LITHOS

Land at East Bierley

For Rouse Homes

Report no: 3233/1A

Date: February 2019

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	3233	**Site area/ha**	1.85
Client:	Rouse Homes	**NGR:**	SE 197 289
Site:	East Bierley	**Nearest postcode:**	BD4 6PZ

The site is located off Soureby Cross Way, approximately 5.5km south-east of Bradford city centre, and currently comprises a single grassed field sloping gently to the south-west that has been undeveloped throughout history.

Lithos were commissioned by Rouse Homes to provide a geoenvironmental appraisal of the site, which it is understood is to be redeveloped with 43 No. 2 & 3 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. Lithos' investigation included review of a 3rd party report, the site's history and environmental setting, and a ground investigation comprising 12 trial pits and 7 window sample boreholes.

A summary of salient geoenvironmental issues is provided in the table below.

Issue	Remarks
Made ground	None encountered.
Natural ground	Topsoil overlying Cohesive Residual soils, with Granular Residual soils encountered below in the majority of exploratory holes. Coal Measures bedrock (siltstone) was encountered underlying Residual soils from an average depth of 1.8m.
Contamination & Remediation	Marginally elevated concentrations of arsenic have been recorded within the topsoil. Given the lack of any sources of arsenic, this are considered to be representative of 'background' levels. Therefore, the topsoil is considered suitable for re-use in garden/landscaped areas but should not be exported for use on another development site. No other significant contamination was encountered, and no remediation is considered necessary.
Mining & quarrying	Evidence of shallow mineworkings has been identified in the north-east, as well as desk study information suggesting workings exist at a similar depth immediately north of the site. Dril Consolidation of workings by drilling & grouting will be required in the north of the site; additional drilling is recommended to check for the presence of any further workings to the south. This could be done prior to, or during, the proposed drilling & grouting. No known quarries at or within 250m of the site.
Hazardous gas	Shallow mineworkings are located to the north-east of the site therefore wells have been installed and a period of monitoring commenced. The site lies in an area where 1-3% of properties are above the action level for radon.
Foundations	All plots will be founded on traditional strip foundations placed in Cohesive Residual Soil at a minimum of 0.9m, and over deepened where necessary due to tree influence.
Groundwater & excavations	Groundwater was located in three exploratory holes along the north-western boundary as seepages. Monitoring to date suggests groundwater lies at between 0.4m and 1.7m depth. Trenches for foundations and utilities are likely to remain stable in the short term.
Flooding & drainage	The site is located in Flood Zone 1. Based on the in-situ testing, soakaways will not provide a suitable means of surface water disposal, therefore water balancing may be required.
Highways	Based on visual inspection of the shallow natural materials and published guidance, the Cohesive Residual soil should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

Significant developer abnormals relating to geoenvironmental issues at the site are:

- Presence of underground mineworkings in the north of the site

Some further work is required, most notably:

- Further delineation of the extent of the underground mineworkings. This could be done during, or prior to, the drilling & grouting.
- A Specification for the Treatment of Shallow Mineworkings (including a proposed grouting grid) should be prepared.

This brief summary should not be assumed to represent a complete account of all the potential geo-environmental issues that may exist at the site. As such it is strongly recommended that the report be read in its entirety.

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03	Geotechnical testing
04	Contamination laboratory analysis & interpretation
05	Hazardous gas
06	Soakaways

Appendix B - Drawings

Drawing	Revision	Title
3233/1	-	Site location plan
3233/2	-	Proposed site layout
3233/3	-	Site features
3233/4	-	Site photographs
3233/5	-	Preliminary conceptual site model
3233/6	-	Exploratory hole locations
3233/7	-	Revised conceptual site model
3233/8	-	Drilling and Grouting Location Plan

Appendix C - Commission

Appendix D - Historical OS plans#

Appendix E - Search responses#

From	Date	Content
Landmark	12th November 2018	Environmental search data
HETS	1989	Borehole investigation
Coal Authority	13th November 2018	Mining report

Appendix F to H - Exploratory records

Appendix F	TP01 to TP12
Appendix G	WS01 to WS07
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Appendix I - Chemical test results

Appendix J - Geotechnical test results

Appendix K - Gas monitoring results

Appendix L - Soakaway results

Appendix M - Yorkshire Water Contaminated Land Assessment Form

Some of this data is not included within the paper or PDF copies of this report; by request, it can be provided on a CD.

FOREWORD (geoenvironmental appraisal report)

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

The report presents observations and factual data obtained during our site investigation and provides an assessment of geoenvironmental issues with respect to information provided by the Client regarding the proposed development. Further advice should be sought from Lithos prior to significant revision of the development proposals.

The report should be read in its entirety, including all associated drawings and appendices. Lithos cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context. However, it should be noted that in order to keep the number of sheets of paper in the hard copy to a minimum, some information (e.g. full copy of the Landmark/Groundsure Report) is not included in the pdf, by request, it can be provided on a CD.

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

The report represents the findings and opinions of experienced geoenvironmental consultants. Lithos does not provide legal advice and the advice of lawyers may also be required.

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

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

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

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

Lithos cannot be responsible for the consequences of changing practices, revisions to waste management legislation etc that may affect the viability of proposed remediation options.

Lithos reserve the right to amend their conclusions and recommendations in the light of further information that may become available.

GEOENVIRONMENTAL APPRAISAL
of land at
EAST BIERLEY

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Rouse Homes to carry out a geoenvironmental appraisal of land off Soureby Cross Way, East Bierley.

1.1.2 This document is a revision of the Geoenvironmental Appraisal (Report 3233/1) issued by Lithos in January 2019; Report 3233/1 is now superseded. This document now includes the findings of the intrusive mining investigation undertaken at the site, with the only significant revisions to 3233/1 having been made in Sections 8.6, 14.2 & 14.4 and Drawings 3233/6 & 3233/8.

1.1.3 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:

- Review of a third-party report
- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- A mining risk assessment in accordance with Coal Authority guidance.
- An intrusive ground investigation comprising 12 trial pits (with soakaway testing in 5 pits) and 7 window sample boreholes
- Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
- A qualitative assessment of contamination risks

1.1.4 Primary aims of this investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable Rouse Homes to obtain budget costs for: foundations; gas protection measures; and site preparatory and remediation works.

1.2 The proposed development

1.2.1 It is understood that consideration is being given to redevelopment of the site with 43 No. 2 & 3 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A site layout has been provided by Rouse Homes (Drawing reference SK01, dated September 2018) which is reproduced as Drawing 3233/2 in Appendix B to this report.

1.3 Report format and limitations

1.3.1 All standard definitions, procedures and guidance are contained within Appendix A, which includes background, generic information on:

- Assessment of the site's environmental setting
- Ground investigation fieldwork
- Geotechnical testing
- Contamination testing
- Hazardous gas

- Soakaways

1.3.2 General notes and limitations relevant to all Lithos geoenvironmental investigations are described in the Foreword and should be read in conjunction with this report. The text of the report draws specific attention to any modification to these procedures and to any other special techniques employed.

1.3.3 In accordance with the agreed scope of works, the ground investigation reported here is not fully compliant with Eurocode 7 (EC7) and this report does not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. The ground appraisal, parametric assessment and preliminary design guidance presented are intended to assist others as they prepare the design of the proposed works.

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 3233/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	5.5 km south-east of Bradford city centre
NGR	SE 197 289
Approximate area	1.73ha (4.27 acres)
Known services	Underground water & overhead electric

2.2 Site features

2.2.1 Existing salient features, at the time of the walkover are presented on Drawing 3233/3 in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current Access	Off Soureby Cross Way
Topography	Sloping down to the south-west at a gradient of c. 1 in 25, but steeper along the north-east (1 in 7) and far south-west (1 in 12)
Nature of boundaries	North-west – Mature trees and wire fencing North-east – wire fencing South-west – wire fencing and hedgerow South-east – dry stone walls and wire fencing
Surrounding land uses	North-west – Recreation ground and Hunsworth Lane North-east – Soureby Cross Way and residential housing South-west – Dirt track, residential housing and open fields South-east – Open fields and football pitches

2.2.2 Lithos completed a walkover survey of the site on 20th November 2018. The site consists of a single grassed field to the south of Soureby Cross Way.

2.2.3 Current use of the field is not known. However, it is covered by short grass that is reasonably well kept by cutting/ possibly grazing etc. Horses were noted on neighbouring fields.

2.2.4 The site slopes down towards the south-west at an average gradient of 1 in 25. However steeper gradients were noted on the boundary of the site with Soureby Cross Way (1 in 7) and in the far southwest (1 in 12).

2.2.5 Low voltage overhead electric cables cross the site from north-east to south-west. An underground 600mm ductile iron water pipe runs below the site, parallel to the north eastern boundary.

2.2.6 Vehicular access is via a field gate off Soureby Cross Way in the north-east. A second gate on the south-east boundary allows access from the adjacent field to the south; it is understood that a public right of way runs between the two (though no evidence can be seen on the ground).

2.2.7 Rouse Homes' proposed layout refers to an area of Japanese Knotweed just beyond the north-western boundary. During the walkover, weeds (likely Japanese Knotweed) were spotted here; their approximate location is shown on Drawing 3233/3 (c.110m^2). Further advice should be sought from an ecologist.

2.2.8 A selection of site photographs is included on Drawing 3233/4.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1852 have been examined. Some of these plans are presented in Appendix D to this report.

3.2 The table below provides a summary of the salient points relating to the history of the site. It is not the intention of this report to describe in detail all the changes that have occurred on or adjacent to the site. Significant former uses/operations are highlighted in **bold** text for ease of reference.

Date	Site	Surrounding land
1852	**Open fields** occupy the entire site. Footpath through site.	East Bierley village to the north. **Tong Moor Pit** 150m north. Pond 70m north. Cross House (1662) and Moor House (1632) 50m and 230m northeast respectively.
1893	No significant changes.	Common land adjacent to the north. Housing on Hunsworth Lane 40m to north-west. Coal pit 150m north no longer labelled. **Cross Pit** (Coal & Ironstone) 200m to south. **No.8 Pit** (Coal & Ironstone) 200m to west labelled disused.
1908		Reservoir 200m south associated with Cross Pit.
1921		**Tank** and chimney 25m north-east. **Warpsizing works (textiles)** 50m north-east. Cross Pit labelled disused. **Well** 100m northwest of site.
1932		Warpsizing works now labelled Crosses works.
1938		Expansion of Bierley with housing. Housing along Hunsworth lane to southwest.
1948	Circular fencing in northwest corner.	No significant changes
1956	Track through site and along southeast boundary.	Recreation ground labelled adjacent to north. Football ground 80m to south. **Slag heap** 150m to south. Pond labelled 220m west.
1983	No significant changes.	No.8 Pit no longer shown.
1992		Crosses works buildings no longer shown.
1995		New housing adjacent to north-east on site of former Crosses works.
2003	Track no longer shown through site.	No significant changes.

3.3 'Warpsizing' is a process also known as 'tape sizing' and is essential to the textile industry where a sizing agent is added to yarn to reduce its breakage on the weaving machine. Different types of sizing agents (usually water-soluble polymers) were used such as modified starch, Polyvinyl alcohol (PVA), carboxymethyl cellulose (CMC) and acrylates.

4 ENVIRONMENTAL SETTING

4.1 General

4.1.1 Notes describing how the site's environmental setting has been assessed are included in Appendix A to this report. Extracts from the response received from Landmark, and the response from the Coal Authority are presented in Appendix E. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 77) 1:10,000 BGS map (Sheet SE 12 NE) BGS online logs	Made Ground – shown in the south-east and centre of the site (likely to be colliery spoil). Drift – None recorded. Solid – Lower Coal Measures (mudstone, siltstone & sandstone) in north-east and (sandstone) in south-west. Sandstone/mudstone at c. 2m on BGS borehole logs for adjacent land. Shallowest coal seam – Blocking Coal (0.5 to 0.8m thick) at about 30m depth. See Section 4.2 for further details. Strata dip – Gentle to south. Faults – East Bierley fault just beyond northern boundary trending northwest-southeast downthrown to the north.
Mining	Coal Authority	This site is located within a Coal Mining Development Low Risk Area. Coal Mining Development High Risk Area adjacent to the north separated by East Bierley Fault. See Section 4.2 for further details
Quarrying	Historical OS plans	None within 250m of site.
Landfills	Envirocheck Report	No known landfills within 250m. Potentially infilled land associated with Tong Moor pit 150m north and Colliery Spoil tip 200m south.
Radon	Public Health England	The north lies in an area where 1-3% of homes are estimated to be above the action level, the south lies in an area where <1% of homes are estimated to be above the action level
Hydrogeology	Environment Agency Envirocheck Report	Groundwater Source Protection Zone? No. Aquifer: Secondary A (Drift) Groundwater abstractions? One abstraction 1km north-west for Toftshaw Industrial Estates Limited for general industrial use. Not significant due to distance and a non-potable end use. Soil leaching potential - High. Pollution incidents? None recorded.
Hydrology	Environment Agency Envirocheck Report	Nearest watercourse(s) – Un-named pond 70m north. Lodge Beck 200m south flowing south. Water quality – The site is located within the Spen Beck from source to River Calder catchment area currently rated as ecologically moderate and chemically good. Pollution incidents? None within 500m within last 5 years. Abstractions? None recorded. Discharge consents? One sewage discharge to groundwater via a soakaway for a property 700m north-east.
Flood risk	Environment Agency	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. In accordance with Chapter 10 of the National Planning Policy Framework, a site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency).

4.2 Coal & mining

4.2.1 In July 2011 the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology relating to coal mining development areas.

4.2.2 This site is located within a Coal Mining Development Low Risk Area - within the defined coalfield, but no known defined risks have been recorded by the Coal Authority; there may still be unrecorded issues. A CA mining report states that:

- *There are known mineworkings in 3 coal seams (Whinmoor, Black Bed & Better Bed) beneath the property at between 80m and 187m depth.* This means there are no recorded workings in the shallow seams beneath the site.
- *There are no probable unrecorded shallow workings or spine roadways at shallow depth.* This comment indicates that it is unlikely there is shallow mineworkings beneath the site.
- *There are no recorded mine entries on site or within 100m of the site's boundary.*
- *There are no geological faults, fissures or breaklines recorded within the site's boundary.*
- *There are no recorded opencast mines or Coal Authority managed tips within 500m of the site's boundary.*
- *The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50m of the enquiry boundary, since 31st October 1994.*
- *There are no recorded incidences of mine gas within 500m of the boundary.*
- *The property is not in an area where a notice to withdraw support has been given*

4.2.3 The mining reports suggests there are no known shallow workings (i.e. at less than c. 50m depth). However, it should be noted that it did not become a statutory requirement to maintain and preserve plans of abandoned mines until the Mine (Coal) Regulations Act of 1872 and consequently there may be mineworkings beneath the site for which the Coal Authority have no records.

