower than the

¹¹ Addison, J., et al., 1988. *The Release of Dispersed Asbestos Fibres from Soils*. Research Report TM/88/14. Institute of Occupational Medicine, Edinburgh.

range of background concentrations of asbestos in outdoor air described by the HPA.

- 5.5.21 Consequently, it is considered that even under unfavourable circumstances (i.e., vigorous disturbance of dry, bare soil to the extent that dust is released), the resulting temporary concentration of asbestos within the air above the soil would not exceed the known background concentrations for urban areas.
- 5.5.22 Accordingly, remediation to protect future site residents from exposure to asbestos fibres released from site soils, over and above that required to protect site end users against exposure to chemical soil contamination, is not considered to be necessary.
- 5.5.23 Where asbestos fibres were detected within soils, the concentration was well below the 0.1% threshold for classification as hazardous waste.

Suspected Surface Asbestos Cement Fragments

- 5.5.24 The suspected asbestos cement fragments observed on the ground surface in the western part of the site should be removed from the site to a suitably licenced waste management facility prior to redevelopment.

5.6 Risks to Controlled Waters

- 5.6.1 Although some potentially mobile soil contamination and perched groundwater within made ground was identified by the site investigation, the presence of a significant thickness of low-permeability clay soils underlying the contaminated made ground, as expected within the preliminary conceptual model has been proven by the site investigation.
- 5.6.2 Therefore, the risk of pollution to groundwater and consequent risk of off-site migration to surface water associated with the site is low; no remedial measures are considered to be necessary in this respect.

5.7 Risks to Buried Water Mains

- 5.7.1 The concentrations of organic contaminants including petroleum hydrocarbons and PAH within made ground at the site are likely to result in a requirement from Yorkshire Water that barrier water mains, e.g., Protectaline, is used within the site to prevent contamination of domestic water supplies.

5.8 Risks to Site Workers during Redevelopment at the Site

- 5.8.1 Ground workers should be protected from exposure to soil contamination by provision of overalls, gloves and hygiene facilities during excavation, earthworks and remediation works.

5.9 Risks to Future Site Buildings

- 5.9.1 Based on the guidance given in BRE Special Digest 1¹², the site has been classified as Brownfield, with Mobile groundwater conditions. The chemical test results on soil samples show that the maximum concentration of water-soluble sulphate in soils is 1,500mg/l, with the lowest pH in soils being 4.
- 5.9.2 Following the calculations detailed within SD-1, pyritic ground does not appear to be present.
- 5.9.3 Taking into account the above, buried concrete structures (e.g. foundations) should conform to design sulphate class DS-2, and aggressive chemical environment for concrete (ACEC) class AC-5z.

¹² BRE. 2005. *BRE Special Digest 1– Concrete in Aggressive Ground*.

5.10 Revised Conceptual Model

5.10.1 The preliminary conceptual model produced within the Phase 1 Site Investigation Report has been refined based on the ground investigation data and risk assessments detailed above to produce a revised conceptual model for the site following redevelopment. The revised conceptual model for potential contaminant linkages is summarised in Tables 8 and 9 for organic and inorganic contaminants respectively.

5.10.2 The key for Tables 8 and 9 is as follows:

KEY: LOW – potential risks associated with the presence of the contaminant linkage are low and further assessment or remediation is not considered necessary.

MOD – potential risks associated with the presence of the contaminant linkage are moderate and further assessment or remediation should be considered.

HIGH – potential risks associated with the presence of the contaminant linkage are high and further assessment or remediation is considered necessary.

N/A – The contaminant has no potential to affect the receptor via this exposure pathway.

TBC – A risk assessment will be completed following completion of the ground gas monitoring programme (scheduled for June 2015).

Table 8: Summary Revised Conceptual Model and Risk Assessment – Organic Contaminants

Receptors and Pathways	Petroleum Hydrocarbons	PAH	BTEX, Phenol	Cyanides	Landfill Gases	Notes
Human Health On-site Dermal contact with soil. Intake via direct ingestion of soil and contaminated dusts indoors and outdoors. Ingestion of garden grown vegetables and attached soils Intake via inhalation of contaminated dusts outdoors and tracked indoors.	LOW LOW LOW LOW	HIGH HIGH HIGH HIGH	LOW LOW LOW LOW	HIGH HIGH HIGH HIGH	N/A N/A N/A N/A	Site-wide concentrations of several PAH compounds exceed adopted human health risk assessment criteria. Elevated concentrations of cyanide are present within site soils. Site-wide concentrations of petroleum hydrocarbons, BTEX compounds and phenols are less than the adopted human health risk screening criteria.
Intake via inhalation of soil vapours and ground gases indoors and outdoors. Explosion of methane, VOC and hydrocarbon vapours.	LOW	HIGH	LOW	LOW	TBC	Site-wide concentrations of the volatile PAH compound naphthalene exceed the adopted human health risk assessment criteria. There is therefore a risk to future residents from inhalation of soil vapours that migrate into the houses and accumulate in confined spaces. A ground gas risk assessment will be produced upon completion of the monitoring programme in June 2015.
Underground water mains	HIGH	HIGH	HIGH	N/A	N/A	The concentrations of organic contaminants on the site exceed Yorkshire Water's limits for the use of standard plastic water pipes.
Site Buildings Concrete foundations	LOW	N/A	LOW	N/A	N/A	Organic compounds can affect building materials only if they are present in very high concentrations.
Controlled Waters Migration to groundwater Migration to surface water	LOW LOW	LOW LOW	LOW LOW	LOW LOW	N/A N/A	The site is underlain by low permeability clay soils and a Secondary Aquifer. Migration of contaminants to Controlled Waters is therefore considered unlikely.

Table 9: Summary Revised Conceptual Model and Risk Assessment – Inorganic Contaminants

Receptors and pathways	Heavy Metals	Sulphates	Asbestos	Acids/ Alkalis	Notes
Human Health On-site					
Dermal contact with soil.	HIGH	LOW	N/A	HIGH	Site-wide concentrations of arsenic and lead exceed the adopted human health risk assessment criteria. Acidic soils are locally present. Although asbestos fibres are locally present, they are present in such low concentrations that soil disturbance would not result in airborne fibre concentrations greater than background concentrations.
Intake via direct ingestion of soil and contaminated dusts indoors and outdoors.	HIGH	LOW	N/A	HIGH	
Ingestion of garden grown vegetables and attached soils	HIGH	LOW	N/A	HIGH	
Intake via inhalation of contaminated dusts outdoors and tracked indoors.	HIGH	LOW	LOW	N/A	
Intake via inhalation of soil vapours and ground gases indoors and outdoors.	LOW	N/A	N/A	N/A	
Underground water mains	N/A	N/A	N/A	N/A	
Site Buildings					
Concrete foundations	N/A	HIGH	N/A	HIGH	Acidic soils and elevated sulphate concentrations have been identified on the site.
Controlled Waters					
Migration to groundwater	LOW	LOW	N/A	LOW	The site is underlain by low permeability clay soils and a Secondary Aquifer. Migration of contaminants to Controlled Waters is therefore considered unlikely.
Migration to surface water	LOW	LOW	N/A	LOW	

6 Waste Soil Management and Soakaways

6.1 Waste Soil Management

- 6.1.1 Soils to be removed from the site as waste must be classified for disposal in accordance with Schedule 10 of the Environmental Permitting Regulations (Landfill Waste Acceptance Criteria). The waste categories are inert, non-hazardous and hazardous.
- 6.1.2 The chemical analysis undertaken on soils and stream sediment from the site allows a preliminary classification to be made.
- 6.1.3 This assessment is based on our interpretation of the legislation and various available guidance documents. Each landfill and waste management facility operator has their own varying acceptance criteria, and the waste soils classification should be confirmed with them prior to disposal.

Made Ground Contaminated by Tar and / or Hydrocarbons

- 6.1.4 Laboratory analysis shows that made ground identified in several locations would be likely to be classified as hazardous waste, due to the concentration of total PAH and / or TPH exceeding 1,000mg/kg.
- 6.1.5 The locations where the concentration of total PAH and / or TPH exceeded 1,000mg/kg were WS03, WS05, TP02 and TP03A.

Other Made Ground

- 6.1.6 Made ground on the site that is not contaminated by tar or hydrocarbons is likely to be classified as non-hazardous waste. Where asbestos fibres were identified within the made ground, the concentration was well below the 0.1% threshold to be classified as hazardous waste.
- 6.1.7 In places the made ground contains significant proportions of coarse inert materials, mainly comprising sandstone and brick. These would be classified as inert waste if fully segregated from the finer made ground matrix.

Asbestos-containing Materials (ACMs)

- 6.1.8 If found to contain asbestos, the suspected asbestos cement fragments noted on the ground surface in the western part of the site would be classified as hazardous waste.
- 6.1.9 Any other ACMs identified on the site, or any soils containing visible ACMs would be classified as hazardous waste, unless the ACMs can be fully segregated from the soil matrix.

Natural Subsoils

- 6.1.10 Where natural uncontaminated clay subsoils are excavated and require disposal, they would be classified as inert waste and should be carefully segregated from made ground and other wastes for disposal.

6.2 Soakaways

- 6.2.1 Due to the presence of deep, locally contaminated made ground underlain by low permeability clay subsoils, the use of soakaways on the site is considered to be unfeasible.