4.2.4 Geological maps suggest that one coal seam underlies the site at shallow depth, the Blocking Coal (about 0.5m to 0.8m thick) at approximately 30m depth.

4.2.5 The East Bierley Fault lies close to the site's northern boundary and separates the Low Risk area from a High Risk Area present immediately north. Published BGS geological maps and the CA report suggest this fault does not lie within the site boundary.

4.2.6 In addition to the CA report and BGS maps, online borehole records (available on the BGS website) include the findings of a ground investigation (22 boreholes) undertaken along the line of Soureby Cross Way by HETS in 1989. A plan included summarises areas where evidence of mineworkings and faulting were encountered. The findings of the BHs are summarised in the table on page 7; the borehole location plan is copied into Appendix B.

4.2.7 HETS' exploratory hole plan marks the 'fault zone' (presumably referring to the East Bierley Fault) around 100m north of its conjectured line on the BGS plan.

4.2.8 Broken ground, cavities and 'old workings' were encountered within boreholes drilled along Soureby Cross Way, south of the 'fault zone'. The broken ground could be attributed to a 'shatter zone' associated with the East Bierley Fault. However, they could equally be associated within mineworkings which might extend beneath the north of the site.

4.2.9 Given the depth to the broken ground (between 10m and 13m), if these do represent evidence of old mineworkings, these could pose a risk to surface stability. Therefore, a further investigation (rotary probeholes) is recommended to confirm depth, nature and extent of any mineworkings beneath the site.

Hole	Final depth (mbgl)	Depth to Base : (mbgl)								Remarks
		CLAY	SHALE / MUDSTONE	COAL	SHALE	BROKEN GROUND	COAL	SHALE	SANDSTONE with shale bands	
BH1 (SE12NE634)	15.0	1.8	6.8	7.0	10.4	11.7	-	15.0	-	10.4m to 11.7m: Soft ground with slight air loss.
BH2 (SE12NE635)	15.0	2.5	7.3	7.5	10.8	11.8	-	15.0	-	10.8m to 11.8m: Soft ground (backfilled/consolidated workings) with slight air loss.
BH3 (SE12NE636)	15.0	2.2	8.0	8.2	11.0	12.0	-	15.0	-	11.0m to 12.0m: No flush returns.
BH4 (SE12NE637)	15.0	3.6	8.5	8.7	11.7	12.6	-	15.0	-	11.7m to 12.6m: Broken ground with poor returns.
BH5 (SE12NE638)	15.0	2.5	8.5	8.7	11.5	12.3	-	15.0	-	11.5m to 12.3m: Soft ground (backfilled/consolidated workings with slight air loss.
BH6 (SE12NE639)	15.0	2.6	9.1	9.2	11.7	-	12.6	15.0	-	-
BH7 (SE12NE640)	15.0	1.2	9.6	9.8	11.9	13.3	-	15.0	-	11.9m to 13.3m: Soft and broken ground (cavity) with no flush returns.
BH8 (SE12NE641)	15.0	1.3	10.4	10.6	13.9	-	14.6	15.0	-	-
BH9 (SE12NE642)	15.0	1.4	10.9	11.1	14.3	-	15.0	-	-	-
BH10 (SE12NE643)	15.0	1.8	11.0	11.2	14.5	-	15.0	-	-	-
BH11 (SE12NE644)	15.0	1.5	11.3	11.5	14.6	15.0	-	-	-	14.6m to 15.0m: Poor returns (old workings)
BH12 (SE12NE645)	15.0	1.7	12.2	12.4	15.0	-	-	-	-	-
BH13 (SE12NE646)	15.0	1.2	12.4	12.6	15.0	-	-	-	-	-
BH14 (SE12NE647)	15.0	1.5	12.3	12.5	15.0	-	-	-	-	-
BH15 (SE12NE648)	15.0	1.6	12.2	12.4	15.0	-	-	-	-	-
BH16 (SE12NE649)	15.0	1.2	12.3	12.5	15.0	-	-	-	-	-
BH17 (SE12NE650)	15.0	1.3	11.1	12.6	15.0	-	-	-	-	-
BH18 (SE12NE651)	15.0	0.9	12.3	12.5	15.0	-	-	-	-	-
BH19 (SE12NE652)	15.0	0.7	12.5	12.7	15.0	-	-	-	-	-
BH20 (SE12NE653)	15.0	0.9	12.6	12.8	15.0	-	-	-	-	-
BH21 (SE12NE654)	15.0	3.0	-	-	-	-	-	-	15.0	2.3m to 15.0m: Poor returns (fault zone)
BH22 (SE12NE655)	15.0	2.5	-	-	-	-	-	-	15.0	-

4.3 Mineral safeguarded areas

4.3.1 The site is underlain by coal and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).

4.3.2 MSAs are areas of known mineral resources that are of sufficient economic or conservation value to warrant protection for generations to come. The purpose of MSAs is not to preclude automatically other forms of development, but to make sure that mineral resources are adequately and effectively considered in land-use planning decisions.

4.3.3 Specialist guidance on Mineral Safeguarding "A Guide to Mineral Safeguarding in England" has been produced by The Coal Authority and the British Geological Survey.

4.3.4 Paragraph 204 of the National Planning Policy Framework (NPPF) requires Local Authorities, when preparing Local Plans to:

- Define Minerals Safeguarding Areas and adopt appropriate policies in order that known locations of specific minerals resources of local and national importance are not needlessly sterilised by non-mineral development, whilst not creating a presumption that resources defined will be worked; and define Minerals Consultation Areas based on these Minerals Safeguarding Areas.
- Set out policies to encourage the prior extraction of minerals, where practicable and environmentally feasible, if it is necessary for non-mineral development to take place.

4.3.5 NPPF Paragraph 144 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.

4.3.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require Rouse Homes to consider the opportunity to recover (extract) the coal. Applicants submitting planning applications may need to demonstrate to the Local Authority that they will extract the coal, unless:

- It can be shown it is not economically viable to do so, or
- It is not environmentally acceptable to do so, or
- The need for the development outweighs the need to extract the coal, or
- The coal will not be sterilised by the development

4.3.7 The viability of coal extraction at this site should be considered in light of the findings of an intrusive mining investigation.

5 PREVIOUS INVESTIGATION FINDINGS

5.1 General

5.1.1 Rouse Homes have provided Lithos with a copy of the following report: Land off Soureby Cross Way, East Bierley: Contamination Report (Phase 1) (Ref. 064502-00-XX-GE-001-V01), issued by Curtins in August 2017.

5.2 Summary of Curtins' findings

5.2.1 The desk study includes a review of data from an Envirocheck report, BGS maps, a non-residential mining report from the Coal Authority, UXO maps and historical OS maps dating back to 1850s. Sections 1 to 4 of this Lithos Report include similar content to the Curtins' report, but with further detail.

5.2.2 Curtins' evaluated the site as Low Risk for a residential end-use development, except for ground gas for which a Moderate Risk rating was given.

5.2.3 Curtins' recommended a ground investigation comprising:

- Window sample boreholes – to acquire geotechnical data and allow shallow installations for gas and ground water monitoring
- Machine excavated trial pits – to recover samples and allow inspection of the mass characteristics of shallow soils
- Geotechnical and environmental laboratory testing – to classify material for construction works risk assessments and suitability of re-use on site or off-site disposal
- Gas monitoring – to assess the risk presented by ground gases.

5.3 Lithos comments

5.3.1 The boundary of the Envirocheck Report contained within Curtin's desk study is significantly smaller than the site itself. Given this, it was deemed appropriate to request new search information (as presented in Sections 3 and 4 above).

5.3.2 Lithos broadly agree with their ground investigation scope, with the addition of soakaway testing to ascertain the viability of surface water disposal via individual soakaways and a mining investigation given the findings presented in Section 4.2.

6 GROUND INVESTIGATION DESIGN

6.1 Anticipated ground conditions & potential issues

6.1.1 Based on the data reviewed in Sections 4 (Environmental Setting) and 5 (Previous Investigation Findings), anticipated ground conditions are expected to comprise:

Anticipated condition	Remarks
Made ground	Possible colliery spoil in the centre/south-west.
Natural soils	Residual soils (firm gravelly clays/clayey gravels).
Bedrock	Likely mudstone/sandstone at shallow depth (<3m).
Mineworkings	Unlikely to be present at shallow depths, shallowest recorded workings (Whinmoor seam) at 80m.
Groundwater	Likely to be at depth in bedrock.

6.1.2 Based on the data above and that in Sections 2 (Site Description) and 3 (History), potential ground-related issues associated with this site are likely to include:

Type of issue	Specific issue	Remarks
Potential on-site contamination sources	1. naturally occurring contaminants 2. made ground (colliery spoil)	1. metals 2. organics, metals, asbestos
Potential off-site contamination sources	1. shallow mineworkings 2. potentially infilled land associated with Tong Moor Pit and colliery tip (see Section 4.1) 3. former industrial use to the north	1&2. hazardous gas 3. wind-blown contaminants
Potential geotechnical hazards	1. None identified	
Other potential constraints	1. overhead and underground utilities 2. Japanese Knotweed	1. may require easement/diversion 2. specialist advice required

6.2 Preliminary conceptual site model

6.2.1 A preliminary conceptual site model, presented as Drawing 3233/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 6.1 inclusive of this report.

6.2.2 Historical plans show that the site has been occupied by arable farmland which is not considered likely to have caused significant ground contamination. Nonetheless, activities such as slurry spreading, the discharge of chemicals to ground, and unregulated burial have all occurred on farmland. Potential pollutants associated with farming activity might include any of the following:

Agricultural activity	Potential contaminant
Sewage farming, slurry spreading	Methane, metals, oxygen depletion
Soil conditioners	Metals, sulphates, PAH
Field sports	Lead shot
Naturally occurring contaminants	Arsenic, metals

6.3 Ground investigation design & strategy

6.3.1 The preliminary conceptual site model was used as a basis for design of an appropriate ground investigation, the scope of which is summarised below.

Exploratory holes	Purpose
Twelve Trial Pits (including five soakaway test pits)	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of shallow soils, including any made ground • Suitability of the ground for founding structures and highways To determine whether soakaways could be utilised for storm water drainage.
Seven window sample Boreholes	To install monitoring wells across the site in order to monitor for hazardous and any shallow groundwater.
Six rotary openhole probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings, particularly in the north of the site.

6.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site and to target potential areas of interest. A nominal 50m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

6.3.3 The number of representative samples taken will be reflective of the geological complexity actually encountered. However, in general about 3 samples will be taken from most trial pits.

7 FIELDWORK

7.1 Objectives

7.1.1 The original investigation strategy is outlined in Section 6.3 above.

7.2 Scope of works

7.2.1 Fieldwork was supervised by Lithos between 3rd and 4th December 2018 & 4th and 11th February 2019 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 01 to 12	2.0m to 2.8m	Vane tests in cohesive soils. Trial pits terminated in weathered bedrock.
Soakaway tests	Within TPs 01 to 05	2.0 to 2.3m	Soakaway tests undertaken in weathered bedrock.
Window sample boreholes	WSs 01 to 07	1.4m to 2.0m	Sample barrel refused on weathered bedrock. Well installation for gas and groundwater monitoring (WS01 to WS06).
Rotary openhole probeholes	PHs 01 to 06	15.0m to 30.0m	To determine the depth, nature and extent of any shallow coal or workings to the north of site.

7.2.2 Notes describing ground investigation techniques, in-situ testing and sampling are included in Appendix A to this report.

7.2.3 Exploratory hole logs are presented in Appendices F to H to this Report. These logs include details of the:

- Samples taken
- Descriptions of the solid strata, and any groundwater encountered.
- Results of the in-situ testing
- The monitoring wells installed

7.2.4 Exploratory hole locations are shown on Drawing 3233/6 presented in Appendix B.

8 GROUND CONDITIONS

8.1 General

8.1.1 A complete record of strata encountered beneath the proposed development site is given on the various exploratory hole records, presented in Appendices F to H.

8.1.2 No made ground was encountered within any of the exploratory holes.

8.2 Natural ground

8.2.1 Natural ground typically comprised:

- **Topsoil:** Dark brown slightly sandy CLAY. Encountered across the site from surface to a typical depth of 300mm.
- **Cohesive Residual Soil:** Stiff mottled (light grey and brown) CLAY and gravelly CLAY encountered in all exploratory holes immediately beneath topsoil to depths of between 0.9m and 2.3m (average 1.6m).
- **Granular Residual Soil:** Light grey clayey angular and subangular lithorelict GRAVEL encountered in 10 exploratory holes beneath Cohesive Residual Soil to depths of between 1.4m and 2.6m (average 2.0m).
- **Weathered Lower Coal Measures (siltstone):** Weak thinly bedded light grey SILTSTONE recovered as angular gravel and cobble. Encountered beneath Cohesive and Granular Residual Soil in every exploratory hole from depths of between 1.4m and 2.6m (average 1.8m).

8.3 Visual & olfactory evidence of organic contamination

8.3.1 No visual or olfactory evidence of organic contamination was encountered during the investigation.

8.4 Groundwater

8.4.1 Groundwater was encountered in three exploratory holes (TPs 02, 10 & 11) as seepages at depths of between 0.5m and 1.5m. These holes are all along the north-western boundary.

8.4.2 Groundwater levels within monitoring wells have been dipped on one occasion to date (9th January 2019), as summarised below.

Hole ID	Response zone (depth range & strata)	Groundwater body	Standing water level	
			m bgl	m AoD#
WS01	0.4m to 1.4m (Residual soil)	Shallow	1.04	204.21
WS02	0.8m to 1.8m (Residual soil)		1.59	205.16
WS03	0.5m to 1.5m (Residual soil)		0.41	203.84
WS04	0.5m to 1.4m (Residual soil)		0.48	203.27
WS05	0.6m to 1.5m (Residual soil)		-	-
WS06	1.0m to 2.0m (Residual soil)		1.74	197.51

 # estimated from topo survey

8.4.3 Based on the initial results, groundwater appears to be relatively shallow within the Residual Soils, sitting at between 0.4m and 1.7m depth, (197.5mAoD and 205mAoD).

8.5 Stability

8.5.1 Slight overbreak of sidewalls was noted in TPs 08 & 10 due to large boulders. Otherwise, stability of excavations was generally good.

8.6 Mining investigation

Shallow workings (rotary probeholes)

8.6.1 It is apparent from section 4.2 that the site could be underlain by shallow mineworkings, as identified in a previous site investigation along Soureby Cross Way to the north of the site. Therefore, 6 rotary probeholes were advanced along the northern boundary to ascertain the depth and nature of any coal or associated workings (anticipated at around 10m to 15m depth).

8.6.2 Lithos' investigation identified coal, soft ground and voids as summarised in the Table on pages 15 to 6.

8.6.3 Analysing the data obtained from the 6 mining investigation probeholes, it is apparent that:

- Two seams of coal underlie the north of site at shallow depths. It is not clear which seams they are, but they could be Middleton 11 Yard (lower) and Wheatley Line (upper), although these are shown to be washed out in the local area.
- The shallower seam (encountered between c.10m and 12m), is between 0.2m and 0.5m thick, with the deeper seam (encountered at between c.14m to 15m), between 0.3m and 0.5m thick.
- Clay was encountered above the upper seam in PHs 01 to 03.
- Two of the six holes advanced through the coal seams encountered potential evidence of workings (PHs 04 & 05), including soft ground with loss of flush, and voids from 14.8m to 16.5m in PH04 and 9.0m to 11.5m in PH05.
- The depth and sequence of strata encountered (including the depth to workings) is very similar to that of HETS' investigation to the north (see Section 4.2)
- The thickness of competent (rock) cover above the voids ground in PHs 04 & 05 is less than 10 times void thickness.
- In PH06, only a single seam was encountered (12.7m to 13.2m), with no evidence of clay above or any workings within 30m depth

8.6.4 CIRIA ('Construction over abandoned mine workings', 1989) suggest a thickness of solid rock through which a void can migrate as 7h to 10h above the roof of the workings, where h is the height of the workings (generally assumed to be similar to the seam thickness). The lower end of this range (7h) is generally only acceptable where the overlying strata are predominantly thickly bedded sandstones.

8.6.5 The succession here comprises mudstones and sandstones, therefore considered appropriate to use a figure of 10 h for void migration calculations (5m for both coal seams).

8.6.6 In PHs 1 to 3 and 6, sufficient cover of competent rock is present above the coal seams and no evidence of workings was encountered. However, there is not enough competent cover above the voids encountered in PHs 04 & 05.

8.6.7 It is possible that the thickness of the voids encountered in PHs 04 & 05, which are substantially thicker that the maximum seam thickness, is due to underground workings of both a coal seam and associated 'fireclay'. This is evidenced further by the fact that clay (as encountered in PHs 1 to 3 above the shallower seam), was not encountered in PHs 04 & 05.

8.6.8 The change in the geological sequence between PHs 05 and 06 (deeper coal and absence of clay or 2nd seam in PH06), could be due to faulting. It is possible that the East Bierley Fault (which separates the Coal Authority Development High and Low Risk Areas) is actually further south than originally suspected, and lies between PHs 05 & 06. This would also explain the presence of the suspected workings encountered by HETS in their investigation along Soureby Cross Way to the north (see Section 4.2).

8.6.9 Given the findings of the mining investigation, mitigation measures (i.e. consolidation by drilling & grouting) will be required, see Section 14.2. Additional drilling will also need to be undertaken to better delineate the area underlain by shallow mineworkings, although this could be done as part of the proposed drilling & grouting.

8.7 Revised conceptual ground model (ground conditions)

8.7.1 The Preliminary Conceptual Site Model has been revised in light of data obtained during the ground investigation, most notably with respect to the absence of any significant made ground.

8.7.2 Further refinement of the Conceptual Site Model is presented in Section 11.2, where the results of laboratory testing for contaminants have been considered.

Summary of Ground Conditions

Hole	Final depth (mbgl)	Depth to Base of Natural Soils: (mbgl)			Depth to Coal Measures bedrock (mbgl)	Penetration (m)	Remarks
		Topsoil	Cohesive Residual Soil (gravelly CLAY)	Granular Residual Soil (Clayey GRAVEL)			
TRIAL PITS							
TP01	2.0	0.3	0.9	1.4	1.4	0.6	Soakaway test undertaken
TP02	2.2	0.3	1.6	-	1.6	0.6	
TP03	2.3	0.3	2.3	-	2.3	0.0	
TP04	2.3	0.3	1.8	-	1.8	0.5	
TP05	2.1	0.3	1.1	1.8	1.8	0.3	
TP06	2.6	0.3	2.0	2.5	2.5	0.1	-
TP07	2.2	0.3	1.5	1.9	1.9	0.3	-
TP08	2.8	0.3	1.9	2.6	2.6	0.2	-
TP09	2.3	0.3	2.0	-	2.0	0.3	-
TP10	2.2	0.3	1.5	2.0	2.0	0.2	-
TP11	2.5	0.4	1.7	2.4	2.4	0.1	-
TP12	2.3	0.3	1.6	-	1.6	0.7	-
WINDOW SAMPLE BOREHOLES							
WS01	1.4	0.4	1.4	-	1.4	-	Monitoring well installed
WS02	1.8	0.3	1.8	-	1.8	-	
WS03	1.5	0.3	1.5	-	1.5	-	
WS04	1.4	0.4	1.2	1.4	1.4	-	
WS05	1.5	0.2	1.5	-	1.5	-	
WS06	2.0	0.3	1.5	2.0	2.0	-	
WS07	1.8	0.3	1.6	1.8	1.8	-	-

Summary of Mining Investigation Findings

Hole ID	Final depth (m)	Depth to rockhead (m)	Upper Seam		Lower Seam		Remarks
			Depth to coal (m)	Thickness of Coal (m)	Depth to Coal (m)	Thickness of Coal (m)	
PH01	18.0	0.5	9.7*	0.2	14.1	0.3	**Clay** (easy to drill) encountered 9.1m to 9.4m
PH02	30.0	2.1	10.0*	0.5	15.2	0.4	**Clay** (easy to drill) encountered 9.2 to 10.0m
PH03	18.0	2.0	10.8*	0.5	15.1	0.5	**Clay** (easy to drill) encountered 8.6 to 9.0m
PH04	16.5	1.6	-	-	14.2	0.4	**Void** between 14.8m and 16.5m
PH05	15.0	1.4	-	-	-	-	**Soft ground** 6.9m to 9.0m **Void** 9.0m to 11.5m.
PH06	30.0	1.8	12.7	0.5	-	-	Lost flush at 30.0m

** - encountered as mudstone with coal traces*

9 SOAKAWAY TEST RESULTS

9.1 UK Guidance

9.1.1 General notes about soakaways, including their location, design, and Lithos' test methodology is presented in Appendix A.

9.1.2 CIRIA C753:2015[1] recommends that soakaways should not be constructed 'in ground where the water table reaches a level within 1m below the base of the soakaway at any time of the year'.

9.1.3 BRE Digest 365 "Soakaway Design" advises that each soakaway pit should be filled and allowed to drain three times to near empty on the same or consecutive days.

9.2 Field tests

9.2.1 Five soakaway tests were carried out in general accordance with BRE Digest 365[2] "Soakaway Design". The locations of the soakaways are shown on 3233/6 presented in Appendix B to this report.

9.2.2 Infiltration rates for each soakaway test are calculated in accordance with BRE Digest 365. This design takes into account time for the water level to fall from 75% to 25% of its effective depth. The effective depth is the difference between the starting water level and the soakaway pit base depth. However, where the water level did not fall to 25% effective depth within 3 hours, the test was not considered suitable for calculation of an infiltration rate; this was the case for all tests undertaken.

9.2.3 Calculated infiltration rates for each successful test are summarised in the table below, and copies of the associated calculations are presented in Appendix L to this report.

Soakaway	Stratum	Infiltration rate (m/s)	Remarks
SA01 (TP01)	0.9m to 1.4m (Granular Residual Soil) 1.4m to 2.0m (Weathered Coal Measures)	-	Test 1 did not attain 25% effective depth
SA02 (TP02)	1.0m to 1.6m (Cohesive Residual Soil) 1.6m to 2.2m (Weathered Coal Measures)	-	Test 1 did not attain 25% effective depth Water level rose by 100mm due to water seepage.
SA03 (TP03)	1.1m to 2.3m (Cohesive Residual Soil) 2.3m (Weathered Coal Measures)	-	Test 1 did not attain 25% effective depth
SA04 (TP04)	0.9m to 1.8m (Cohesive Residual Soil) 1.8m to 2.3m (Weathered Coal Measures)	-	Test 1 did not attain 25% effective depth
SA05 (TP05)	1.1m to 1.8m (Granular Residual Soil) 1.8m to 2.1m (Weathered Coal Measures)	-	Test 1 did not attain 25% effective depth

9.3 Discussion & conclusions

9.3.1 Given the results of the in-situ testing, soakaways will not provide a suitable drainage solution for the discharge of surface water run-off at the site; and therefore, there may be a need for surface water balancing.

9.3.2 Drainage solutions are discussed further in Section 14.8.

[1] CIRIA C753. The SUDS Manual (2015).
[2] BRE Digest 365. Soakaway Design (1991).

10 CONTAMINATION (ANALYSIS)

10.1 General

10.1.1 The site's former usage is considered unlikely to have given rise to any significant ground contamination. Furthermore, no significant made ground was encountered during the ground investigation. However, samples of topsoil have been recovered in order to confirm its suitability for re-use.

10.1.2 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 6.2.

10.1.3 In the context of risks to human health associated with residential redevelopment, the Tier 1 Soil Screening Values referenced in this report have been derived via the CLEA default conceptual site model (CSM) used for generating SGVs, but amended, where appropriate, to be more specific to redevelopment within the planning process.

10.1.4 Where available, Category 4 Screening Levels (C4SL) have also been referenced.

10.1.5 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

10.2 Testing scheduled

10.2.1 Based on the above assessment, Lithos submitted a test schedule (summarised in the table below) to a UKAS accredited laboratory.

Type of sample	No. of samples	Determinands
Topsoil	6	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Speciated Polycyclic Aromatic Hydrocarbons (PAH) Total Organic Carbon (TOC)

10.3 Soil contamination results

10.3.1 The soil contamination test results are summarised in the tables on page 19.

10.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix I to this report.

Summary of degree of soils contamination (topsoil)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with garden**s end-use.														
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Zn $	PAH		TOC (%)	Asbestos I.D.
														B(a)P ∞	Naphthalene		
				37	5	26	3000	200	200	169	127	350	200	5	8		
TP01	0.20	Topsoil	5.5	18	0.5	0.2	11	21	36	0.1	13	0.4	64	0.3	0.4	7.7	N.D.
TP03	0.20	Topsoil	6.1	**41**	0.7	0.3	44	47	94	0.3	25	1.2	97	2.0	2.0	3.8	N.D.
TP04	0.20	Topsoil	7.1	26	1.0	0.2	36	35	73	0.6	25	0.9	100	0.7	0.4	6.1	N.D.
TP05	0.20	Topsoil	6.5	34	1.2	0.3	45	42	76	0.3	25	1.0	110	1.0	1.5	5.2	N.D.
TP10	0.10	Topsoil	6.4	**46**	0.6	0.3	26	51	120	0.4	26	1.2	110	1.5	1.1	5.5	N.D.
TP11	0.10	Topsoil	5.0	**49**	0.4	0.2	21	62	110	0.2	26	1.2	82	2.7	3.4	1.6	N.D.
TP02	0.20	Topsoil	-	**40**	-	-	-	-	-	-	-	-	-	-	-	-	-
TP06	0.20	Topsoil	-	**39**	-	-	-	-	-	-	-	-	-	-	-	-	-
TP08	0.10	Topsoil	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-
TP09	0.20	Topsoil	-	36	-	-	-	-	-	-	-	-	-	-	-	-	-
TP12	0.10	Topsoil	-	**39**	-	-	-	-	-	-	-	-	-	-	-	-	-

Key	
36	Parameter tested for and found to be in excess of Tier 1 value.
179	Parameter tested for and found to be > 5 x Tier 1 value.
12	Parameter tested for but not found to be in excess of Tier 1 value.
	Parameter not tested for.
♣	Tier 1 Value is pH dependent.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.
ND	No fibres detected (asbestos screen)

Source of guidance trigger level	
With the exception of those annotated with one of the symbols below (∞, $, ~), all Soil Screening Values in brackets above have been derived using CLEA v1.06.	
∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
$	MAFF. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
~	Engineering judgement (Lithos). Boron is a phytotoxic, although most phytotoxic compounds can pose a risk to human health if sufficient concentrations are present. However, plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.

Inorganic determinands

10.3.3 Samples have been classified by comparison with Tier 1 Soil Screening Values for an end use including domestic gardens and any area where plants are to be grown (the most sensitive of the proposed end-uses).

10.3.4 Of the 6 samples of topsoil initially analysed for inorganic parameters, 3 can be classified as uncontaminated and 3 could be classified as contaminated based on arsenic concentrations above Lithos' Tier 1 Soil Screening Value of 37mg/kg.

10.3.5 Given the results of the initial testing, 5 additional samples (11 in total) of topsoil from other exploratory holes were scheduled for arsenic analysis. Of all 11 samples tested, 5 recorded results above Lithos' Tier 1 Screening Value.

10.3.6 Statistical analysis of 11 arsenic results has been carried out in general accordance with the methods outlined in "Guidance on Comparing Soil Contamination Data with a Critical Concentration", CIEH/CL:AIRE (2008) (see comments in Appendix A, Contamination Testing) and the results are summarised below.

Stratum	No. of samples	US_{95} values for contaminants that have yielded one or more Tier 1 exceedances for a given made ground type
		Arsenic (37)
Topsoil	11	**41**

Notes: Values in **bold** indicate that the US95 value exceeds the relevant Tier 1 value.

10.3.7 Where there is 95% confidence or greater that the true mean concentration of a given contaminant within a particular soil type is less than the Tier 1 value, it can be concluded that the contaminant does not pose a significant risk to human health.

10.3.8 This statistical analysis indicates that the upper 95th percentile bound value (US95) for arsenic in topsoil is marginally elevated in comparison with Lithos' Soil Screening Value of 37mg/kg.

10.3.9 No outliers were detected.

10.3.10 There are no known sources of arsenic contamination on site, or within its vicinity. Given the number of samples tested and the concentrations recorded, it is likely that these are representative of local 'background' concentrations (typical of the Bradford area). In addition, the US95 value is only marginally above Lithos' Tier 1 of 37 mg/kg.

10.3.11 Given the above, risks to human health associated with arsenic contamination in the topsoil appear to be very low, and no remediation is considered necessary.

Asbestos

10.3.12 No asbestos fibres were identified in any of the 6 topsoil samples screened.

Organic determinands

10.3.13 This site is essentially greenfield and therefore for organic compounds, the Tier 1 Values used in this report have been derived with reference to a CSM that assumes a residential with gardens end use, with no clean soil cover will be placed in gardens/landscaped areas (Lithos Scenario A).