7 Conclusions and Recommendations

7.1 Conclusions

7.1.1 The Phase 2 Site Investigation has concluded with the following:

- The site is underlain by made ground, to a maximum recorded depth of 2.85m bgl, including fragments of potentially contaminating man-made materials such as, ash, clinker and slag. Visual and olfactory evidence of coal tar, hydrocarbon and cyanide-bearing gasworks purifier wastes was observed in several locations.
- The made ground is underlain by soft to stiff sandy clay, to the full depth of investigation.
- The site-wide concentrations of the arsenic, lead and several PAH compounds within the made ground are greater than adopted human health risk assessment values.
- Accordingly, remedial measures are required during redevelopment to make the site suitable for the residential occupation (see Section 7.2 below).
- There is a low risk to human health from exposure to asbestos fibres within soils following redevelopment.
- Due to elevated sulphate concentrations and the presence of acidic soils, below-ground concrete should conform to Design Sulphate Class DS-2 and ACEC Class AC-5z.
- The risk of pollution of controlled waters from the site is considered to be low.
- A ground gas monitoring programme is ongoing, to be completed in June 2015. A ground gas risk assessment will be issued upon completion.
- Due to the concentrations of PAH and hydrocarbons, some made ground on the site would be classified as hazardous waste, should it require disposal from the site.
- Soakaways are unlikely to be a viable method of surface water disposal, due to the presence of low permeability clay subsoils underlying the site.

7.2 Remediation Recommendations

ACM Removal

7.2.1 All asbestos-containing materials should be removed from the ground surface during site clearance, and disposed of to a suitably licenced waste management facility.

Ground Gas Protection

7.2.2 The requirement for ground gas protection measures within the proposed houses will be determined upon completion of the gas monitoring programme, scheduled for June 2015.

Soil Vapour Protection

7.2.3 The site-wide concentrations of the volatile PAH compound naphthalene exceed the adopted S4UL value. As indoor vapour inhalation is identified as the primary pathway that drives the risk to human health from exposure to naphthalene, the proposed houses and garages should be provided with soil vapour protection, comprising a vapour barrier that is resistant to hydrocarbon and organic solvent vapours, e.g., Visqueen GX Flexi Hydrocarbon Barrier¹³.

¹³ http://www.visqueenbuilding.co.uk/ourproducts_details.asp?catid=2&productid=102

- 7.2.4 The vapour barrier should be installed by experienced contractors, in strict accordance with the manufacturer's instructions.

Capping Layer

- 7.2.5 Due to the contamination of made ground at the site, remedial works are required in order to make the site suitable for residential occupation.
- 7.2.6 A capping layer of clean soil materials should be provided in all gardens and soft landscaped areas following redevelopment. In accordance with the current best practice document¹⁴, and assuming that the capping materials contain contaminants in concentrations that are less than or equal to appropriate human health screening criteria, the thickness of the capping layer should be a minimum of 600mm in thickness. Dependent on finished ground levels, this may require localised removal of existing material.
- 7.2.7 Should made ground be removed from garden areas and natural clay subsoil be exposed, the clean capping materials can be placed directly onto this.
- 7.2.8 The capping layer can comprise any combination of clean subsoil and topsoil. In accordance with NHBC Standards however, the minimum thickness of the topsoil should be 100mm.
- 7.2.9 The subsoil component can comprise any suitable certified clean subsoil of natural origin, including clean clay subsoils arising from excavations on the site. Builder's sand purchased directly from a builder's merchants has been found to be suitable for this use, as it is consistent in its quality and easily placed and levelled on site.
- 7.2.10 Similarly, the topsoil should be from a certified source and contain little to no man-made materials such as brick, plastic or metal, etc. A topsoil provider with documented quality control procedures and certification, such as British Sugar, is strongly recommended (see Appendix E for details).
- 7.2.11 Offers of cheap or free subsoil and topsoil from other development sites should be viewed with caution, as experience shows that these often contain contaminant concentrations that are unsuitable for use on residential sites.

Verification Requirements

- 7.2.12 Clean natural subsoils excavated from the site for drains, foundations, etc., can be considered chemically suitable and do not require further testing to be used in capping layers on the site.
- 7.2.13 Subsoil that is virgin material produced at a quarry does not require specific chemical suitability analysis as this comprises natural materials that cannot plausibly be considered likely to be contaminated.
- 7.2.14 Topsoil and other types of subsoil materials imported to the site should be analysed for the following contaminants:
- Arsenic;
 - Cadmium;
 - Chromium (total);
 - Copper;
 - Lead;
 - Mercury;
 - Nickel;
 - Selenium;
 - Zinc;
 - Speciated PAH - EPA 16 compounds (the testing laboratory will offer this analysis as standard)

¹⁴ BRE, 2004. BRE Report 465. *Cover Systems for Land Regeneration*.

- Fraction of organic carbon / soil organic matter.
 - Asbestos presence / absence. If asbestos is detected, quantitative analysis is required.
- 7.2.15 The concentrations of contaminants should be less than relevant assessment criteria, e.g., the C4SL / S4UL values listed in Table 6 of this report. Should applicable new soil risk assessment criteria be published prior to the remediation taking place, these may be used as the acceptance criteria.
- 7.2.16 Topsoil or subsoil with olfactory evidence of petroleum hydrocarbon or other contamination is not acceptable.
- 7.2.17 It is recommended that the analysis results are known before the soil is imported to the site to avoid a situation where unsuitable soil is placed on the site which then has to be removed and replaced.
- 7.2.18 The number of tests to be undertaken should be in accordance with the guidance published by the NHBC¹⁵. For a site with 4no. plots, the testing frequency is 1 test per plot, i.e., 4no. tests per each type of imported soil material.
- 7.2.19 The analysis should be undertaken by a UKAS and MCERTS accredited laboratory.
- 7.2.20 Statistical analysis of soil testing results undertaken in accordance with the CL:AIRE and Chartered Institute of Environmental Health guidance referenced above may be undertaken should some analysis results be greater than the acceptance criteria to determine the true mean concentration within imported soils. If the mean concentration at 95% confidence limit is less than the relevant acceptance criteria, the material can be deemed suitable for use on the site.
- 7.2.21 The key stages in the verification may be summarised as follows:
- Consultant checks that imported soil meets specification;
 - Capping layer is placed on site in accordance with this document;
 - Consultant checks capping layer thickness by digging trial pits and taking photographs.
- 7.2.22 The verification of placement should be undertaken as soon as possible following placement, and before placement of turf, fences, etc., in the gardens. It is strongly recommended that the approval of the local authority and NHBC (if applicable) is confirmed prior to placement of turf and fences, etc.
- 7.2.23 The depth of the cover layer should be verified at one location in each rear garden area and at one location in each front garden area.
- 7.2.24 Photographs of each trial pit should be taken with a digital camera and there should be a clear record to identify the plot being photographed and whether the front or back garden is being photographed. The photographs should show the depth of the trial pit using a tape measure or similar.

Verification Report

- 7.2.25 Following satisfactory verification of the capping layer, the environmental consultant will produce a remediation verification report. The report will contain information including the following:
- Photographs of trial pits showing topsoil thickness (if there are several, these may be supplied separately on a CD-ROM);
 - Trial pit location plan and logs (if applicable);
 - Laboratory analysis certificates;

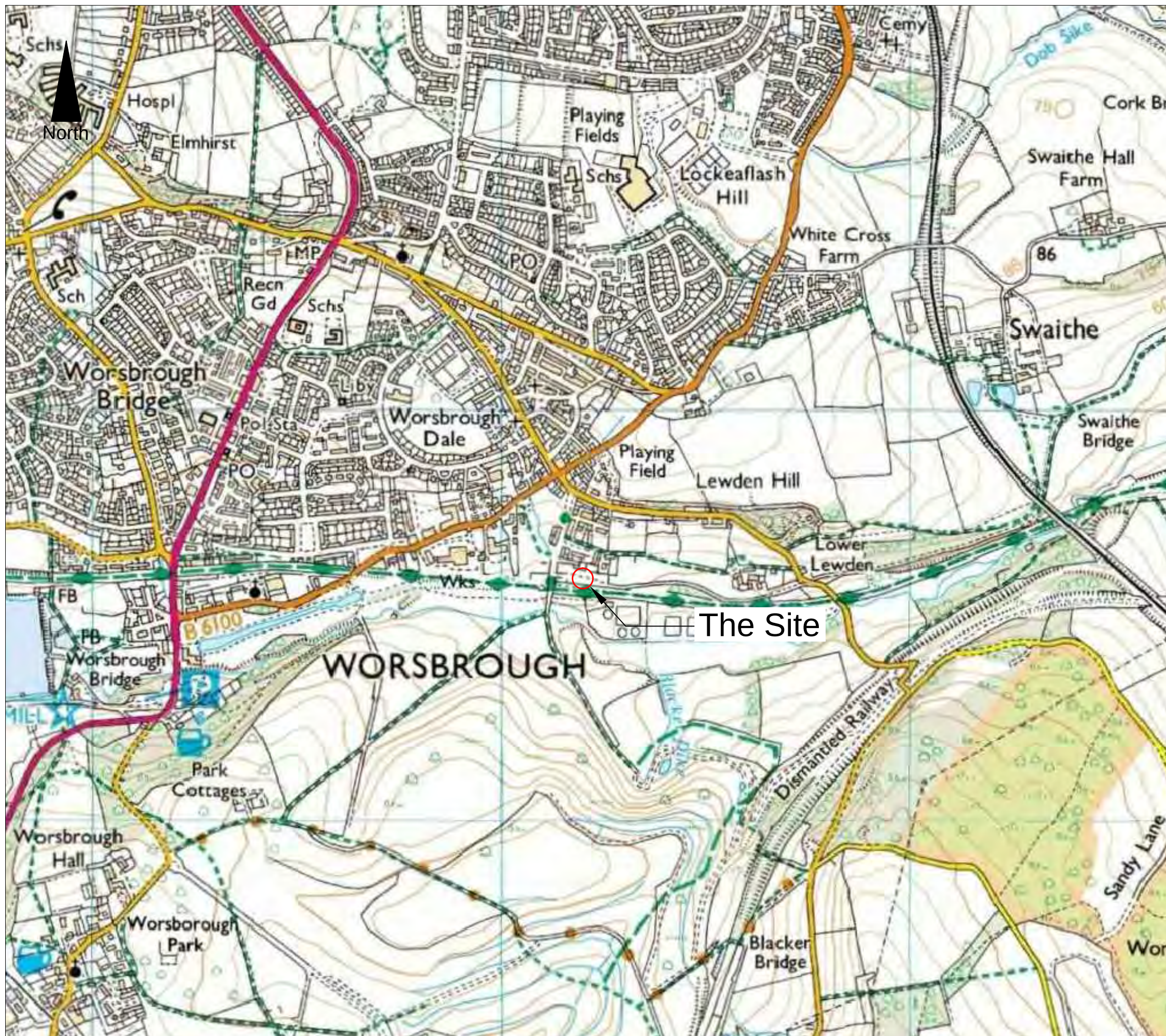
¹⁵ NHBC Technical Extra 08, November 2012.

- Confirmation that the contaminant concentrations in imported materials meet the acceptance criteria.
- Confirmation that the remediation has been undertaken satisfactorily;
- Confirmation that the remediation objectives have been achieved;
- Any necessary precautions to be taken considering that some potentially contaminated soil may remain on site;
- Revised conceptual model showing no significant potential contaminant linkages;
- Statement that there is now unlikely to be a significant possibility of significant harm associated with contamination on the site.

7.2.26 The remediation of the plots may be undertaken in phases; a letter report can be issued for each group plot as and when they are remediated and verified.

Appendix A: Figures

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Phase 2 Site Investigation

Edmunds Road, Worsborough

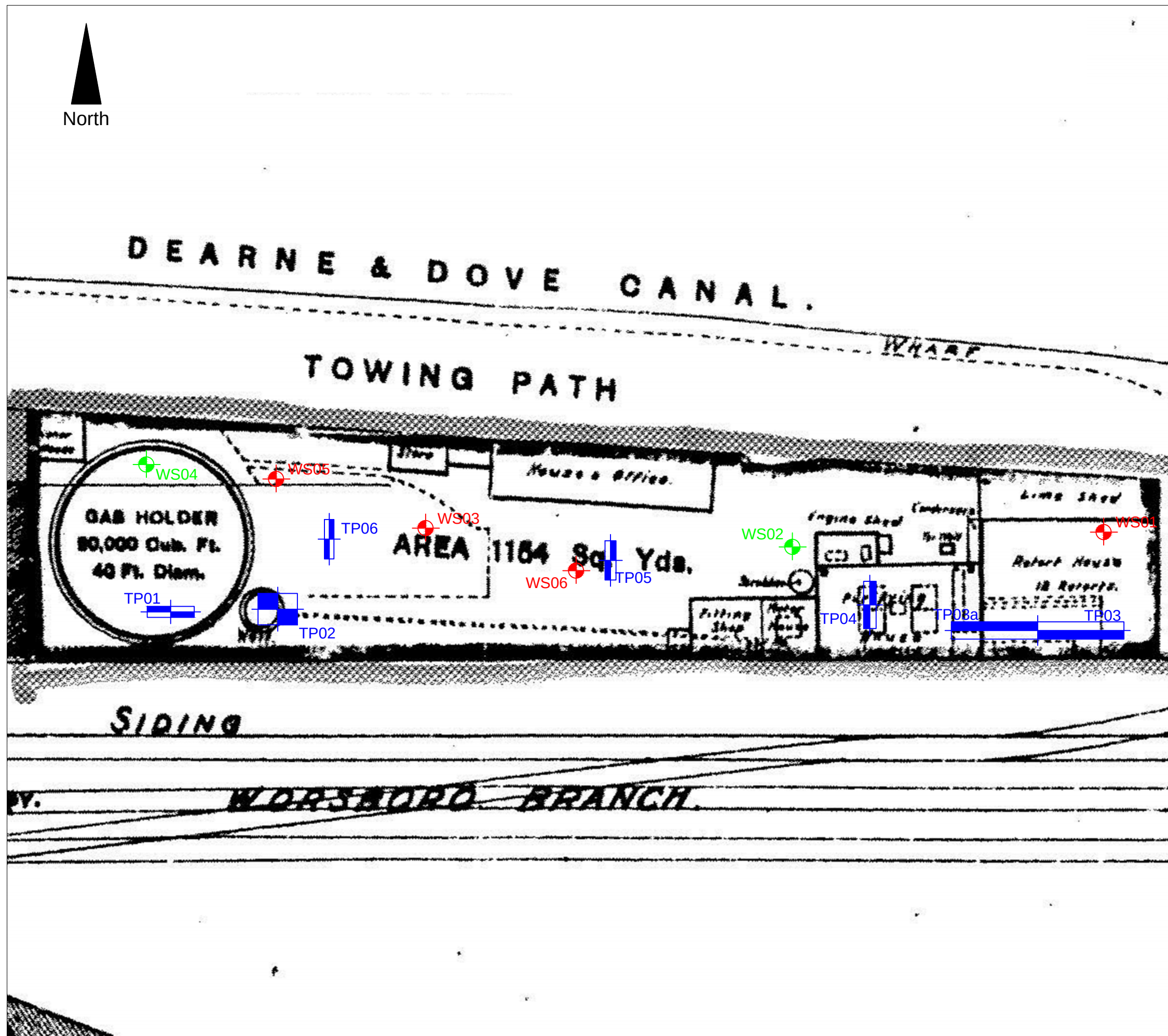
Job No. 4236

Site Location Plan

Brook Holt ■ Blackburn Road ■ Sheffield ■ S61 2DW
tel: 0114 266 9292 ■ www.ecusltd.co.uk

Key:

-  **WS01** Windowless Sampler Borehole Location
-  **WS01** Windowless Sampler Borehole Location with Ground Gas Monitoring Well
-  **TP01** Trial Pit Location



Phase 2 Site Investigation

Edmunds Road, Worsborough

Job No. 4236

Exploratory Hole Location Plan

Brook Holt ■ Blackburn Road ■ Sheffield ■ S61 2DW
tel: 0114 266 9292 ■ www.ecusltd.co.uk