10.3.14 Lithos have used the CLEA model to derive risk-based screening values for hydrocarbons, in accordance with the methodology detailed by the TPHCWG, and reviewed by a UK workshop of experts with respect to UK adoption of the method.

10.3.15 However, these screening values assume a Soil Organic Matter (SOM) of 6% (equivalent to a TOC of 3.5%). Many organic contaminants are more mobile when the SOM is lower, and consequently comparison of soil results with lower screening values may be required.

10.3.16 In order to check the validity of Lithos' Tier 1 Soil Screening Values, the average TOC for each common fill type (beyond any areas of obvious hydrocarbon impact) have been determined.

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Topsoil	5%	No

Polycyclic Aromatic Hydrocarbons (PAH)

10.3.17 There are numerous PAH compounds. The USEPA identified 16 PAHs that are considered to represent the most problematic in terms of toxicology, fate and behaviour. The UK have also focused on these 16 and these are included in the laboratory report where speciated PAH analysis has been scheduled.

10.3.18 Speciated PAH analysis has been undertaken in order to determine concentrations of the key "marker" compounds: benzo(a)pyrene (considered the most toxic of the PAHs); and naphthalene (the most mobile and volatile of the PAHs).

10.3.19 Speciated analysis has confirmed the absence of significant concentrations of both benzo(a)pyrene and naphthalene in the soils beneath this site.

11 CONTAMINATION (QUALITATIVE RISK ASSESSMENT & REMEDIATION)

11.1 Summary of significant contamination

11.1.1 A veneer of topsoil underlies the majority of the site, which is typically 300mm thick. Testing suggests this material is chemically suitable for re-use.

11.1.2 However, given the concentrations of arsenic recorded, it is not recommended that this material be exported for use on another development site.

11.2 Revised conceptual ground model (contamination)

11.2.1 No plausible contaminant linkages have been identified.

11.3 Waste classification

11.3.1 Some excess arisings may be generated by excavations for foundations, sewers etc.

11.3.2 As there is no WRAP protocol for soils, the characterisation, sampling and classification of soils arising from brownfield sites has been incorporated within the Environment Agency's Technical Guidance WM3[3]. Classification of soils as inert, non-hazardous or hazardous in accordance with WM3 is quite a complex process. However, all soil arisings generated by excavations at this site are likely to be classified inert.

11.3.3 Off-site disposal to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[4] any excess natural soil arisings should be suitable for Direct Transfer to another development site, for use either as clean cover material, or bulk fill for use, without the need for waste legislation to be applied.

[3] Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015
[4] The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

11.3.4 Contractors exporting waste from the site should review the site investigation data and make their own assessment. Alternatively, Lithos could undertake this assessment once exported waste streams have been identified.

12 HAZARDOUS GAS

12.1 General

12.1.1 Consideration of the conceptual site model and potential linkages has enabled a preliminary qualitative assessment of risks associated with gas:-

Source	Receptors	Hazard	Pathway	Initial risk
Off-site shallow mine workings (to the northeast)	Human health	Asphyxiation & explosion	Lateral migration, ingress & accumulation	**Very Low:** mineworkings present immediately adjacent, but separated by fault line.
	Buildings	Explosion		

12.1.2 Given the above gas monitoring wells have been installed in 6 boreholes across the site. Details of the installations are given on the borehole logs presented in Appendix K to this the report.

12.1.3 The generation potential of the gas source was initially considered to be Very Low and this has been confirmed by the monitoring results obtained. Consequently, in accordance with CIRIA Report C665, given the proposed residential end use, 6 visits have been scheduled over a 3-month period.

12.2 Scope of works

12.2.1 To date, the wells have been monitored on one occasion for groundwater levels and soils-gases, and the results are presented in Appendix K.

12.2.2 A standard procedure was followed, in accordance with CIRIA guidance:

- Ambient oxygen concentration
- Atmospheric temperature & pressure
- Methane, oxygen and carbon dioxide concentrations and flow rates using a Gas Data GFM436 infra-red gas analyser
- Standing water level using a dipmeter
- Ambient oxygen concentration (check for instrument drift)

12.3 Monitoring results

12.3.1 Wells have been monitored on one occasion to date (9th January 2019), results are summarised below.

Monitoring well	Response zone	Methane (% v/v)	Carbon dioxide (% v/v)	Steady flow rate (litre/hour)
WS01	0.4m to 1.4m (Residual soil)	0.0	0.4	0.0
WS02	0.8m to 1.8m (Residual soil)	0.0	0.4	0.0
WS03	0.5m to 1.5m (Residual soil)	0.0	0.1	0.0
WS04	0.5m to 1.4m (Residual soil)	0.0	0.6	0.0
WS05	0.6m to 1.5m (Residual soil)	0.0	0.6	0.0
WS06	1.0m to 2.0m (Residual soil)	0.0	1.3	0.0

12.4 Discussion

12.4.1 Generic Note 05 in Appendix A outlines how monitoring results are interpreted.

12.4.2 No initial or steady flow rates were detected within any of the monitoring wells. Furthermore, no concentrations of methane were detected, and carbon dioxide levels were all below 1%.

12.4.3 An initial high flow was recorded in WS04 of 58.3litres/hour after bailing, which fell to 0.0litres/hour. This peak flow is almost certainly associated with a rise in the water table. Where water rises into the plain casing, above the slotted pipe, a positive pressure is created within the casing. This "trapped" air is released as/when the well valve is opened resulting in a short-lived, but high flow, and consequently represents release of a positive pressure rather than significant generation of gas.

12.4.4 A hazardous gas risk assessment incorporating all of the results will be issued on completion of monitoring in March 2019.

12.5 Radon

12.5.1 Requirements with respect radon measures are set out in Building Regulations Approved Document C. Probability bandings (based on the proportion of properties in a given area that exceed the Action Level; currently 200 $Bq.m^{-3}$) are used to determine whether a property requires no, basic or full measures.

12.5.2 At present Approved Document C advocates basic measures for the probability banding 3% to 10% (full measures if >10%). However, Public Health England would like to see all new build include basic measures.

12.5.3 The Public Health England UK radon map and the Landmark report indicate that the site is in an area where between 1% and 3% of homes are estimated to be above the action level.

12.5.4 Consequently, basic radon protection measures are not required. However, in light of Public Health England advice, the Developer might consider providing all new dwellings with basic radon protection measures.

13 GEOTECHNICAL TESTING

13.1 General

13.1.1 A total of 10 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

13.1.2 The geotechnical laboratory test results are presented in Appendix J to this report.

13.2 Atterberg limits

13.2.1 The plasticity indices of 10 samples of cohesive soil have been determined; results are summarised below.

Soil type	No. samples tested	Moisture content range (average)	Range of Plasticity Indices* (average)	Shrinkability
Cohesive Residual Soil	10	13 to 25 (18)	21 to 30 (25)	Medium

* Modified where appropriate in accordance with Chapter 4.2 of the NHBC Standards.

Note. The term Shrinkability is equivalent to the term Volume Change Potential used in Chapter 4.2.

13.2.2 For the purposes of foundation design, it is recommended that all cohesive soils be regarded as being of medium shrinkability.

13.3 Soluble sulphate and pH

13.3.1 In accordance with BRE Special Digest 1:2005, this site has been classified as greenfield with a mobile groundwater regime.

13.3.2 It is envisaged foundations will extend to depths of about 1m through natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).

13.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 10 samples were determined.

13.3.4 The highest water-soluble sulphate concentration and the lowest pH value for each soil type analysed are shown in the table below.

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Cohesive Residual Soil	7	5.1	32
Granular Residual Soil	2	6.1	<10
Weathered Coal Measures	1	5.3	<10

13.3.5 The two samples yielded magnesium and nitrate results of less than 10mg/l, and a max chloride value of 26mg/l. When this is accounted for, the equivalent sulphate value is 35mg/l.

13.3.6 In accordance with Tables C1 and C2 of SD1, sub-surface concrete should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-2z.

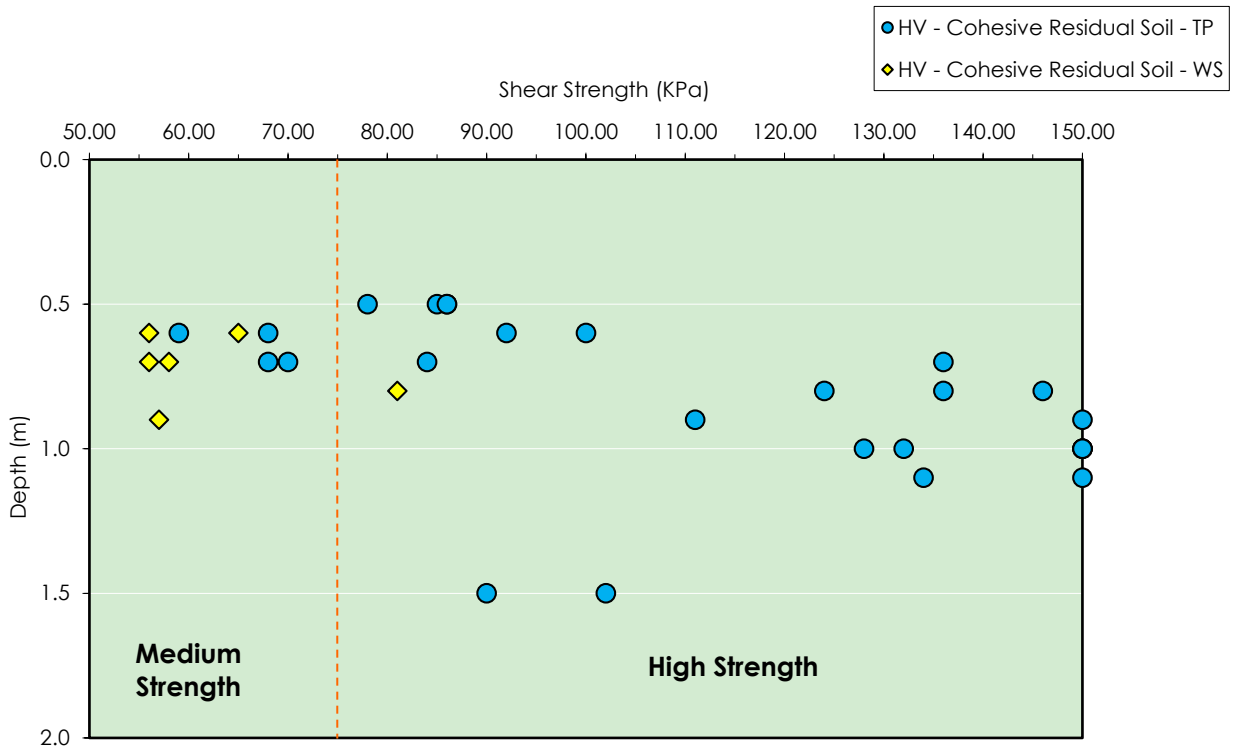
13.4 Undrained shear strength testing

Hand shear vane testing

13.4.1 Hand shear vane testing was undertaken within trial pits in-situ to around 1.0m depth and from larger blocks excavated from below that depth.

13.4.2 The results are summarised within the plot below which shows the majority of results within the 'high strength' range (>75kPa), and the lowest reading at around 55kPa (medium strength).

13.4.3 The plot below provides a summary of undrained shear strengths.



14 GEOTECHNICAL ISSUES

14.1 Conceptual site model

14.1.1 Natural ground typically comprises Cohesive Residual soils (typically stiff mottled clays and gravelly clays) with Granular Residual soils (clayey gravel) below.

14.1.2 Bedrock (siltstone) was encountered within all exploratory holes at an average depth of 1.8m.

14.1.3 Based on the initial results, groundwater appears to be relatively shallow within the Residual Soils, sitting at between 0.4m and 1.7m depth, (197.5mAoD and 205mAoD).

14.2 Mining & quarrying

14.2.1 There are no known quarries on, or within 50m of the site.

14.2.2 This site is located within a Coal Mining Development Low Risk Area, with a High Risk Area immediately north, separated by the East Bierley Fault.

14.2.3 Lithos mining investigation found that two thin seams underlie the north of the site at between c.10m and 15m depth, with overlying clay encountered in the north-west. In the north-east, evidence of workings (soft ground and voids up to 1.7m thick) were encountered, likely associated with workings within both the coal seams and possible 'fireclay'. Insufficient competent cover is in place above the voids.

14.2.4 The results of the investigation indicate that the East Bierley Fault (and therefore the associated Development High Risk Area) may lie further south than shown on the BGS plan and CA records, therefore bring the north of this site into High Risk Area.

14.2.5 Given the above, mitigation against the risk of subsidence associated with the shallow mineworkings will be required in the north-east. This will likely involve consolidation by drilling and grouting.

14.2.6 The area requiring drilling & grouting is shown on Drawing 3233/8 in Appendix B. This is based on the findings to date and the desk study information; additional drilling should be undertaken to ensure that workings do not extend further south. This could be done prior to, or during, the proposed drilling & grouting.

14.2.7 Based on the findings of this investigation and the anticipated nature of the workings, it is considered that the necessary consolidation (grouting) would require drilling holes on a 3m grid. A viscous grout composed of appropriate proportions of OPC, PFA, sand or pea gravel would then be injected into the workings via these holes.

14.2.8 Further holes would need to be drilled in areas of high grout take (to confirm filling of void space), and in areas where several adjacent holes encountered solid coal (to confirm that the local area is underlain by no workings, rather than pillars).

14.2.9 Drilling and grouting operations should be carried out with engineering supervision and be undertaken in accordance with a revision of Lithos' "General Specification for the Treatment of Shallow Mineworkings" tailored to the site-specifics, including a grouting grid in relation to the proposed layout.

14.3 Site regrade and/or ground improvement

14.3.1 Due to the slight slope across the site to the south-west some localised regrading may be necessary to create flat development platforms.

14.3.2 Any digital terrain modelling undertaken or commissioned by Rouse should consider implications for the foundation recommendations outlined below.

14.4 Foundation recommendations

General

14.4.1 Foundation recommendations assume that development will be two or three storey construction and that line loads will not exceed 90kN/m run. If this is not the case significant alteration to these recommendations will be required.

14.4.2 We have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation. Any digital terrain modelling undertaken, or commissioned by, Rouse Homes should consider implications for the foundation recommendations outlined below.

14.4.3 Refinement of the advice outlined below might be required in light of the recommended mining investigation (see Section 14.2).

14.4.4 Sub-surface concrete in contact with the natural ground should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-2z.

Strip/trench fill footings

14.4.5 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for all two or three storey houses constructed at the site. Footings will be founded in stiff clay or competent rock.

14.4.6 Reinforcement, as a precaution against differential settlement, is recommended only where foundation excavations encounter significant lateral and vertical variations in strata. One layer of B385 mesh placed 75mm above the base of the footing is likely to provide suitable reinforcement, but further advice should be sought from the Structural Engineer.

14.4.7 Overdeepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.

14.4.8 In order to minimise softening and swelling of cohesive soils or loosening of granular soils, it is recommended that footings are cast as soon as formation level is reached (or alternatively formation could be blinded using concrete with as low a water:cement ratio as possible).

14.4.9 In areas where shallow workings have been encountered. Even after consolidation, foundations should be "beefed-up" to accommodate any potential time dependant differential settlement. Further advice regarding reinforcement should be sought from the appointed Structural Engineer, but in the meantime reference should be made to the table below.

Rock cover above grouted seam	Preferred Foundation
<5 x seam thickness [5]	Raft - designed to span 3m over potential soft spots and cantilever 1.5m at corners. Either stiffened, flat-bottomed rafts a minimum of 300mm thick, on 450mm of compacted Type 1 material, with reinforcement top and bottom. Or, rafts could be of 300mm concrete with a 150mm upstand to allow for wall construction provided that the base of compacted type 1 material lies at a depth of at least 600mm
>5 x seam thickness – 10m	Strip footing OK, but thickened (300mm), and reinforced top and bottom
>10m	Strip footing OK, but needs to be 300mm thick reinforced with one layer of mesh

[5] *See s5.6 of Structural Foundations Manual (M F Atkinson) 2nd Ed.*

14.4.10 Rouse Homes or their groundworker should seek further advice from Lithos if unexpected ground conditions are encountered in foundation or sewer excavations, including any conflict between soft ground associated with a backfilled trial pit excavation and the line of a proposed footing.

Cohesive soils (clay)

14.4.11 Clay classification tests suggest that natural cohesive soils at the site should be regarded as being of medium shrinkability. A minimum founding depth of 900mm is therefore recommended for all soils on the site where strip footings are proposed.

14.4.12 In accordance with NHBC Standards, founding depths in cohesive soils should be taken from original or finished ground level, whichever is the lower, to the underside of the footing.

14.4.13 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 30% of the site may be affected by trees.

14.4.14 Trench fill foundations should be designed in accordance with NHBC Standards, Chapter 4.2. Heave precautions (a suitable approved compressible void former) should be used on the internal face of all external walls where the foundation is within the zone of influence of trees and greater than 1.5m deep.

14.4.15 Any trench fill foundation deeper than 2.5m will need to be designed by a Chartered Engineer, whose status is accepted by NHBC (NHBC Standards, Technical Requirement R5); however, it is likely that the presence of bedrock will result in few, if any, foundations being deeper than 2.5m.

14.4.16 A safe bearing capacity of around 160kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true

- A foundation length of 8m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.9m
- An undrained shear strength of 55kPa for the firm clay (typical minimum recorded on site)

14.4.17 Assuming the foundation geometry detailed above, settlements of less than 25mm would be anticipated. This is considered likely to be acceptable. However, further advice should be sought from the Structural Engineer responsible for foundation design.

Granular soils (weathered bedrock)

14.4.18 Granular residual soil was encountered at depths of >1m, but might be encountered in foundation excavations where deepening due to trees is required.

14.4.19 Where encountered, foundations need not be deepened any further and need only penetrate the granular residual soils by the foundation thickness (subject to a minimum founding depth of 0.6m).

14.4.20 The weathered in-situ siltstone (gravel) is assumed to have a relative density of at least medium dense (in accordance with BS5930:2015).

14.4.21 A safe bearing capacity of around 160kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true:

- A foundation length of 8m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.6m
- An angle of shearing resistance of ϕ=32° for the granular deposits

14.4.22 Assuming the foundation geometry detailed above, minimal settlements would be anticipated. This is considered likely to be acceptable. However, further advice should be sought from the Structural Engineer responsible for foundation design.

14.4.23 In accordance with NHBC Standards, a minimum founding depth of 450mm (due to potential frost susceptibility) is required in granular soils. This depth should be taken from finished ground level to the underside of the footing. If finished ground level is to be above existing ground level then the foundation excavation simply needs to ensure that there is sufficient depth of excavation to allow casting of the footing entirely within natural ground (not made ground or topsoil).

14.4.24 It should be noted that founding at shallow depth (450mm), whilst desirable from an excavation stability viewpoint, may not provide sufficient bearing capacity due to the lesser depth of (resisting) overburden. Consequently, a minimum founding depth of 600mm is recommended.

14.4.25 However, if the excavation is dug from original ground level in cold conditions when freezing is expected, then foundation depth should be taken from the existing, not finished, ground level.

14.4.26 Where ground level is being raised, it would be prudent to proof roll the exposed granular soils after stripping topsoil (to mitigate any near-surface disturbance), and ideally fill should be placed prior to construction (otherwise the Developer will need to consider the potential for movement associated with placement of the fill).

14.4.27 It should also be noted that the footing may require deepening or stepping in order to allow plot drainage to exit the plot footprint (either over or under the footing).

Bedrock

14.4.28 Siltstone bedrock might be encountered in foundation excavations where deepening due to trees is required.

14.4.29 Where encountered, foundations need not be deepened any further and need only penetrate the bedrock by the foundation thickness.

14.4.30 The bedrock is generally considered to have a safe bearing capacity of at least 300kPa and minimal settlements would be anticipated.

14.4.31 Where rock is encountered at shallow depth foundations should be placed entirely on rock and not partially on rock and partially on soil. This may, depending on surface gradient, necessitate significant overdeepening of foundations.

14.4.32 Bedrock at the site comprises siltstone which can be relatively easy to excavate using a backhoe excavator and will be recovered as a tabular gravel. Where in-situ siltstone is encountered at founding depth (minimum of 450mm), it will provide a suitable founding stratum for two or three storey dwellings and need only be penetrated by the proposed foundation thickness. Note: any overlying residual soil (typically clay with gravel-sized lithorelicts of mudstone) is likely to be a shrinkable soil; siltstone is not.

14.5 Floor slabs

14.5.1 Where foundations are within the influence of existing or proposed trees, NHBC require a suspended floor slab, with sub-floor void. The floor slab is most commonly a precast block and beam construction, but alternatively could comprise a suspended timber floor, or a slab cast on a suitable compressible void former. Ground-bearing and cast in-situ suspended slabs (other than those cast on a void former) are not acceptable where foundations are within the influence of trees.

14.5.2 In accordance with NHBC Standards Chapter 4.2, a minimum void height of 250mm should be adopted for a precast block and beam (or suspended timber) floor; this includes a 150mm ventilation allowance. If a suspended, cast in-situ slab (on a void former) is proposed, a minimum clear void height of 100mm should be adopted; of course, the actual thickness of the void former will be significantly greater.

14.5.3 Beyond the influence of existing or proposed trees, it is considered that the natural ground is generally suitable for the use of ground bearing floors. However, ground bearing slabs should not be cast on topsoil or made ground. Where plots are elevated for design reasons, the depth of engineered stone below a ground bearing slab should not exceed 600mm, in accordance with NHBC guidance.

14.5.4 The natural ground beneath this site includes cohesive soils and is therefore subject to seasonal variation in moisture content. If ground slabs were constructed on desiccated soil, heave of the slab would occur on re-hydration of the ground. If any significantly desiccated soil is present, a suspended floor slab, with sub-floor void will be required.

14.5.5 It should be noted that NHBC have suffered a significant number of claims resulting from the use of ground bearing floor slabs. Consequently, if ground bearing slabs are proposed, care should be taken to ensure correct and careful construction. For example, if fill to the internal face of the foundation excavation is not properly compacted, subsequent settlement can result in cracking of the slab.

14.5.6 Floor slab design should be finalised/take account of the results of the gas monitoring and protection measures required, which will be detailed in Lithos' gas risk assessment, to be issued on completion of monitoring in March 2019.

14.6 Designated concrete mixes

14.6.1 Designated mixes are considered in BRE Special Digest SD1 and BS 8500 -1:2015+A1:2016. However, in addition to soil chemistry (sulphate class), there are a number of other considerations relating to structural design that need to be taken into account when determining an appropriate concrete mix.

14.6.2 Consequently, Rouse Homes should seek advice from their appointed Structural Engineer.

14.7 Excavations

14.7.1 Groundwater should be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".

14.7.2 Based on the results of the investigation it is considered unlikely that major groundwater flows will be encountered in shallow excavations. However, steady seepage was encountered along the pits dug on the north-western boundary, and shallow groundwater has been recorded within the monitoring wells on the first visit. It may be prudent to allow for some groundwater control over and above normal site pumping practices.

14.7.3 Excavations should remain stable in the short term.

14.7.4 Bedrock was encountered in several exploratory holes across the site. Based on the exploratory hole logs, excavation greater than 3m is likely to prove difficult across the site. It would therefore be prudent to allow for excavation of hard rock in any deep excavations such as those that may be required for drainage etc.

14.8 Drainage

14.8.1 Based on the results of the in-situ testing, soakaways will not provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

14.8.2 Alternative SUDS options (see CIRIA C753:2015 for further details) include:

- Pervious Pavements – provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate into subsurface storage, with subsequent infiltration or controlled discharge. Pavement could be porous (water able to infiltrate across entire surface material; e.g. reinforced grass), or permeable (water infiltrates via joints between concrete blocks).
- Ponds – designed to have permanent pool of water, but with capacity to provide temporary storage-controlled discharge.

14.8.3 Yorkshire Water have published a guide[6] for developers and designers outlining their design requirements for surface water attenuation assets.

14.8.4 With respect to detention basins, which should normally be dry, water table levels should be taken from borehole monitoring wells over 4 consecutive seasons, for at least 3 points in the basin area. Ground conditions must be suitable to allow free drainage from the detention basin all year round by having regard to groundwater levels, and impermeable liners are not to be used.

14.8.5 The guide also discusses required access to flow control chambers, large diameter (i.e. >900mm) surface water storage pipes, and surface water storage tanks.

14.8.6 It is recommended that the developer contact Yorkshire Water Services with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

14.9 Highways

14.9.1 The natural soils present at shallow depth (anticipated formation) are predominantly cohesive. Based on visual inspection of the natural materials and the recorded medium plasticity indices at the site, published tables[7] indicate that the Cohesive Residual soil would be expected to provide a CBR value of at least 3%. This should be verified prior to or during construction.

14.9.2 Whilst the CBRs estimated above should be achievable, significant deterioration during/after periods of significant rainfall and/or site trafficking is likely. Consequently, it would be prudent to consider flexibility in the groundworks programme to enable highway construction during prolonged dry/warm weather (typically between May and September) when formation will be least vulnerable to deterioration. Alternatively, a minimum 200mm thickness of suitable granular fill (i.e. a "blanket" of 6F2) could be placed along the line of proposed highways to protect formation during the construction phase.

[6] *Design Requirements for Surface Water Attenuation Assets, February 2017.*

[7] *Interim Advice Note 73/06 Revision 1 (2009), Chapter 5. Characterisation of Materials Design Guidance for Road Pavement Foundations - Draft HD25*

14.10 External works

14.10.1 Any digital terrain modelling undertaken, or commissioned by Rouse Homes should be made available to their Engineering Designer prior to issue of an External Works Drawing.

15 REDEVELOPMENT ISSUES

15.1 General

15.1.1 This report has presented options with respect to foundation solutions, re-use of topsoil etc that are considered technically feasible and in line with current good practice. Consequently, we would expect to obtain regulatory approval for whichever option is adopted, although this cannot be guaranteed. Copies of this report should be forwarded to the relevant regulatory authorities (Warranty Provider & Local Authority) for their comment/approval.

15.1.2 If unanticipated ground is encountered during the site preparatory works, the Contractor should immediately seek further advice from the Engineer.

15.2 Good practice guidance

15.2.1 The construction phase groundworker should follow good environmental practice to minimise the risks of spillage, leakage etc with reference, but not limited, to the following documents:

- CIRIA C502 'Environmental Good Practice on Site'
- EA Pollution Prevention Guidelines[8]:
  - PPG6 - Working at construction and demolition sites
  - PPG2 - Above ground oil storage tank
  - PPG7 – The safe operation of refuelling facilities.
  - PPG21 – Incident Response Planning

15.3 New utilities

15.3.1 It is strongly recommended that all statutory service bodies are consulted at an early stage with respect to the ground conditions within which they will lay services in order to enable them to assess at an early stage any potential abnormal costs.

15.3.2 This site is greenfield, and no previous or current usage of the site or its immediate surroundings is likely to have resulted in ground contamination. Furthermore, no significant made ground was encountered in any of the exploratory holes during the ground investigation.

15.3.3 Consequently, the use of 'standard' polyethylene water supply pipes should be acceptable, although Rouse Homes should consult Yorkshire Water at the earliest opportunity to confirm this.

15.3.4 This site investigation has enabled completion of Yorkshire Water's Contaminated Land Assessment Form, a copy of which is included in Appendix M.

[8] *Whilst this has formally been withdrawn it can still be accessed via the EA archives and provides useful information on managing risks.*

15.4 Health & safety issues - construction workers

15.4.1 Access into excavations etc. must be controlled and undertaken in accordance with the CDM Regulations 2015, most notably Regulation 22, to mitigate risk of collapse or asphyxiation.

15.4.2 Before site operations are started, the necessary COSHH statements and Health & Safety Plan should be drafted in accordance with the CDM regulations.

15.5 Potential development constraints

15.5.1 The overhead electric cables present a potential development constraint unless they can be relocated. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required by each service undertaker if they remain in-situ. The Red line plan provided by Rouse suggest that Yorkshire Electric Board require 12 months' notice to divert.

15.5.2 It is almost certain that Yorkshire Water will have restrictions with respect to development in the vicinity of the 600mm water mains; an easement of 8m is required according to Rouse's layout.

15.5.3 The right of way across the site appears to have been considered within Rouse's proposed layout.

16 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

16.1 General

16.1.1 The site is located 5.5km south-east of Bradford city centre and comprises a parcel of land covered by a single grassed field that slopes gently to the south-west.

16.1.2 It is understood that consideration is being given to redevelopment of the site with 43 No. traditional 2 and 3 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers.

16.1.3 The site is underlain by a veneer of topsoil overlying Cohesive Residual soils with Granular Residual soils encountered below in the majority of exploratory holes. Coal Measures Bedrock (siltstone) was encountered underlying Residual soils from an average depth of 1.8m.