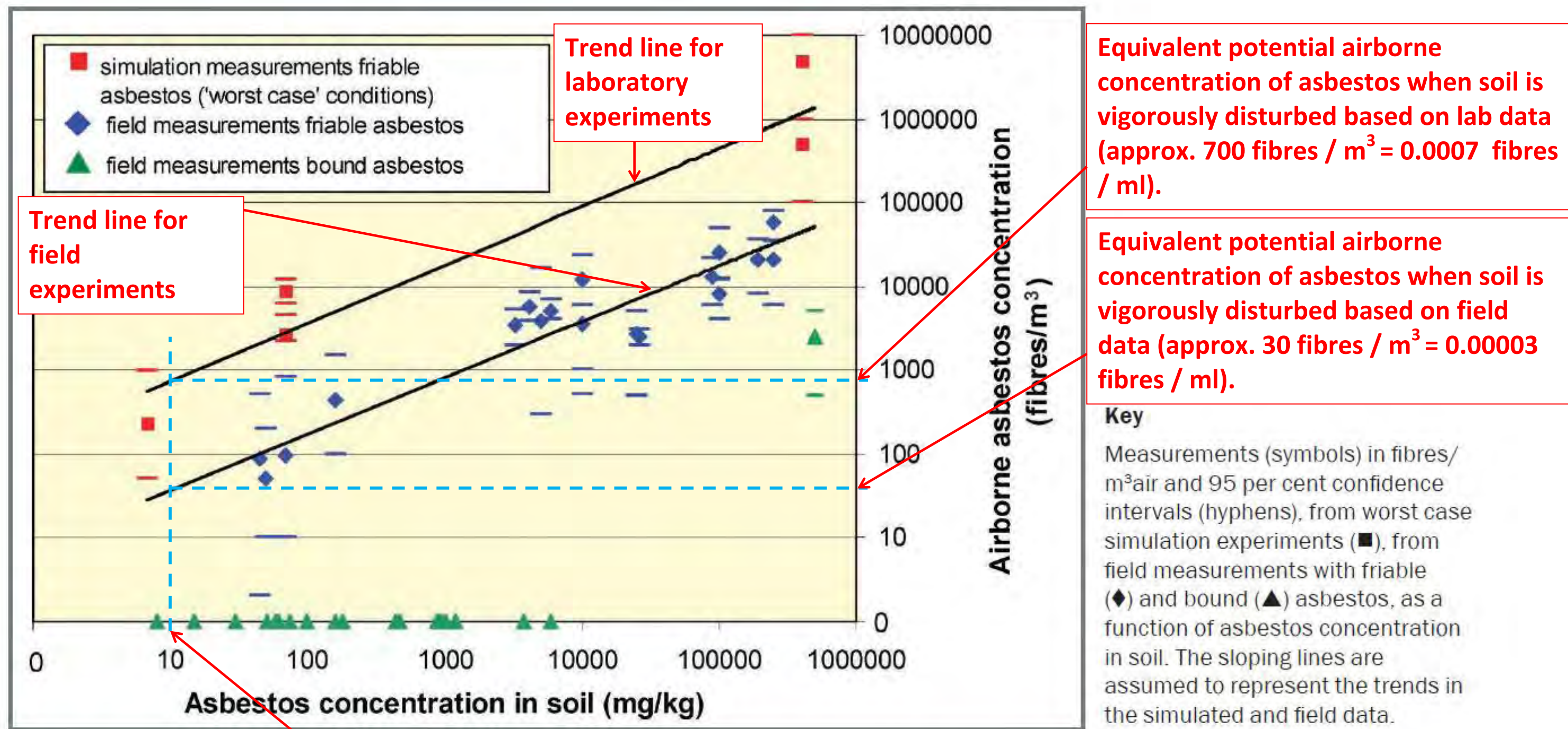
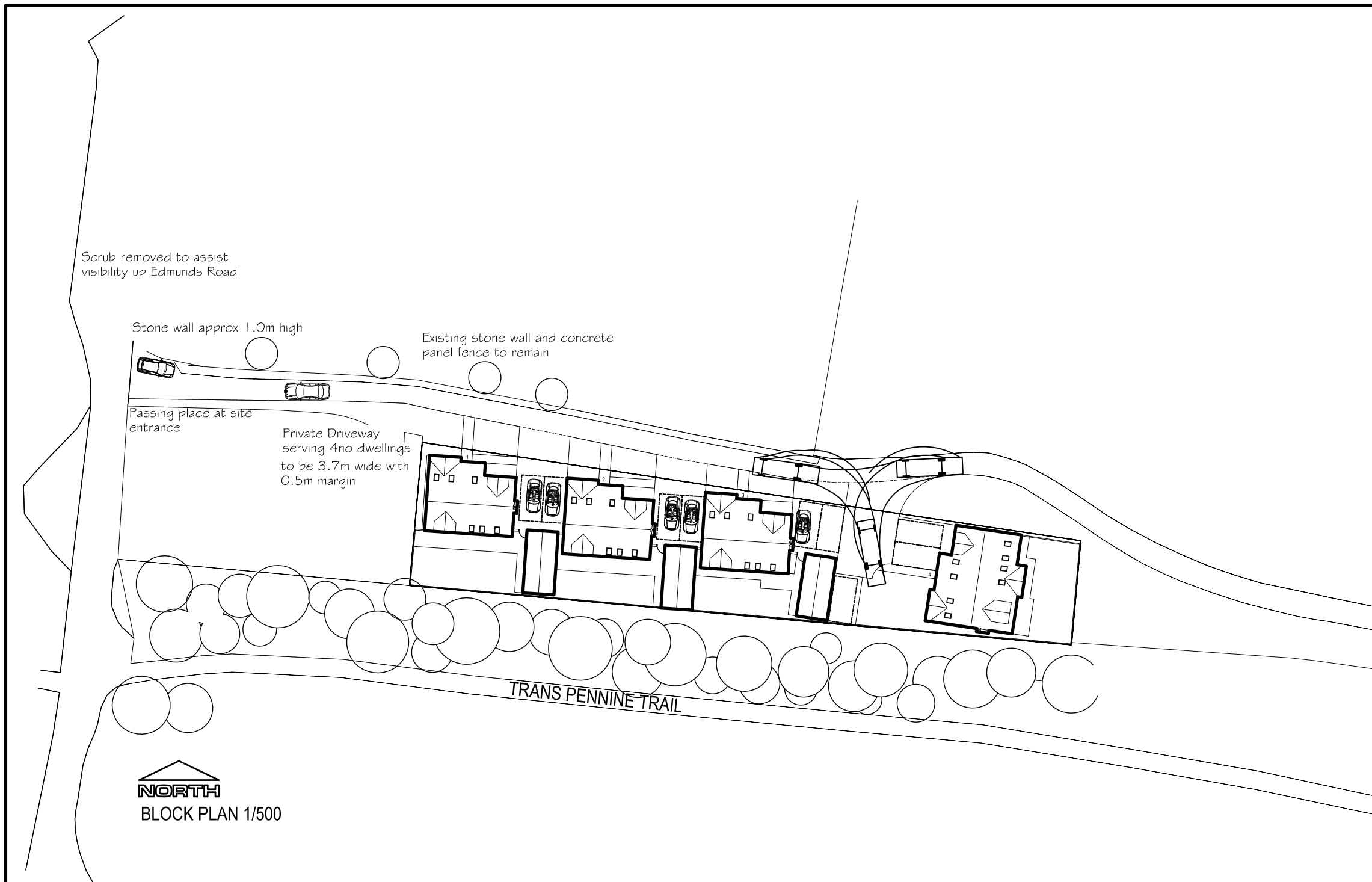
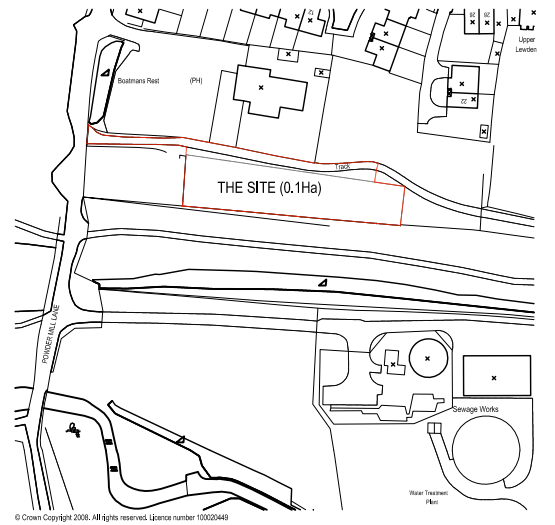


Figure 9.1 Average airborne asbestos concentrations from simulated and field measurements (after Swartjes and Tromp, 2008)

Maximum possible concentration of free chrysotile fibres in made ground on the site: 0.001% (10mg/kg)

Estimation of asbestos fibre concentration in air that could be caused by vigorous disturbance of existing shallow soil, assuming maximum concentration of free asbestos fibres within made ground is 0.001%. Based on Figure 9.1 from Nathanail et al., 2014. Ecus notation is in red text.



LOCATION PLAN 1/1250

Client
Martin Benson and Maria Frith

Project
RESIDENTIAL DEVELOPMENT
EDMUNDS ROAD
BARNSELY

Drawing
LOCATION AND BLOCK PLANS

DRAFT

windle cook architects



927 Chesterfield Road, Sheffield S8 0SS

tel. 0114 235 9910

fax. 0114 235 9861

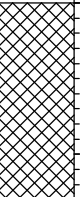
Drawn by MC	Date APRIL 2015	Scale 1/500, 1250
Checked by	Drawing No. 15-185-C01	Rev.

Appendix B: Borehole and Trial Pit Logs

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BOREHOLE LOG

Project Land off Edmunds Road, Worsborough, Barnsley				HOLE No WS01	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used Archway Competitor Dart Windowless Sampling Rig				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
1.00	SPT	N6 (2,1/1,1,2,2)				(1.30)	MADE GROUND: Loose dark brown gravelly very clayey sand. Gravel is of fine, subrounded to subangular brick and sandstone. Rare subangular sandstone cobble.		
1.40	D					(0.65)	Soft to firm dark grey mottled orange-brown sandy CLAY.		
1.70	HSV	32kPa				1.95			
1.80	HSV	38kPa							
1.90	HSV	58kPa							
2.00	SPT	N18 (2,3/3,5,4,6)				(0.75)	Firm light grey mottled orange very sandy CLAY.		
2.90	HSV	88kPa				2.70			
3.00	SPT	N19 (3,3/4,4,6,5)							
3.70	HSV	40kPa				(1.90)	Soft to stiff light brown mottled grey gravelly sandy CLAY. Gravel is of fine to medium, subrounded sandstone.		
3.90	HSV	32kPa							
4.00	SPT	N22 (4,4/5,6,5,6)				4.60			
4.80	HSV	56kPa							
5.00	SPT	N20 (4,4/4,5,5,6)							
6.00	SPT	N24 (5,5/5,6,5,8)				(2.40)			
7.00	SPT	N25 (7,5/5,6,6,8)				7.00			

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	
						1) Borehole drilled from surface. 2) Borehole terminated at appropriate depth. 3) Groundwater seepage at 4.2m. 4) Borehole backfilled with arisings on completion.
All dimensions in metres Scale 1:50		Client Hadfields Development		Contractor Exploration Ltd		Logged By RZ



Project Land off Edmunds Road, Worsborough, Barnsley				HOLE No WS02
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()	
Method/Plant Used Archway Competitor Dart Windowless Sampling Rig				Sheet 1 of 1

ECUS WINDOW SAMPLE LOG AG 4236.GPJ NEW.GDT 8/4/15

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia. mm	Water Dpt	
						1) Borehole drilled from surface. 2) Borehole terminated at appropriate depth. 3) No groundwater encountered. 4) 50mm ground gas monitoring well installed.
All dimensions in metres Scale 1:50		Client Hadfields Development		Contractor Exploration Ltd		Logged By RZ

BOREHOLE LOG

Project Land off Edmunds Road, Worsborough, Barnsley				HOLE No WS04	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used Archway Competitor Dart Windowless Sampling Rig				Sheet 1 of 1	

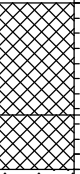
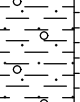
SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.20	D					0.05	MADE GROUND: Soft dark brown very sandy clay.		
0.20	J					0.10	MADE GROUND: Soft dark brown slightly gravelly very sandy clay. Gravel is of fine subangular brick.		
0.20	V					(0.70)			
0.50	D					0.80	MADE GROUND: Medium dense dark grey gravelly sand. Gravel is of fine to medium, rounded to subangular slate, quartz, brick, sandstone, ash, clinker and slag. Strong sulphurous odour.		
1.00	SPT	N10 (2,3/2,3,3,2)				(0.60)	MADE GROUND: Medium dense dark grey slightly gravelly sand. Gravel is of fine, rounded to subangular brick, ash and quartz. Strong sulphurous odour.		
						1.40			
						1.60	MADE GROUND: Brick cobble.		
2.00	SPT	N7 (1,1/2,2,1,2)				(1.05)	MADE GROUND: Firm dark grey gravelly sandy clay. Gravel is of fine to coarse, rounded to subrounded sandstone, brick, slate and rare slag.		
2.65	D					2.65			
2.70	HSV	48kPa					Firm light grey mottled orange slightly sandy gravelly CLAY. Gravel is of fine to medium, rounded to subrounded sandstone.		
2.90	HSV	42kPa							
3.00	SPT	N11 (1,2/2,3,3,3)							
3.60	HSV	58kPa				(2.35)			
4.00	SPT	N11 (2,2/2,2,3,4)							
5.00	SPT	N50 (25/34,7,4,5)				5.00			

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	
						1) Borehole drilled from surface. 2) Borehole terminated due to refusal in hard strata. 3) No groundwater encountered. 4) 50mm ground gas monitoring well installed.

All dimensions in metres Scale 1:50		Client Hadfields Development	Contractor Exploration Ltd	Logged By RZ
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BOREHOLE LOG

Project Land off Edmunds Road, Worsborough, Barnsley				HOLE No WS05	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used Archway Competitor Dart Windowless Sampling Rig				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.40 0.40 0.40	D J V					(0.74) 0.74	MADE GROUND: Medium dense dark brown clayey gravelly sand. Gravel is of fine to medium, rounded to subangular brick, quartz, ash, slag and clinker.		
1.00	SPT	N10 (2,3/3,2,2,3)				1.10	MADE GROUND: Dark brown sandy gravelly clay with fibrous plant material. Gravel is of fine to medium, rounded to subangular brick, sandstone and quartz.		
1.20	D					(0.40) 1.50	Soft dark brown very sandy CLAY.		
1.60 1.70 1.90 2.00	HSV HSV HSV SPT	74kPa >43kPa >50kPa N13 (1,1/2,3,4,4)				(1.20) 2.70	Firm light grey mottled orange-brown sandy gravelly CLAY. Gravel is of fine to medium, rounded to subrounded sandstone.		
2.80 3.00	HSV SPT	96kPa N15 (3,3/3,3,4,5)				(1.30) 4.00	Firm to stiff light grey mottled orange-brown sandy gravelly CLAY. Gravel is of fine to coarse, rounded to subrounded sandstone.		
3.90 4.00	HSV SPT	>50kPa N50 (25/22,10,9,9)							

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	
						1) Borehole drilled from surface. 2) Borehole terminated due to refusal in hard strata. 3) No groundwater encountered. 4) Borehole backfilled with arisings on completion.
All dimensions in metres Scale 1:50		Client Hadfields Development		Contractor Exploration Ltd		Logged By RZ

BOREHOLE LOG

Project Land off Edmunds Road, Worsborough, Barnsley				HOLE No WS06	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used Archway Competitor Dart Windowless Sampling Rig				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.40	D					(0.54)	MADE GROUND: Soft dark brown slightly sandy slightly gravelly clay. Gravel is of fine, rounded to subrounded brick, quartz and sandstone. Frequent glass and timber fragments.		
0.40	J					0.54			
0.40	V					0.70	MADE GROUND: Medium dense light brown very sandy gravel. Gravel is of fine to medium, subrounded sandstone.		
1.00	SPT	N12 (2,2/3,3,3,3)				(0.40)	MADE GROUND: Firm dark grey sandy very gravelly clay. Gravel is of fine to medium, rounded to subangular brick, coal and sandstone.		
1.80	HSV	52kPa					Soft to firm light grey mottled orange-brown sandy gravelly CLAY. Gravel is of fine to medium, rounded to subrounded sandstone.		
1.85	HSV	>30kPa							
2.00	SPT	N21 (1,2/3,6,5,7)				(2.10)			
3.00	SPT	N16 (3,3/4,4,4,4)				3.20			
4.00	SPT	N24 (3,4/5,6,6,7)				(0.80)	Firm to stiff light brown very gravelly CLAY. Gravel is of medium to coarse, subrounded sandstone.		
						4.00			

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	
						1) Borehole drilled from surface. 2) Borehole terminated at appropriate depth. 3) No groundwater encountered. 4) Borehole backfilled with arisings on completion.

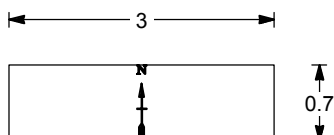
All dimensions in metres Scale 1:50	Client Hadfields Development	Contractor Exploration Ltd	Logged By RZ
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TRIAL PIT LOG

Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP01	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.30	D J V					(0.40)	MADE GROUND: Brown sandy gravelly clay. Gravel is fine to coarse, angular to sub-angular, of concrete, sandstone and asphalt. With fragments of bottle glass and polythene. On northern side of pit, with much gravel of asphalt.		
0.30						0.40			
0.30						(0.40)	MADE GROUND: Firm sandy gravelly clay. Gravel is fine to medium, sub-angular to sub-rounded, of sandstone.		
						0.80			
0.85	D J V					(0.40)	MADE GROUND: Brown and grey-brown sandy gravel. Gravel is fine to coarse, sub-angular to sub-rounded, of slag, ash and clinker. With sulphurous odour.		
0.85						1.20			
0.85						(0.80)	... from c. 1.2m bgl becoming gravelly sand.		
						2.00			
						(0.85)	... from c. 2m bgl becoming sandy gravel with cobbles of slag. With strong odour of sulphur.		
						2.85			

Shoring/Support:
 Stability:



GENERAL REMARKS

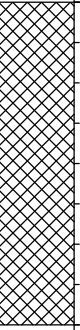
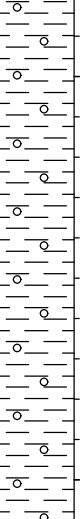
1. Excavated within footprint of former gas holder.
2. Excavation terminated due to presence of solid base to gas holder.
3. Trial pit remained stable throughout excavation.
4. Standing water at 2.6m bgl on completion.
5. Backfilled with arisings.

TRIAL PIT 4236.GPJ NEW.GDT 15/4/15

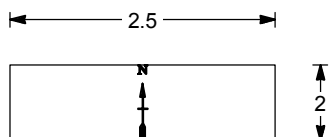
All dimensions in metres Scale 1:18.75	Client Hadfields Development	Contractor Hather Plant Hire	Logged By AL
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TRIAL PIT LOG

Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP02	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.30 0.30 0.30	D J V					(0.80) 0.80	MADE GROUND: Light orange-brown very sandy gravelly clay. Gravel is fine to coarse, sub-angular to sub-rounded, of sandstone with occasional brick and slag. With large pocket of blue coloured clay from c. 0.25m bgl.		
						(1.30) 2.10	Firm orange-brown sandy gravelly CLAY. Gravel is fine to coarse, sub-angular to sub-rounded, of sandstone.		

Shoring/Support:
Stability:



GENERAL REMARKS

- Excavated across footprint of former well. Well encountered in situ in west of pit, with sandstone masonry wall; apparent solid base encountered at 3.5m bgl. Small horizontal lead pipe encountered at 0.7m bgl, with odour of hydrocarbons. Large diameter vertical pipe present to base of well. Well structure filled with made ground of ash and clinker with many roof tiles.
- Trial pit remained stable.
- Backfilled with arisings.

All dimensions in metres
Scale 1:18.75

Client
Hadfields Development

Contractor
Hather Plant Hire

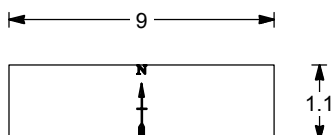
Logged By
AL

TRIAL PIT LOG

Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP03	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet	1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.10	D						MADE GROUND: Loose dark brown slightly clayey slightly ashy very gravelly sand with cobbles and boulders of sandstone and brick and concrete (boulders are up to 0.7 x 0.6 x 0.2m). Gravel is fine to coarse, angular to sub-angular, of brick, sandstone and clinker. With occasional fragment of metal and fragments of large diameter earthenware pipe. 2 no. large metal girders encountered. Approximately 80% oversize material.		
0.30	D								
0.30	J								
0.30	V								
						(1.00)			
						1.00			
						(0.80)	MADE GROUND: Loose red-brown gravelly sand. Gravel is fine to coarse, angular to sub-rounded, of brick, sandstone and ash.		
						1.80			
						1.85	MADE GROUND: Concrete slab of unknown thickness.		

Shoring/Support:
 Stability:



GENERAL REMARKS

1. Concrete floor encountered at 1.8m bgl.
2. Trial pit extended to west.
3. Brick wall with metal furnace door encountered in southern side of pit.
4. Brick wall encountered in western end of pit.
5. Backfilled with arisings.

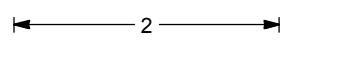
All dimensions in metres
 Scale 1:18.75

Client
 Hadfields Development

Contractor
 Hather Plant Hire

Logged By
 AL

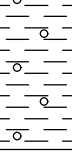
Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP03A
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()	
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet 1 of 1

<p>Shoring/Support: Stability:</p> 	<p style="text-align: center;">GENERAL REMARKS</p> <ol style="list-style-type: none"> 1. Brick wall encountered in eastern end of pit. 2. Trial pit remained dry and stable. 3. Terminated in natural strata. 4. Backfilled with arisings.
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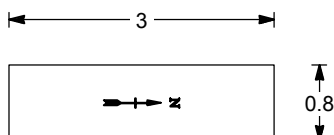
All dimensions in metres Scale 1:18.75	Client Hadfields Development	Contractor Hather Plant Hire	Logged By AL
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TRIAL PIT LOG

Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP04	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
1.70 1.70	J V					(1.00) 1.00	MADE GROUND: Dark grey-brown clayey sand and gravel. Gravel is fine to coarse, angular to sub-rounded, of brick, sandstone, ash and clinker. With occasional fragments of timber and metal.		
						(0.60) 1.60	MADE GROUND: Light orange-brown sandy gravelly clay. Gravel is fine to coarse, angular to sub-rounded, of sandstone. With some cobbles and boulders of sandstone, occasional bricks and some fragments of pottery.		
						(0.20) 1.80	... from c. 1.6m bgl becoming grey and oily.		
						(0.40) 2.20	Firm orange-brown sandy gravelly CLAY. Gravel is fine to coarse, sub-angular to sub-rounded, of sandstone.		