16.2 Mining

16.2.1 Evidence of shallow mineworkings has been identified in the north-east, as well as desk study information suggesting workings exist at a similar depth immediately north of the site. Dril

16.2.2 Consolidation of workings by drilling & grouting will be required in the north of the site; additional drilling is recommended to check for the presence of any further workings to the south. This could be done prior to, or during, the proposed drilling & grouting.

16.3 Hazardous gas

16.3.1 The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level.

16.3.2 Due to shallow workings to the north-east the site is considered potentially susceptible to mines gas.

16.3.3 Monitoring wells have been installed and gas monitoring is currently ongoing. A hazardous gas risk assessment will be issued on the completion of the monitoring in March 2019.

16.4 Contamination & remediation

16.4.1 Marginally elevated concentrations of arsenic have been recorded within the topsoil. Given the lack of any sources of arsenic, concentrations are considered representative of 'background' levels and are only marginally above Lithos' Tier 1 Screening Value.

16.4.2 Therefore, the topsoil is considered suitable for re-use in garden/landscaped areas, but should not be exported for use on another development site.

16.5 Foundations

16.5.1 All plots will be founded on traditional strip/trench-fill foundations, founding within Cohesive Residual soils at a minimum of 0.9m depth, over-deepened where necessary due to tree influence.

16.5.2 Where foundations require over-deepening, granular residual soils/bedrock may be encountered, at which point foundations can be cast and need only penetrate the granular residual soils/bedrock by the foundation thickness.

16.5.3 Refinement of foundation advice may be required in light of the recommended mining investigation.

16.6 Flooding

16.6.1 The EA indicate that the site is not located within an indicative floodplain.

16.7 Drainage

16.7.1 Due to very slow infiltration rates, soakaways will not provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

16.8 Highways

16.8.1 Based on visual inspection of the shallow natural materials and published guidance, the Cohesive Residual soil should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

16.9 Further works

16.9.1 Further delineation of the extent of the underground mineworkings. This could be done during, or prior to, the drilling & grouting.

16.9.2 A Specification for the Treatment of Shallow Mineworkings (including a proposed grouting grid) should be prepared.

Appendix A

General Notes

01 - Environmental setting
Generic notes – geoenvironmental Investigations

General

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

Geology, mining & quarrying

In order to establish the geological setting of a site, Lithos refer to BGS maps for the area, and the relevant geological memoir. Further information is sourced by reference to current and historical OS plans.

In July 2011, the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology. The CA, using its extensive records has prepared plans for all coalfield Local Planning Authorities, which effectively refines the defined coalfield areas into High Risk and Low Risk areas. High Risk areas are likely to be affected by a range of legacy issues that pose a risk to surface stability, including: mine entries; shallow coal workings; workable coal seam outcrops; mines gas; and previous surface mining sites. Low Risk areas comprise the remainder of the defined coalfield, and are areas where no known defined risks have been recorded; although there may still be unrecorded issues. Where a site lies within either a High or Low Risk area, a mining report is obtained from the CA.

Landfills

Lithos obtain data from Landmark or Groundsure, the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site. Historical OS plans are also inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Radon

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

In order to assess potential risks associated with radon gas, Lithos refer to BRE Report BR211[1], and the Public Health England website. Advice on the limitation of exposure of the population to radon in buildings was originally published in 1990 by the National Radiological Protection Board (NRPB), which joined the Health Protection Agency (HPA) in 2005; the HPA updated NRPB advice in July 2010[2]. The HPA became part of Public Health England in 2013.

The HPA recommended that the NRPB radon Action Level for homes be retained, and a new Target Level for radon in homes be introduced. The values of the Action Level and Target Level, expressed as the annual average radon concentration in the home, are 200 Bqm^{-3} and 100 Bqm^{-3} respectively. The Target Level was to provide an objective for remedial action in existing homes and preventive action in new homes.

The term 'radon Affected Area' is defined as those parts of the country with >1% of homes estimated to be above the Action Levels. The NRPB first indicated which parts of the country should be regarded as radon Affected Areas in 1990. A more detailed mapping method was developed by the HPA in conjunction with the British Geological Survey in 2007[3]. The level of protection needed is site-specific and can be determined by reference to this mapping on the Public Health England website, which indicates the highest radon potential within each 1km grid square. Each 1km grid square is classified on the basis of the percentage of existing homes within that grid square estimated to have radon concentrations above the Action Level. There are 6 'bands': <1%; 1 to 3%; 3 to 5%; 5 to 10%; 10 to 30%; and >30%.

The NRPB advised that action should be taken to reduce radon concentrations in existing homes if the radon concentration exceeded the Action Level of 200 Bqm^{-3} in room air averaged over a year; ten times the average UK domestic radon concentration. NRPB advice informed changes in the requirements for radon protection in new buildings.

- **Basic** preventive measures are required in new buildings, extensions, conversions and refurbishments if the probability of exceeding the Action Level is **>3%** in England and Wales, and >1% in Scotland and Northern Ireland.
- Provision for further preventive (**Full**) measures is required in new buildings if the probability of exceeding the Action Level is **>10%**.

At present Building Regulations Approved Document C advocates basic measures for the probability banding 3% to 10%, and full measures if >10%. However, Public Health England would like to see all new build include basic measures.

Action and Target Levels should also be applied to non-domestic buildings with public occupancy exceeding 2,000 hours per year and to all schools.

Hydrogeology

Lithos obtain information from the Environment Agency (EA), and Landmark or Groundsure with respect to:

- Groundwater quality
- Recorded pollution incidents
- Licensed groundwater abstractions

From April 2010 the EA's Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply), but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey. The maps are split into two different types of aquifer designation:

- Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels
- Bedrock - solid permeable formations e.g. sandstone, chalk and limestone

The maps display the following aquifer designations:

Principal aquifers: These are layers of rock or superficial deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary aquifers: These include a wide range of rock layers or superficial deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into three types:

- Secondary A - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers
- Secondary B - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers
- Secondary undifferentiated - In most cases, this is because the rock type in question has previously been designated as both a minor and non-aquifer in different locations due to the variable characteristics.

[1] BRE Report BR211, 2015: "Radon: guidance on protective measures for new buildings.

[2] Limitation of Human Exposure to Radon, Documents of the Health Protection Agency - Radiation, Chemical and Environmental Hazards, RCE-15. July 2010.

[3] Miles JCH, Appleton JD, Rees DM, Green BMR, Adlam KAM and Myers AH (2007). Indicative Atlas of Radon in England and Wales. Chilton, HPA-RPD-033.

Unproductive strata: These are rock layers or superficial deposits with low permeability that have negligible significance for water supply or river base flow.

The EA maps only display the principal and secondary aquifers as coloured areas. All uncoloured areas on the map will be unproductive strata. However, for uncoloured areas on the superficial (drift) designation map it is not possible to distinguish between areas of unproductive strata and areas where no superficial deposits are present; to do this, it is necessary to consult the published geological survey maps.

For the purposes of the EA's Groundwater Protection Policy the following default position applies, unless there is site specific information to the contrary:

- If no superficial (drift) aquifers are shown, the bedrock designation is adopted
- In areas where the bedrock designation shows unproductive strata (the uncoloured areas) the superficial designation is adopted
- In all other areas, the more sensitive of the two designations is used (e.g. If secondary superficial overlies principal bedrock, an overall designation of principal is assumed)

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

Hydrology

Lithos obtain information from the Environment Agency and Landmark or Groundsure with respect to:

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

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

General Quality Assessment (GQA) grades reflect actual water quality. They are based on the most recent analytical testing undertaken by the EA. There are 6 GQA grades (denoted A to F) defined by the concentrations of biochemical oxygen demand, total ammonia and dissolved oxygen.

The susceptibility of a site to flooding is assessed by reference to a Flood Map on the Environment Agency's website. These maps show natural floodplains - areas potentially at risk of flooding if a river rises above its banks, or high tides and stormy seas cause flooding in coastal areas. There are two different kinds of area shown on the Flood Map:

1. Dark blue areas (Flood Zone 3) could be flooded by the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year, or by a river by a flood that has a 1% (1 in 100) or greater chance of happening each year
2. Light blue areas (Flood Zone 2) show the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Where there is no blue shading (Flood Zone 1), there is less than a 0.1% (1 in 1000) chance of flooding occurring each year.

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

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

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

If a site falls within a floodplain, it is recommended that a flood survey be undertaken by a specialist who can advise on appropriate mitigating measures; i.e. raising slab levels, provision of storage etc. In accordance with Chapter 10 of the National Planning Policy Framework, a site-specific flood risk assessment is required for: proposals of 1 hectare or greater in Flood Zone 1, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and any new development in Flood Zones 2 and 3.

COMAH & explosive sites

Lithos obtain information from Landmark or Groundsure with respect to Control of Major Accident Hazards (COMAH) or explosive sites within 1km of the proposed development site. Lithos' report refers to any that are present, and recommends that the Client seeks further advice from the HSE.

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

Preliminary conceptual site model

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

Assessment of contaminated land is based on an evaluation of pollutant linkages (source-pathway-receptor). Contaminants within the near surface strata represent a potential source of pollution. The environment (most notably groundwater), site workers and end users are potential receptors.

Potential pollutant linkages are shown on a preliminary conceptual site model (pCSM). A CSM is essentially a cross-section through a site that reflects both the surface topography and underlying geology, and shows surface features of interest. The most significant sources of contamination are then superimposed onto this cross-section together with potential receptors (human health & controlled waters), and plausible pathways between the two. In addition to environmental issues, the CSM should also highlight geotechnical issues.

A pCSM is prepared after consideration of all available "desk study" data, and before design of the ground investigation. Data reviewed should include historical plans (with superimposition on a current-day plan), previous SI reports, geological maps etc. The pCSM, in conjunction with knowledge of site constraints (buildings, services, slopes etc) is used to design the ground investigation.

The revised CSM takes account of data obtained during the ground investigation, including the distribution of made ground, the nature and distribution of contamination etc.

02 - Ground investigation fieldwork
Generic notes – geoenvironmental investigations

General

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

- BS5930:2015 "Code of practice for site investigation"
- Eurocode 7: BS EN 1997-1:2004. Geotechnical design - Part 1: General rules
- Eurocode 7: BS EN 1997-2:2007. Geotechnical design - Part 2: Ground investigation and testing
- BS10175:2013 "Code of practice for the identification of potentially contaminated sites"
- "Technical Aspects of Site Investigation" – EA R&D Technical Report P5-065/TR (2000)
- "Development of appropriate soil sampling strategies for land contamination" – EA R&D Technical Report P5-066/TR (2001)
- Contaminated Land Reports 1 to 6, most notably CLR Report No. 4 "Sampling strategies for contaminated land"
- "Guidance on the protection of housing on contaminated land" – NHBC & EA R&D Publication 66 (2000)
- AGS: 1996 "Guide to the selection of Geotechnical Soil Laboratory Testing"

Exploratory hole locations

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

Investigation techniques

Ground conditions can be investigated by a number of techniques; the procedures used are in general accordance with BS5930: 2015 and BS1377: 1990. Techniques most commonly used by Lithos include:

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

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

In-situ testing

Relative densities of granular materials given on the trial pit logs are based on visual inspection only, they do not relate to any specific bearing capacities.

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

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

Sampling

Typically Lithos collect at least three soil samples from each exploratory hole, although in practice a greater number are often taken. The collection of a sufficient number of samples provides a sound basis upon which to schedule laboratory analysis, ensuring:

- A sufficient number of samples from each (common) site material are tested
- Horizontal and vertical coverage of the site is adequate, thereby providing a robust data set for use in the conceptual ground model
- Any localised, significant, but non-pervasive conditions are considered

Made ground and natural soils encountered in the field during a ground investigation often contain a significant proportion of coarse grained material (e.g. brick etc). Soil samples obtained during most investigations are often only truly representative of the in-situ soil mass where there is an absence of particles coarser than medium gravel; i.e the entire soil mass would pass a 20mm sieve.

Representative bulk samples of the **soil mass** are retrieved from coarse soils for specific geotechnical tests (most notably grading and compaction); this typically requires the collection of at least 10kg of soil, and occasionally >50kg. However, in the context of assessing land contamination, it is generally accepted that samples should be representative of the **soil matrix** of the stratum from which they are taken. Consequently, truly representative samples of coarse soils for subsequent contaminant analysis are not obtained - only the finer fraction is placed in sample containers. Coarse constituents not sampled would typically comprise any 'particles' with an average diameter greater than about 20mm (i.e. coarse gravel, cobble and boulder).

At present, neither ISO/IEC 17025 nor MCERTS specify sample pre-treatment with respect to stone removal. Unsurprisingly therefore UKAS accredited testing laboratories do not adopt the same approach to stones[1] – some crush and test the "as received" soil, whilst others sieve out stones and analyse only the residual soil (the sieve size used varies depending on the laboratory).

[1] *Mark Perrin. Stoned – Sample Preparation for Soils Analysis. Ground Engineering, April 2007.*

In essence, samples taken from coarser soils for contaminant analysis are "screened" by the geoenvironmental engineer in the field, and often sieved again by the laboratory during sample preparation. Geoenvironmental engineers do not typically re-calculate soil mass contaminant concentrations by taking account of the unsampled coarse fraction. Likewise, laboratories that remove stones typically report contaminant concentrations based on the dry weight of soil passing the sieve. In the context of land contamination and human health risk assessment, this is considered reasonable, because it is the soil matrix which is of greatest concern. Stones are unlikely to:

- Provide a significant source for plant uptake (consumption of vegetables)
- Remain on vegetables after washing (consumption of vegetables)
- Be eaten (accidentally by an adult, or deliberately by a child)
- Be whipped-up by the wind for dust generation (inhalation)
- Stick to the skin for any length of time (dermal contact)
- Yield toxic vapour (inhalation)

Consequently, Lithos instruct labs to remove all stones >10mm, and to report the results as dry-weight based on the mass of matrix tested. However, the laboratory are given site-specific instruction where coarse stones are coated in say oil, or impregnated with mobile contaminants such as diesel. Where the stones are predominantly natural, or inert (e.g. brick, concrete etc), removal will clearly result in higher reported concentrations, than if the stones were crushed and added to the matrix.

Where the stones include a significant proportion of contaminant-rich material (e.g. slag, fragments of galvanised metal etc) an argument could be made for crushing and analysing. However, provided the stones are stable (i.e. unlikely to disintegrate or degrade) they should not pose a significant risk to human health for the reasons stated above.

Sometimes it is necessary to obtain samples that are not representative of the wider soil matrix, for example when investigating localised, significant, but non-pervasive conditions. Any such unrepresentative samples are annotated with the suffix '*' (eg 2D*, or 4G*). Lithos' site engineer describes both the unrepresentative sample, and the soil mass from which it was been taken.