Shoring/Support:
 Stability:



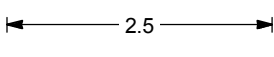
GENERAL REMARKS

1. In situ brick wall in western side of pit from surface to 0.9m bgl in south end of pit.
2. Slow flow of oily water from 1.6m bgl.
3. Trial pit remained stable.
4. Terminated in natural strata.
5. Backfilled with arisings.

TRIAL PIT 4236.GPJ NEW.GDT 15/4/15

All dimensions in metres Scale 1:18.75	Client Hadfields Development	Contractor Hather Plant Hire	Logged By AL
---	---------------------------------	---------------------------------	-----------------

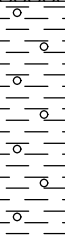
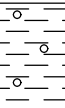
Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP05
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()	
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet 1 of 1

<p>Shoring/Support: Stability:</p> 	<p style="text-align: center;">GENERAL REMARKS</p> <ol style="list-style-type: none"> 1. Brick wall encountered from surface to 1.2m bgl in north end of pit, with boulders of sandstone at 1.5m bgl. 2. Trial pit remained dry and stable throughout excavation. 3. Terminated in natural strata. 4. Backfilled with arisings.
--	---

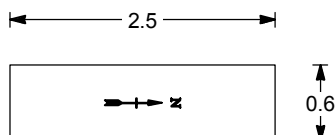
All dimensions in metres Scale 1:18.75	Client Hadfields Development	Contractor Hather Plant Hire	Logged By AL
---	---------------------------------	---------------------------------	-----------------

TRIAL PIT LOG

Project Land off Edmunds Road, Worsborough, Barnsley				TRIAL PIT No TP06	
Job No 4236	Date 30-03-15 30-03-15	Ground level (m)	Co-Ordinates ()		
Method/Plant Used CAT 432E backhoe excavator with 0.6m wide toothed bucket.				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
1.60	HSV	66kPa				(0.90) 0.90	MADE GROUND: Grey-brown coloured blue in places, clayey gravelly sand. Gravel is fine to coarse, angular to sub-rounded, of brick, sandstone and ash, with cobbles of brick, cobbles and boulders of sandstone, fragments of porcelain and metal.		
						(0.60) 1.50	Firm light orange-brown sandy gravelly CLAY. Gravel is fine to coarse, angular to sub-rounded, of sandstone.		
						(0.30) 1.80	... from c. 1.5m bgl becoming grey-brown.		
						(0.20) 2.00	... from c. 1.8m bgl becoming light orange-brown and light grey.		

Shoring/Support:
Stability:



GENERAL REMARKS

1. Trial pit remained dry and stable throughout excavation.
2. Terminated in natural strata.
3. Backfilled with arisings.

TRIAL PIT 4236.GPJ NEW.GDT 15/4/15

All dimensions in metres Scale 1:18.75	Client Hadfields Development	Contractor Hather Plant Hire	Logged By AL
---	---------------------------------	---------------------------------	-----------------



Job: Phase 2 Site Investigation
Site: Land off Edmunds Road, Worsbrough, Barnsley
Ref: 4236

Trial pit TP02, facing west. Intact wall to former 'well' visible to right, with intact vertical iron pipe in centre of photograph.



Job: Phase 2 Site Investigation
Site: Land off Edmunds Road, Worsbrough, Barnsley
Ref: 4236

Trial pit TP03, facing east. Intact concrete slab visible at base of trial pit.

Ecus Ltd
 Brook Holt
 3 Blackburn Road
 Sheffield. S61 2DW

Tel : (0114) 2669292
www.ecusltd.co.uk





Job: Phase 2 Site Investigation
Site: Land off Edmunds Road, Worsbrough, Barnsley
Ref: 4236

Trial pit TP04, facing south-west. Intact brick wall in area of former purifier house.



Job: Phase 2 Site Investigation
Site: Land off Edmunds Road, Worsbrough, Barnsley
Ref: 4236

Trial pit TP03, facing south-west. Intact brick furnace / retort wall and iron door in centre of photograph.

Ecus Ltd
 Brook Holt
 3 Blackburn Road
 Sheffield. S61 2DW

Tel : (0114) 2669292
www.ecusltd.co.uk



Appendix C: Chemical Laboratory Analysis Results

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Report Number: 467135-1

Date of Report: 15-Apr-2015

Customer: ECUS
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW

Customer Contact: Mr Andrew Lake

Customer Job Reference: 4236
Customer Purchase Order: 9547
Customer Site Reference: Edmunds Road, Worsbrough
Date Job Received at SAL: 31-Mar-2015
Date Analysis Started: 07-Apr-2015
Date Analysis Completed: 15-Apr-2015

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22



Report checked
and authorised by :
Chris Murphy
Project Manager

Issued by :
Chris Murphy
Project Manager

SAL Reference: 467135 Project Site: Edmunds Road, Worsbrough Customer Reference: 4236 Soil Analysed as Soil PAH US EPA 16 (B and K split)					
SAL Reference					467135 014
Customer Sample Reference					TP04
Depth					1.7
Date Sampled					30-MAR-2015
Top Depth					
Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T149	AR	0.01	mg/kg	2.6
Acenaphthylene	T149	AR	0.01	mg/kg	1.4
Acenaphthene	T149	AR	0.01	mg/kg	2.3
Fluorene	T149	AR	0.01	mg/kg	2.5
Phenanthrene	T149	AR	0.01	mg/kg	7.4
Anthracene	T149	AR	0.01	mg/kg	3.7
Fluoranthene	T149	AR	0.01	mg/kg	11
Pyrene	T149	AR	0.01	mg/kg	9.2
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	3.9
Chrysene	T149	AR	0.01	mg/kg	2.7
Benzo(b)fluoranthene	T149	AR	0.01	mg/kg	4.5
Benzo(k)fluoranthene	T149	AR	0.01	mg/kg	1.8
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	2.8
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	1.4
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	0.59
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	1.1
PAH(total)	T149	AR	0.01	mg/kg	59

SAL Reference: 467135 Project Site: Edmunds Road, Worsbrough Customer Reference: 4236											
Soil		Analysed as Soil									
Heavy Metals(9)											
SAL Reference				467135 001	467135 003	467135 005	467135 007	467135 010	467135 011	467135 013	
Customer Sample Reference				WS02	WS03	WS04	WS05	TP01	TP02	TP03A	
Depth				0.5	0.2	0.2	0.4	0.3	0.3	0.3	
Date Sampled				30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	
Top Depth				0.3							
Determinand	Method	Test Sample	LOD	Units							
Arsenic	T6	M40	1	mg/kg	45	37	38	30	21	18	130
Cadmium	T6	M40	1	mg/kg	<1	3	<1	<1	1	<1	<1
Chromium	T6	M40	1	mg/kg	21	33	50	23	56	36	11
Copper	T6	M40	1	mg/kg	82	97	230	65	210	51	74
Lead	T6	M40	1	mg/kg	440	660	460	810	300	180	210
Mercury	T6	M40	1	mg/kg	3	2	<1	<1	<1	<1	3
Nickel	T6	M40	1	mg/kg	31	39	27	10	35	18	13
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	160	620	480	61	520	90	70

<p>SAL Reference: 467135</p> <p>Project Site: Edmunds Road, Worsbrough</p> <p>Customer Reference: 4236</p>					
Soil		Analysed as Soil			
Heavy Metals(9)					
SAL Reference					467135 014
Customer Sample Reference					TP04
Depth					1.7
Date Sampled					30-MAR-2015
Top Depth					
Determinand	Method	Test Sample	LOD	Units	
Arsenic	T6	M40	1	mg/kg	11
Cadmium	T6	M40	1	mg/kg	<1
Chromium	T6	M40	1	mg/kg	17
Copper	T6	M40	1	mg/kg	23
Lead	T6	M40	1	mg/kg	50
Mercury	T6	M40	1	mg/kg	<1
Nickel	T6	M40	1	mg/kg	12
Selenium	T6	M40	3	mg/kg	<3
Zinc	T6	M40	1	mg/kg	51

<div>SAL Reference: 467135 Project Site: Edmunds Road, Worsbrough Customer Reference: 4236</div>												
Soil		Analysed as Soil										
pH												
SAL Reference					467135 001	467135 002	467135 003	467135 004	467135 005	467135 007	467135 008	
Customer Sample Reference					WS02	WS02	WS03	WS03	WS04	WS05	WS05	
Depth					0.5	1.2	0.2	0.4	0.2	0.4	1.2	
Date Sampled					30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	
Top Depth					0.3							
Determinand		Method	Test Sample	LOD	Units							
pH		T7	AR			7.6	7.4	6.2	4.5	7.4	4.6	4.0

<p>SAL Reference: 467135</p> <p>Project Site: Edmunds Road, Worsbrough</p> <p>Customer Reference: 4236</p>								
Soil		Analysed as Soil						
pH								
		SAL Reference		467135 010	467135 011	467135 013	467135 014	
		Customer Sample Reference		TP01	TP02	TP03A	TP04	
		Depth		0.3	0.3	0.3	1.7	
		Date Sampled		30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	
		Top Depth						
Determinand		Method	Test Sample	LOD	Units			
pH		T7	AR			7.2	4.6	6.9
								7.3

SAL Reference: 467135 Project Site: Edmunds Road, Worsbrough Customer Reference: 4236 Soil Analysed as Soil Miscellaneous					
SAL Reference					467135 014
Customer Sample Reference					TP04
Depth					1.7
Date Sampled					30-MAR-2015
Top Depth					
Determinand	Method	Test Sample	LOD	Units	
Cyanide(Total)	T4	AR	1	mg/kg	120
Total Phenols	T149	AR	0.01	mg/kg	2.4

<div>SAL Reference: 467135</div> <div>Project Site: Edmunds Road, Worsbrough</div> <div>Customer Reference: 4236</div>									
Soil		Analysed as Soil							
Suite C									
SAL Reference					467135 001	467135 002	467135 004	467135 008	
Customer Sample Reference					WS02	WS02	WS03	WS05	
Depth					0.5	1.2	0.4	1.2	
Date Sampled					30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	
Top Depth					0.3				
Determinand		Method	Test Sample	LOD	Units				
(Water Soluble) SO4 expressed as SO4		T242	AR	0.01	g/l	<0.01	0.04	1.3	0.08
(Acid Soluble) SO4		T192	M40	0.01	%	0.38	0.04	2.9	0.77
Sulphur (total)		T6	M40	0.01	%	0.15	0.02	0.87	0.20

SAL Reference: 467135											
Project Site: Edmunds Road, Worsbrough											
Customer Reference: 4236											
Soil Analysed as Soil											
Sulphate(2:1)											
SAL Reference				467135 001	467135 003	467135 005	467135 007	467135 010	467135 011	467135 013	
Customer Sample Reference				WS02	WS03	WS04	WS05	TP01	TP02	TP03A	
Depth				0.5	0.2	0.2	0.4	0.3	0.3	0.3	
Date Sampled				30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	30-MAR-2015	
Top Depth				0.3							
Determinand	Method	Test Sample	LOD	Units							
SO4(2:1)	T6	AR	0.1	g/l	<0.1	<0.1	<0.1	1.5	<0.1	<0.1	0.7

SAL Reference: 467135 Project Site: Edmunds Road, Worsbrough Customer Reference: 4236 Soil Analysed as Soil Sulphate(2:1)					
SAL Reference					467135 014
Customer Sample Reference					TP04
Depth					1.7
Date Sampled					30-MAR-2015
Top Depth					
Determinand	Method	Test Sample	LOD	Units	
SO4(2:1)	T6	AR	0.1	g/l	0.4

Index to symbols used in 467135-1

Value	Description
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
AR	As Received
13	Results have been blank corrected.
9	LOD raised due to dilution of sample
110	LOD raised due to low internal standard recovery.
S	Analysis was subcontracted
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos

Method Index

Value	Description
T6	ICP/OES
T7	Probe
T54	GC/MS (Headspace)
T192	HCl Extraction/ICP/OES (TRL 447 T2)
T149	GC/MS (SIR)
T8	GC/FID
T27	PLM
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T286	Calc TOC/100
T4	Colorimetry

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Cyanide(Total)	T4	AR	1	mg/kg	U	001,003,005,007,010-011,013-014
Total Phenols	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
SO4(2:1)	T6	AR	0.1	g/l	N	001,003,005,007,010-011,013-014
Arsenic	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Cadmium	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Chromium	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Copper	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Lead	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Mercury	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Nickel	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Selenium	T6	M40	3	mg/kg	U	001,003,005,007,010-011,013-014
Zinc	T6	M40	1	mg/kg	U	001,003,005,007,010-011,013-014
Naphthalene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Acenaphthylene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Acenaphthene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Fluorene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Phenanthrene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Anthracene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Fluoranthene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Pyrene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Chrysene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Benzo(b)fluoranthene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Benzo(k)fluoranthene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
PAH(total)	T149	AR	0.01	mg/kg	U	001,003,005,007,010-011,013-014
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-002,004,008
(Acid Soluble) SO4	T192	M40	0.01	%	N	001-002,004,008
Sulphur (total)	T6	M40	0.01	%	N	001-002,004,008
Benzene	T54	AR	1	µg/kg	U	001,003,005,007,010-011,013-014
Toluene	T54	AR	1	µg/kg	U	001,003,005,007,010-011,013-014
EthylBenzene	T54	AR	1	µg/kg	U	001,003,005,007,010-011,013-014
M/P Xylene	T54	AR	1	µg/kg	U	001,003,005,007,010-011,013-014

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
O Xylene	T54	AR	1	µg/kg	U	001,003,005,007,010-011,013-014
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	U	001,003,005,007,010-011,013-014
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C10-C12 aliphatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C12-C16 aliphatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C16-C21 aliphatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C21-C35 aliphatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C10-C12 aromatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C12-C16 aromatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C16-C21 aromatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
TPH (C21-C35 aromatic)	T8	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
Asbestos Quantification	T27	AR	0.001	%	SU	006,009,012-013
pH	T7	AR			U	001-005,007-008,010-011,013-014
Chromium VI	T6	AR	1	mg/kg	N	001,003,005,007,010-011,013-014
Mass Fraction of organic carbon	T286	M40			N	004,010,014



Appendix D: Summary of Statistical Analysis of Soil Contamination Results

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Appendix E: British Sugar Topsoil Details

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The essential guide



Get it right the
first time ✓



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0870 240 2314



Understanding topsoil

Good topsoil is a mixture of mineral particles, water, nutrients, organic matter, air and living organisms.

Nutrients

Nitrogen

Required for the growth of leaves and stems, its deficiency causes weak, stunted growth and yellowing of older leaves. However, excess nitrogen can also be detrimental causing such effects as disproportionate leaf growth at the expense of other parts of the plant (e.g. flowers).

Phosphorous

Principle nutrient for root growth and development, deficiencies may be seen through stunted root systems whilst the leaves on some plants may also exhibit a dull green or purple coloration.

Magnesium

A constituent of chlorophyll, the green pigment which enables plants to photosynthesise, magnesium deficiency may be noted by the interveinal yellowing of the plant's older leaves.

Organic Matter

Organic matter consists of living organisms and is very important to soil function and plant growth as it influences soil structure (and hence aeration, drainage and root growth), water-holding capacity and soil fertility. It binds mineral particles into granular or crumb structures and the proportion of water that is available for plant uptake. It is a major source of essential plant nutrients including nitrogen, phosphorus, potassium and sulphur; it is also the food for soil organisms, and without it, biochemical activity, which is essential for ecosystem functioning, would cease.

pH

pH is the measure of the acidity or alkalinity of a soil. It affects nearly all soil properties and is a major factor in determining where trees, shrubs and grasses will grow. It influences structural stability, plant nutrient availability, microbe activity and soil pollutant mobility.

Electrical Conductivity

General measure of the soluble salt content or salinity of a soil, a good quality topsoil should have an electrical conductivity value within the range of 100-1500uS/cm (soil : water extract).

Potentially Toxic Elements (PTEs)

Excessive concentrations may be hazardous to health and inhibit plant growth. Laboratory analysis is necessary to indicate the levels of PTEs.

Leaching

The removal of materials in solution from the soil, often as a result of excessive rainfall.

British Standard for topsoil (BS3882:2007)

The British Standard for topsoil BS3882:2007 replaces the 1994 version and specifies the requirements for topsoil that is to be imported or traded, for example in landscaping or remediation projects.

Topsoil is an important aspect of many civil engineering, public and private landscaping projects where it provides support for the growth of vegetation. It should provide a good anchoring substrate, slowly release nutrients and oxygen, drain excess water whilst retaining enough moisture to sustain plant health during droughts.

In this revised standard *Manufactured Topsoil* has been given the same status as *Natural Topsoil*.

There are two grades:

Multipurpose grade:

This is a grade suited to most situations where topsoil is required.

Specific Purpose:

This grade comprises characteristics appropriate for specialist applications, e.g. low fertility, acidic or alkaline.

The Standard gives up-to-date advice on correct soil sampling, handling, analysis, spreading and drainage. In addition to ensuring soils are fit for use, safe and healthy for humans, vegetation and the broader environment, it advises on how to avoid soil erosion and weed establishment including consideration of the subsoil.

Chemical and physical composition, including levels of stone and sharps, are given acceptable limits.

The list of contaminants to be analysed for, and the permissible level for each parameter, is based on the history of the topsoil source as well as the intended use of the topsoil. This is based upon current UK legislation including the 'Contaminated Land Exposure Assessment' (CLEA) model.

Topsoil suppliers are required to provide a Declaration of Analysis to include:

- Location of topsoil source
- Previous and current land use for Natural Soils
- Date of Sampling and Analysis
- BS3882:2007 compliant topsoil must be sampled every 5000 cubic metres (8000t) traded
- Test results including Contamination Parameters
- Written confirmation of compliance with BS3882:2007.

All purchasers and users of topsoil should ask their topsoil supplier for a copy of the following:

- BS3882:2007 Declaration of Analysis
- Analysis Certificate
- Sampling Protocol

Copies of **BS3882:2007** are available from:
BSI Customer Services Department
Tel: (0845 086 9001)

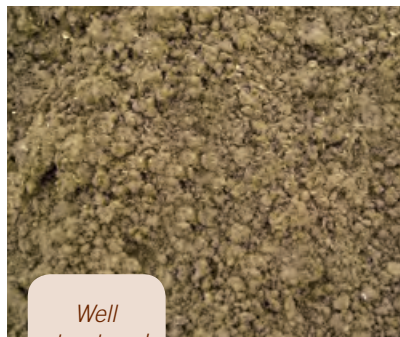
Further information is available at:
www.bstopsoil.co.uk

Topsoil - Terminology

What is Soil Structure?

Soil structure is the aggregation of soil particles (sand, silt, clay and organic matter) into granules, crumbs or blocks. It is the shape that the soil takes based on its physical, chemical and biological properties; it is very important since (along with texture) it affects drainage and aeration capacity of the soil.

Without structure a soil collapses and compacts, resulting in a number of problems for landscaping and civil projects. It can be considered as the “framework” of a Soil Profile.



Well structured soil



Typical soil profile

What is a Soil Profile?

Soils develop over long periods of time and generally become deeper and develop distinct layers or horizons. A soil profile is made up of three layers: **topsoil**, **subsoil** and **parent material**.