Sample Containers (for contaminant analysis). Samples of soil for contaminant testing are placed into appropriate containers (see below). Soil samples for organic analysis are stored in cool boxes, at a temperature of approximately 4ºC, until delivery to the selected laboratory.

Anticipated testing	Container(s)
Asbestos identification	500ml plastic tub
pH & metals, and non-volatile organics	500ml glass jar
Speciated TPH	500ml & 50ml glass jars
VOCs (incl. naphthalene and \or GRO)	50ml glass jar

Sample Containers (for geotechnical analysis). The majority of samples are only scheduled for PI and sulphate testing, for which 500g of sample is required (a full 0.5-litre plastic tub). However, bulk bags are taken where scheduling of compaction or grading tests is proposed.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork. Long-term monitoring of standpipes or piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

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

Description of strata

Soils encountered during a Lithos investigation are described (logged) in general accordance with BS 5930:2015. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text. The materials encountered in the trial pits are logged, samples taken, and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

Key to exploratory hole logs

Keys to logs are presented in the Appendix containing the logs. There are two Keys – Symbols & Legends and Terms & Definitions.

03 – Geotechnical laboratory testing
Generic notes – geoenvironmental investigations

General

Soil samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Lithos. All tests are carried out in accordance with BS 1377:1990. The following laboratory testing is routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

Where soft, cohesive soils are encountered, one-dimensional consolidation tests are scheduled in order to assess settlement characteristics, and unconsolidated undrained triaxial compression tests to assess shear strength.

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

- Grading
- Compaction tests
- Particle density

Test results are presented as received in an Appendix to the Geoenvironmental Report.

Atterberg limits & moisture content

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

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth. Lithos typically only consider a soil to be shrinkable if the proportion finer than 63µm is >35%. PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003), which advocates the use of modified Plasticity Index (I'p), defined as:

I'p = Ip * (%< 425µm/100)

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

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs. Lithos apply engineering judgment where PI results are spread over a range of classifications. Consideration is given to:

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

Unless the judgment strongly indicates otherwise, Lithos typically adopts a conservative approach and recommends assumption of the higher classification.

Soluble sulphate and pH

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

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

Lithos refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2005). SD 1 provides definitions of:

- The nature of the site (greenfield, brownfield or pyritic)
- The groundwater regime (static, mobile or highly mobile)
- The design sulphate class (DS class) and
- The aggressive chemical environment for concrete (ACEC class)

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

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

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

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

Oedometer (Consolidation) tests

Oedometer tests measure a soil's consolidation properties, and are performed by applying different loads to a soil sample and measuring the deformation response. Typically the sample is subject to 5 incremental pressures (4 loading & 1 unloading), and the convention is for each subsequent pressure to be double the previous pressure. BS1377 suggests the **initial** pressure should be:

a) For stiff soils the effective overburden pressure*
b) For firm soils "somewhat less" than the effective overburden pressure
c) For soft soils "appreciably less" than the effective overburden pressure, usually 25 kPa or less
d) For very soft soils very low, typically 5 kPa or 10 kPa

* Effective **overburden pressure** (kNm^{-2}) = depth (m) x soil bulk unit weight (kNm^{-3})

Results from these tests are used to predict how a soil in the field will deform in response to a change in effective stress.

Triaxial tests

This test measures the mechanical properties of a soil by placing the sample between two parallel platens which apply stress in one (usually vertical) direction, with fluid used to apply a confining pressure in the perpendicular directions. During the test, the surrounding fluid is pressurized, and then stress on the platens is increased until the material in the cylinder fails.

From triaxial test data, it is possible to extract fundamental material parameters, including its angle of shearing resistance, apparent cohesion, and dilatancy angle. These parameters are then used in computer models to predict how the material will behave in a larger-scale engineering application.

Quick (single stage, Unconsolidated, Undrained tests) are most appropriate for foundation design**.** This is because load is applied relatively quickly, and shear strength of the clay will be lowest initially; after the applied load causes some consolidation of the ground (after drainage results in dissipation of short-term excess pore water pressure), the in-situ clays will become progressively stronger and hence the factor of safety will increase. Confining pressure is specified as equivalent to overburden pressure (kNm^{-2}).

Foundations on granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Unconsolidated Undrained triaxial tests are most appropriate for assessment of the stability of fill slopes on clays. Similar to foundations, the application of load gradually increases the strength of the clays and hence the critical case is the short term undrained condition.

Consolidated Undrained (or sometimes **Consolidated Drained**) triaxial tests are most appropriate for assessment of the stability of cut slopes in clays. This is because unloading of the ground leads to short term reduction in pore pressures that approximately balance the unloading, hence the soil strength is largely unchanged. Over time the reduced pore pressures suck water in, which leads in to the progressive increase in pore pressure and loss of strength. The fully drained state is critical, which must be modelled using effective strength parameters and a reasonable estimate of the long term water table conditions.

Slopes formed in granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Determination of analytical suite

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

Common contaminants

Common **Inorganic** Contaminants include:

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

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction. Complex cyanide is "bound" in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to UV digestion for determination of both free and total CN.

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

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO_4), sulphides etc.

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

Common **Organic** Contaminants include hydrocarbons, phenols, and polychlorinated biphenyls.

Petroleum is a mixture of hydrocarbons produced from the distillation of crude oil, and includes aliphatics (alkanes, alkenes and cycloalkanes), aromatics (benzene and derivatives) and hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen. Petroleum hydrocarbons can be grouped based on the carbon number range:

- GRO – Gasoline Range Organics (typically C_6 to C_{10}). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C_{10} to C_{28})
- LRO - Lubricating Oil Range Organics (typically C_{28} to C_{40})
- MRO – Mineral Oil Range Organics (typically C_{18} to C_{44})

However, it should be borne in mind that the terms "GRO" and "DRO" analysis are purely descriptive terms, the exact definition of which varies. Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from C_5-C_{40}, whereas others define TPH as C_{10}-C_{30}.

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

Gasoline contains light aliphatic hydrocarbons (especially within the C_4 to C_5 range) that are volatile. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present. Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar nitrogen, sulphur and oxygen-containing compounds (NSO) compounds are also present. Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

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

Volatile Organic Compounds (VOCs) are organic chemicals, and most are liquids that readily evaporate on exposure to air. Examples include benzene, toluene, xylene, chloroform etc. Semi-Volatile Organic Compounds (sVOCs) include phenol and benzo(a)pyrene, and have relatively low boiling points. Both groups of chemicals are readily absorbed through skin and some, such as benzene, are believed to be linked to tumour growth.

Phenols are compounds that have a hydroxyl group (-OH) attached to an aromatic ring (ie include a benzene ring and an –OH group). Most are colourless solids. A solution of phenol in water is known as carbolic acid, and is a powerful antiseptic. However, phenol vapour is toxic, and skin contact can result in burns.

Polychlorinated Biphenyls (PCBs) were used in pre-1974 transformers as dielectric fluids. PCB's are of increasing toxicity relative to the degree of chlorination. Acute symptoms of PCB poisoning are irritation of the respiratory tract leading to coughing and shortness of breath. Nausea, vomiting and abdominal pain are caused by ingestion of PCB's.

Dioxins and furans (polychlorinated dibenzodioxins and polychlorinated dibenzofurans) are some of the most toxic chemicals known; in the environment, they tend to bio-accumulate in the food chain. Dioxin is a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD.

Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxin in the environment comes from waste-burning incinerators and also from backyard burn-barrels. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process and with the production of Polyvinyl Chloride (PVC) plastics and with the production of certain chlorinated chemicals (like many pesticides).

Methods of analysis (organic compounds)

TPH by GC-FID is an analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C_{10} to C_{40} (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a broad, 'banded' breakdown of the TPH results into gasoline range organics (GRO), diesel range organics (DRO) and heavier lubricating oil range organics (LRO), or fully speciated results with the reporting of hydrocarbon concentrations in 14 specific carbon bandings based upon behavioural characteristics, e.g. aliphatic C_6 to C_8, aromatic C_{10} to C_{12} etc.

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

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

Note: PAHs are hydrocarbons and consequently (where present) will be picked-up when scheduling TPH by GC-FID.

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

Current UK guidance

The UK approach to contaminated land is set out in Contaminated Land Report No. 11 (2004) "Model Procedures for the Management of Land Contamination". The approach is based upon risk assessment, where risk is defined as the combination of the probability of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

In the context of land contamination, there are three essential elements to any risk: (1) a contaminant source; (2) a receptor (eg controlled water or people); and (3) a pathway linking (1) and (2). Risk can only exist where all three elements combine to create a pollutant linkage. Risk assessment requires the formulation of a conceptual model which supports the identification and assessment of pollutant linkages.

Lithos adopt a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate UK guidance levels, Lithos risk-derived screening values, or remedial targets. It should be noted that exceedance of Tier 1 does not necessarily mean that remedial action will be required.

Soil screening values used by Lithos

In March 2002 DEFRA and the Environment Agency published a series of technical papers (R&D Publications CLR 7, 8, 9 and 10) outlining the UK approach to the assessment of risk to human health from land contamination. In 2008 CLR 7, 9 and 10 and all corresponding SGV and Tox reports were withdrawn and superseded by new guidance including:

- Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software Handbook (Version 1.071), Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

The approach set out in these documents represents current scientific knowledge and thinking; and includes the Contaminated Land Exposure Model (CLEAv1.06). The Environment Agency are in the process of using this updated approach to regenerate a selection of Soil Guideline Values (SGVs).

CLEA SGVs were derived for standard land use scenarios predominantly in the context of Part IIA, using a conceptual site model (CSM) defined in SR3. Lithos have incorporated amendments to the CSM used to derive SGVs, that more accurately reflect redevelopment within the planning regime; consequently, Lithos have not adopted any published SGV as a screening value.

The CLEA conceptual site model assumes a source located in a sandy loam, with 6% soil organic matter (SOM) - equivalent to 3.5% total organic carbon (TOC). However, where the average TOC value for a particular soil type is significantly lower than the 3.5%, evaluation of Lithos Screening Values should be undertaken and a site specific risk assessment will usually be required. Other CLEA default characteristics adopted by Lithos are:

Sandy Loam characteristics (source)	Default values adopted
Total porosity (fraction)	0.53
Water filled porosity (fraction)	0.33
Air filled porosity (fraction)	0.2

Lithos have derived Screening Values for four different CSMs (scenarios); these are:

A - Residential with gardens, but no cover (or only up to 300mm)

B - Residential with gardens and 600mm 'clean' cover

C - Residential apartments with landscaping (i.e. no home grown produce)

D - Commercial/industrial with landscaping

E – Importation of soil cover

The **exposure** pathways considered for each scenario are detailed in the table below.

Scenario	Land use	Pathways	Justification
A	Residential with garden, but no cover (or only up to 300mm)	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	Minimal cover – insufficient to break any pathways therefore all exposure pathways are relevant.
B	Residential with garden minimum 600mm cover	• Inhalation of indoor vapours • Inhalation of outdoor vapours	The 600mm cover removes the risk from all pathways other than inhalation.
C	Residential apartments with landscaped areas and minimum 300mm cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. However consumption of home grown produce not included as unlikely to be grown in landscaped areas. Where vegetables are to be grown site specific QRA may be required.
D	Commercial/ industrial with landscaped areas no cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumed the commercial development consists of offices to provide a conservative assessment.
E	Importation of soil for cover in garden and landscaped areas	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of outdoor vapours and dust	Material used as cover to break existing pathways therefore all direct and indirect pathways relevant; however cover is **not** placed below plots therefore indoor inhalation is not relevant.

Lithos have assumed the source of contamination is directly below the building foundations; i.e. a depth to source of 0.15m as opposed to the CLEA default of 0.65m. This assumption provides for a more conservative approach than the UK default. This adjustment has been included to account for sites where made ground is re-engineered to enable new buildings to be established on raft foundations. In such situations contamination may lie directly beneath the foundation.

The Soil Screening Values referred to in this document are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part IIA of the Environment Protection Act 1990;
- End uses such as allotments, sports fields, children's playgrounds, care homes, hospitals etc; and
- Controlled waters.

In December 2013 Defra published the results of research project SP1010 – Development of Category 4 Screening Levels (C4SLs) for Assessment of Land Affected by Contamination. The objective of this project was provide technical guidance in support of Defra's revised Statutory Guidance for Part 2A of the Environmental Protection Act 1990 (Part 2A). The revised Statutory Guidance, published in April 2012, introduced a new four-category system for classifying land under Part 2A where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low. Project SP1010 aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- Demonstration of the methodology, via derivation of C4SLs for 6 substances – arsenic, cadmium, chromium IV, lead, benzene & benzo(a)pyrene.

The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology. Development of C4SLs has been achieved by modifying the toxicological and \ or exposure parameters used within CLEA (while maintaining current exposure parameters).

The Part 2A Statutory Guidance was developed on the basis that C4SLs could be used under the planning regime. However, policy responsibility for the National Planning Policy Framework falls to the Department for Communities and Local Government. Defra anticipate that, where they exist, C4SLs will be used as generic screening criteria, and Lithos consider C4SLs to be suitable for use as Tier 1 Screening Values. Lithos have discussed this matter with both NHBC and YAHPAC (collection of Yorkshire & Humberside local authorities) and received confirmation that they are satisfied with this approach.

With respect to **inorganic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Inorganic contaminant	Tier 1 assessment criteria (mg/kg) for Scenarios A to D							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
As	32	37	37	Use (A) in SI Report for initial "screen". If >5 x A, then consider increase of cover to 1,000mm	40	640	37	C4SL adopted
Cd	10	26	26		149	410	26	C4SL adopted
Cr			3,000		3,000	30,000	3,000	Assumes Cr is CrIII
Pb	450	200	200		310	2,330	200	C4SL adopted
Ni	130		127		127	1,700	127	Assessment of health risk only
Se	350		350		595	13,000	434	
Hg	170		169		238	3,640	199	Assumes in an inorganic compound
B			5		5	5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu			80-200		80-200	80-200	80-200	
Zn			200		200	200	200	

With respect to **organic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to D							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
Benzene	0.33	0.87	0.9	0.9	3.3	98	N/A	C4SL adopted
Toluene	610		600	3,000	2,700	5,000	N/A	Calculated value over 10,000
Ethyl Benzene	350		350	932	843	5,000	N/A	
Xylenes	240		246	327	321	5,000	N/A	
Phenol	420		412	2,400	519	5,000	N/A	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo(a)pyrene		5	5	25	5.3	76	5	C4SL adopted. Where source is not a coal tar
Naphthalene			8	9	9	1,000	12	
Gasoline Range Organics			30	34	34	5,000	45	See 3-step assessment of TPH below
Diesel Range Organics			151	156	154	5,000	219	
Lubricating Range Org			1,000	5,000	2,000	5,000	1,000	

* *For a residential end use*

The significance of PAHs can be determined by considering indicator compounds. In most cases benzo(a)pyrene (BaP) is adopted as an indicator due to the amount of toxicological data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. A surrogate marker approach can be used to estimate the toxicity of a mixture of PAHs in soil using toxicity data for individual indicator compounds within that mixture. Exposure to the surrogate marker is assumed to represent exposure to all PAHs in that matrix. The surrogate marker approach relies on a number of assumptions:

- Surrogate marker (bap) must be present in all soil samples
- Profile of the different pah relative to bap should be similar in all samples
- PAH profile in the soil samples should be similar to that used in the pivotal toxicity study[1]

[1] SP1010 Appendix E, Provisional C4SIs for benzo(a)pyrene as a surrogate marker for PAHs, CL:AIRE 2013

To assess the PAH profile in a soil sample, the ratio of the seven genotoxic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene), relative to BaP, should be calculated. The ratio relative to BaP should lie within an order of magnitude above and below the mean ratio to BaP.