Topsoil

This thin layer (usually less than 30cm) is normally the most fertile because of the organic matter that has accumulated from plant and biological activity.

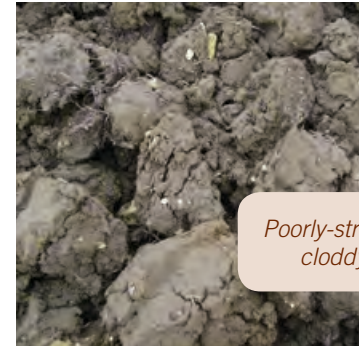
In this layer, the majority of a plant's feeder roots are present which take up nutrients.

Subsoil

Usually lighter in colour as it does not contain as much organic matter as topsoil. This layer can be composed of varying proportions of clay, sand, silt and stones.

Parent Material

This is the original material from which the soil is developed. This layer has deposits of sand, gravel, pebbles, boulders and rock in various mixtures.



Poorly-structured, cloddy soil

Why is Structure Important?

Virtually all soils need an open structure through the soil profile in order to function effectively as a growing medium. In particular, soil structure influences the main soil and plant root functions, aeration, drainage and root development.

Without structure, soils will suffer from anaerobism, waterlogging and nutrient lock-up and, ultimately, plants will die!



Trial pit showing anaerobism (grey colour)

What is Compaction?

Compaction destroys soil structure because it increases the density of the soil by packing the particles closer together; this causes a layer within the soil profile that is impregnable to plant roots, water and air. It can occur in the topsoil and the subsoil layers.

Topsoil is easier to restore than subsoil but the latter cannot be ignored as rooting alone will not break up or restructure a compacted subsoil.

Main causes of compaction

- Misuse of heavy equipment
- Trampling or trafficking over soils
- Handling soils when wet and plastic
- Stockpiling soils inappropriately

Danger signs of compaction

Anaerobism and waterlogging are the biggest soil-related causes of plant failures in landscaping projects but both can be avoided with the right ground preparation.

How you can detect compaction

- Ponding of water on the surface
- Resistance experienced when pushing a soil probe or spade into a soil
- Black, anaerobic layer with a sour odour in a turf-rooting layer
- Uneven plant growth
- Yellowing leaves
- Waterlogging
- Poor root development and shallow root systems
- Anaerobism

>> How British Sugar TOPSOIL is sourced



Talk to us and...
...get it right
first time

TOPSOIL

Premium Products

The TOPSOIL range from British Sugar currently comprises of two premium products, Landscape20 and Sports10.

All of our TOPSOIL products are produced from the prime arable topsoil we receive with the sugar beet we purchase from UK farmers each year. We do not buy topsoil from other sources.

As a producer using a single source we are able to offer a high quality and consistent range of topsoil products.



TOPSOIL is produced at four separate British Sugar sites:

- Bury St Edmunds
- Cantley (Norwich)
- Newark on Trent
- Wissington, Kings Lynn

Quality

All products are quality assured by regular independent analysis. Unlike 'muckaway' and other inconsistent material, they are free of contamination, glass or building material residue and are devoid of invasive weeds, such as Japanese Knotweed. As natural products, none are sterilised, so annual weeds may appear.

Storage

All TOPSOIL products are delivered in optimum condition. To maintain the consistency and ensure easy application, it is advisable to keep them covered when not being used.



Landscape²⁰

A general-purpose, high-quality topsoil, compliant to BS3882:2007 with a sand content of typically 60-65%. The clay and silt in Landscape20 help retain both its moisture and inherent nutrient content, especially phosphate, potassium and magnesium, which are essential for healthy germination and subsequent growth.

Crucially, in non-irrigated areas Landscape20 will naturally hold water, helping to keep schemes green and healthy during periods of dry weather.

Landscape20 comprehensive analysis has gained the confidence of regulators making it the topsoil of choice for contractors.

NHBC Statement

The National House Building Council has allowed TOPSOIL to use the following statement:

“ British Sugar TOPSOIL can help builders meet the requirements of NHBC Standards, Chapter 9.2 “Drives, paths and landscaping”, for topsoil ”

Ideal for:

- ✓ Landscaping
- ✓ Sports pitch construction
- ✓ Bunker construction



Ideal for landscaping and amenity projects both large and small, this fertile, multi-purpose topsoil is trusted by the most discerning customers, making it the most successful product of its type in the UK

Landscape20



In both construction and maintenance of sports fields and golf bunkers, Landscape20 has earned a justifiable reputation for ease-of-use and consistency - its low stone content is a particular asset

Landscape20

Sandy Loam texture

- holds moisture in summer but free-draining in winter
- easy-to-handle

Valuable horticultural properties

- good rates of growth when turfing and planting

Regular independent analysis

- confidence for regulators and clients

No chemical contamination or sharps

- totally safe

Available all-year around

- no downtime during major projects

Low stone content

- eliminates expensive stone picking

One source

- consistent product and growth rates



The affordable answer to the problem of repair and maintenance of heavy-use soil based winter sports pitches. Easily applied, fertile and of consistent quality this is the ideal top dressing for repairing high-wear areas and improving poor drainage.



Sports10 Ideal as a top-dressing and divot mix

80% sand: 20% silt and clay

Regular independent analysis

No chemical contamination or sharps

Available all-year around

Consistent supply

- good drainage properties but also holds moisture and nutrients

- stable when laid and won't blow away

- confidence and consistency for contractors and clients

- totally safe

- no downtime during projects even in winter

- easy to handle

Analysis – your guarantee of quality

In order to avoid unsuitable soil for your project, we strongly advise you obtain a comprehensive analysis of the topsoil from your chosen supplier. It is also vital that this analysis conforms to the recently revised British Standard for topsoil BS3882:2007.

All British Sugar's TOPSOIL products are analysed by an independent laboratory, the accredited Tim O'Hare Associates based in Oxfordshire (see back cover).

The initial visual examination describes the product (colour, moisture level, friability, etc) and covers whether stones, weeds, roots or rhizomes of pernicious weeds are present.

The sample is then submitted to a UKAS- and MCERTS-accredited laboratory for a range of physical and chemical tests to confirm the composition and fertility of the soil, and the absence of potential contaminants.

The following parameters are determined:

- particle size analysis and stone content
- pH value
- electrical conductivity values (CaSO₄ and water extracts)
- major plant nutrients (N, P, K, Mg)
- organic matter content
- heavy metals (As, Ba, Br, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn, B)
- soluble sulphate, elemental sulphur, acid volatile sulphide
- total cyanide and total (mono) phenols
- total petroleum hydrocarbons (C10-C40)
- speciated PAHs (US EPA16 suite)
- aromatic and aliphatic TPH (C5-C35 banding)
- BTEX
- asbestos

Finally, the results are presented on a Certificate of Analysis along with an interpretation of the results.

Planning your order

Order only what you need

Use the following as a guide for ordering the correct amount of topsoil:

1. Calculate the volume (cubic metres) needed for the site:

Multiply the width x length x depth

2. Use the following formula to estimate the tonnage required:

Cubic metre = 1.6 tonne of topsoil

Take account of any site restrictions

When you talk to your supplier/contractor make sure you cover details such as site access as this could affect what size of vehicle can be used; deliveries tend to be made by articulated trucks carrying 29 tonnes or rigid vehicles carrying 20 tonnes. Also consider any effect on local residents and any possible delivery time restrictions.

The dimensions below are based on the truck approaching the entrance in a straight line, **if the approach access is at an angle then more space will be required.**

Articulated Truck

Gross weight: 44 tonne
Net weight: 29 tonne
Width: 3.2 metres
Length: 12.8 metres
Height: 4 metres



Deliveries tend to be made by 29 tonne articulated, or 20 tonne rigid trucks

Rigid Truck

Gross weight: 32 tonne
Net weight: 20 tonne
Width: 3.2 metres
Length: 11.5 metres
Height: 3.7 metres



Client:	British Sugar plc Co-Products
Client Ref:	Wissington
Date:	October 2008
Job Ref No:	TOHA/08/3312/CS
Sample Reference	
Clay (<0.002mm)	% U
Silt (0.002-0.063mm)	% U
Sand (0.063-2.0mm)	% U
Texture Class (UK Classification)	% U
Stones (2-20mm)	% U
Stones (20-50mm)	% U
Stones (>50mm)	% U
pH Value (1:2.5 water extract)	% DW G
Electrical Conductivity (1:2.5 water extract)	units G
* Exchangeable Sodium Percentage (ESP)	uS/cm U
Moisture Content	1670
Organic Matter (WB)	2827
Total Nitrogen (Dumas)	4
Total Carbon	22
C:N Ratio	6.1
Extractable Phosphorus	8.18
Extractable Potassium	3.6
Extractable Sulphur	20



TOPSOIL

TOPSOIL

Sugar Way
Peterborough, PE2 9AY

Tel: 0870 240 2314

Fax: 0870 240 2729

Email: coproducts@britishsugar.com



Peter Jones Associates Ltd

Golf Course Consultants & Agronomists

Tel: 01525 280573 / 07803 729470

info@pja-golf.co.uk

www.pja-golf.co.uk

Peter Jones Associates Ltd is an independent golf course and sports turf consultancy company. The firm advises clients on the key components which help to improve playing quality and good all-year-round conditions, including agronomy, design, course management, budgeting, staff training and mentoring.



Tim O'Hare Associates

Soil and Landscape Consultancy

Tel: 01491 822653

info@toha.co.uk

www.toha.co.uk

Tim O'Hare Associates is an independent soil and landscape science practice. The firm provides soil survey, laboratory analysis, technical design, site supervision and consultancy services to the commercial landscape, sports amenity and construction sectors.

More information can be found at:

www.bstopsoil.co.uk

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TOPSOIL is a business of British Sugar plc

 **BRITISH SUGAR**

TOPSOIL