Naphthalene should also be considered separately against its generic screen. Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than most other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach.

Similarly, **TPH** cannot be assessed as a single "total" value, and reference has been made to the Environment Agency's document P5-080/TR3, "The UK approach for evaluating human health risks from petroleum hydrocarbons in soils". This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down "TPH" into representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the bandings.

The significance of speciated TPH results can be assessed by following the 3 steps outlined in the tables below.

Step	Result	Action
1. Consider indicator compounds: Are BTEX, naphthalene, benzo(a)pyrene above their respective Tier 1 values?	Yes	Remediation or dQRA required
	No	Proceed to Step 2
2. Consider individual TPH fractions: are they above respective screening values?	Yes	Remediation or dQRA required
	No	Proceed to Step 3
3. Assess Cumulative effects: Is the calculated Hazard Index for each source >1	Yes	Remediation or dQRA required
	No	TPH compounds pose no significant risk

Step 1 - Assessing indicator compounds

TPH fraction Indicator compound	End use specific screening value (mg/kg)			
	A: Residential no cover	B: Residential with 600mm cover	C: Residential no gardens	D: Commercial\ industrial
Benzene	0.9	0.9	3.3	98
Toluene	600	3,000	2,700	5,000
Ethyl Benzene	350	932	843	5,000
Xylenes	246	327	321	5,000
Naphthalene	8	9	9	1,000
Benzo(a)pyrene	5	25	5.3	76

Step 2 - Assessing individual TPH fractions

TPH fraction		End use specific screening value (mg/kg)			
		A: Residential no cover	B: Residential with 600mm cover	C: Residential with no gardens	D: Commercial/ industrial
Aliphatic 5-6	GRO	41	41	42	5,000^ per fraction
Aliphatic 6-8	GRO	125	125	125	
Aliphatic 8-10	GRO	31	31	32	
Aliphatic 10-12	DRO	151	156	154	
Aliphatic 12-16	DRO	500^	500^	500^	
Aliphatic 16-21	DRO	1,000^	5,000#	1,000^	
Aliphatic 21-35	LRO	1,000^	5,000#	1,000^	
Aromatic 5-7	GRO	100	123	122	
Aromatic 7-8	GRO	30	34	34	
Aromatic 8-10	GRO	47	50	50	
Aromatic 10-12	DRO	215	287	266	
Aromatic 12-16	DRO	689	1,000*	1,000*	
Aromatic 16-21	DRO	1,000^	5,000#	1,000^	
Aromatic 21-35	LRO	1,000^	5,000#	1,000^	

* Calculated Screening Value exceeded soil saturation limit and could indicate free product, therefore calculated soil saturation limit adopted as a target

^ Calculated Screening Value close to soil saturation limit, screening value selected by Lithos considering visual and olfactory impacts.

Five times the screening value for Scenario A.

Step 3 - Assessing Cumulative Effects

$$HI = \sum_{F_i=1}^{16} HQ\ F_i = \frac{Measured\ concentration\ F_i\ (mg\,kg^{-1})}{SGV\ F_i\ (mg\,kg^{-1})}$$

where HI = Hazard Index
HQ = Hazard Quotient
F_i = Fraction $_i$
SGV = Soil Guideline Value

Other screening values used by Lithos

Tier 1 risk assessment of **hazardous gas** is undertaken through reference to the following documents (and further information is presented in Generic Note No. 5 – Hazardous Gas):

- Approved Document C, Building Regulations 2000
- Boyle & Witherington (2007) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2015 – Code of Practice for the characterisation & remediation from ground gas in affected developments

With respect to the assessment of potential **phytotoxic effects** of contaminants, Lithos refer to "The Soil Code" (MAFF, 1998) for copper and zinc. The CLEA SGV is adopted for nickel due to its human health effects.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, 'Concrete in aggressive ground', 2005.

With respect to the interpretation of the **calorific values**, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that: *"In general … it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn"*.

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate or groundwater concentrations with the appropriate water quality standard. Tier 1 Screening Values have been discussed with the Environment Agency, and typically those in **bold** below are adopted.

Analyte	Source of Tier 1 Screening Value (µg/l)			
	Surface water (Abstraction for drinking) 1996	Water Supply Regulations 2000	Water Framework Directive	EA Advice
Arsenic	50	10	**50**	
Selenium	10	**10**		
Cadmium	5	5	**1.5**	
Chromium	50	50	**32**	
Copper	50	2,000	**28**	
Lead	50	10	**7.2**	
Nickel		20	**20**	
Zinc	3,000		**125**	
Boron		**1,000**		
Mercury	1	1	**0.07**	
Petroleum Hydrocarbons				**10**
1,1,1-Trichloroethane			**100**	
1,1 Dichloroethane				**100**
1,2-Dichloroethane		3	**10**	
1,1-Dichloroethene				**100**
Benzene		1	**10**	
Ethylbenzene				**10**
Tetrachloroethene		10	**10**	
Toluene			**50**	
Trichloroethene		10	**10**	
Vinyl Chloride		**0.5**		
Trichloromethane			**2.5**	
Xylenes			**30**	
Chloroethane				**100**

Waste classification & WAC

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

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

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

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

Lithos typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated, for example where redevelopment proposals include basement construction etc. If off-site disposal of soils classified as hazardous waste during redevelopment is anticipated, then WAC analysis should be scheduled at an early stage in the remediation programme. However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous, and these contaminants can often be dealt with by alternative technologies (eg by bioremediation or stabilisation) and consequently retention on site is often possible.

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

Possible action in event of Tier 1 exceedance

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

1. Undertake further statistical analysis following the approach set out in "*Guidance on Comparing Soil Contamination Data* with *a Critical Concentration - CL:AIRE and CIEH, May 2008*" in order to determine whether contaminant concentrations of inorganic contaminants within soil \ fill actually present a risk (only applicable to assessing the risk to human health).
2. Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.
3. Based on a qualitative risk assessment, advocate an appropriate level of remediation to "break" the pollutant linkage - for example the removal of the contaminated materials or the provision of a clean cover.

Prior to undertaking any statistical analysis the issue of the **averaging area** requires further consideration. The CL:AIRE \ CIEH document still refers to CLR 7, which suggests averaging area should reflect receptor behaviour and therefore might be a single garden, or an open area used by the local community as a play area. This approach to averaging areas is considered applicable within the context of Part IIA of the Environmental Protection Act (EPA) 1990, in terms of an existing residential development.

However, Lithos consider the concept of a single garden as an averaging area to be inappropriate with respect to brownfield redevelopment, which is regulated by the planning regime. In this context, contamination across the entire site needs to be characterised by reference to the Conceptual Site Model. Consequently, Lithos gather and analyse sample results by fill type, and \ or by former use in a given sub-area of the site, before undertaking statistical analysis; ie the averaging area is associated with the extent of a particular fill type, or an area affected by spillage \ leakage.

In terms of brownfield redevelopment, this is considered a more appropriate methodology which provides a more representative sample population for statistical analysis. As such the entire site is considered in terms of the proposed end use, be this residential with, or without gardens.

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

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

05 – Hazardous gas
Generic notes – geoenvironmental investigations

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency). In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 01 – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark Information Group, the Environment Agency and the Local Authority and the British Geological Survey. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

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

Sources

Potential sources of hazardous gas include:

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

Generation

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

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

Migration

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

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

Gas monitoring procedure

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

- Atmospheric temperature, pressure and ambient oxygen concentration
- Gas emission rate
- Methane, oxygen and carbon dioxide concentrations using an infra-red gas analyser
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism. Where samples of gas are required for laboratory analysis, Gresham Tubes or multi-layer Tedlar / ALTEF sampling bags are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Current guidance

CIRIA Report 151 (1995)[i] identified that there was inadequate guidance on trigger concentrations for ground gases. CIRIA concluded that the most important aspect of a gas regime below or adjacent to a site was the surface emission rate, i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. CIRIA Report C665 (2007)[ii] advocates two methodologies for characterising sites:

A – All developments except low rise housing. The advocated methodology is that proposed by Wilson & Card, 1999[iii]

B – Low rise housing. An alternative (traffic light) methodology, derived by Boyle and Witherington, 2006[iv] for NHBC

Both methodologies refer to Gas Screening Values (GSV); previously referred to as limiting borehole gas volume flow.

A – All developments except low rise housing

(Wilson & Card, 1999)[v] revised Table 28 of CIRIA 149[v] in terms of borehole gas volume flow rate (now GSV) in order to achieve a more consistent design of protection measures. This was done to reflect the importance of recognising the gas surface emission rate. Wilson & Card then developed a method for classifying gassing sites (Table 1 below), which took into account the combined gas concentration and GSV.

Characteristic Situation	Gas Screening Value, CH_4 or CO_2 (l/hr)	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% v/v and carbon dioxide not to exceed 5% v/v	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70 litre/hr otherwise increase to Characteristic Situation 3	Natural soil, high peat/organic content
3	<3.5		Old landfill, inert waste, mineworkings flooded.
4	<15	Quantitative Risk Assessment required to evaluate scope of protection measures.	Mineworkings – susceptible to flooding, completed landfill, inert waste
5	<70		Mineworkings unflooded, inactive
6	>70		Recent landfill site

Notes: Borehole flow rate = volume of gas (regardless of composition) which is escaping from well (l/hr). Gas Screening Value (litre/hour) = gas concentration (%) / 100 x borehole flow rate (l/hr). To facilitate design implementation, the limiting values for both methane and carbon dioxide are identical.

B – Low rise housing.

NHBC have developed a characterisation system similar to that of Wilson & Card above, but specific to low-rise housing development (Boyle and Witherington) (Table 8.7). This approach compares measured gas emission rates with generic "Traffic Lights". The Traffic Lights include "Typical Maximum Concentrations" for initial screening, and risk-based Gas Screening Values (GSVs) for consideration of situations where the Typical Maximum Concentrations are exceeded. Calculations are carried out for both methane and carbon dioxide and the worst case adopted in order to establish the appropriate protection measures.

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light Classification	Methane [1]		Carbon Dioxide [1]	
	Typical Maximum Concentration [5] (%v/v)	Gas Screening Value [2,4,6] (l/hr)	Typical Maximum Concentration [5] (%v/v)	Gas Screening Value [2,3,4,6] (l/hr)
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.13
Red				

Notes:

1. The worst gas-regime identified at the site, either methane or carbon dioxide, recorded from monitoring in the worst temporal conditions, will be the decider for which Traffic Light and GSV is allocated.
2. Generic GSVs are based on guidance contained within "The Building Regulations: Approved Document C" (2004) and assume a sub-floor void of 150 mm thickness.
3. A leak of gas from the sub-floor void into a small room (e.g. downstairs toilet with soil pipe potentially passing into sub-floor void) of dimensions 1.50m × 1.50m × 2.50m, with a total room volume of 5.63m^3 has been considered.
4. The GSV, in litres per hour, is as defined in Wilson and Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.
5. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgment will be required, based on a thorough understanding of the gas regime identified at the site where monitoring in the worst temporal conditions has occurred.
6. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

---

i *Harries CR, Witherington PJ and McEntee JM (1995). Interpreting measurements of gas in the ground. CIRIA Report 151*

ii *CIRIA (2007) – Assessing risks posed by hazardous ground gases to buildings.*

iii *Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.*

iv *Boyle & Witherington (2006) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC*

v *Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.*

06 - Soakaways
Generic notes – geoenvironmental investigations

Background

Soakaways have been the traditional way to dispose of stormwater from buildings and paved areas remote from a public sewer or watercourse. In recent years, soakaways have been used within urban, fully-sewered areas to limit the impact on discharge of new upstream building works, and to avoid costs of sewer up-grading outside a development.

Soakaways are increasingly seen as a more widely applicable option alongside other means of stormwater control and disposal. Soakaways must store the immediate stormwater run-off and allow for its efficient infiltration into the adjacent soil. They must discharge their stored water sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent storm. The time taken for discharge depends upon the soakaway shape and size, and the surrounding soil's infiltration characteristics. Soakaways can be constructed in many different forms and from a range of materials.

BRE Digest 365, DG365: 1991 describes design and construction procedures, explains how to calculate rainfall design values and soil infiltration rates, and gives design examples. Further advice is provided in **NHBC** Standards Chapter 5.3 (Section 9 & Appendix F), **Building Regulations** Section 3 of Approved Document H (Drainage & Waste Disposal), and Chapter 13 of **CIRIA**'s SUDS Manual (C753:2015).

Soakaways should generally be built on land lower than or sloping away from buildings and be sited **at least 5m** from the foundations of a building.

BRE365 states that '**Groundwater should not rise to the level of the base of the soakaway** during annual variations in the water table' this is further reinforced in Chapter 13 of CIRIA C753:2015 which states that: "*A minimum distance of 1m between the base of the infiltration system and the maximum likely groundwater level should always be adopted. This is to minimise the risk of groundwater rising into the infiltration component and reducing the available storage volume, to protect the functionality of the infiltration process by ensuring a sufficient depth of unsaturated material and to protect the groundwater from any contamination in the run-off*". There may be a requirement to install groundwater monitoring wells at a site in order to monitor seasonal variations in groundwater level at least over a wet winter period.

Soakaways should **not be sited on sloping sites**, an assessment should also be made to ensure that infiltrating water will not cause a rise in groundwater levels, waterlogging of downhill areas or springs, and that slopes are not made unstable.

Made ground (and ground within 5m of deep fill) is not generally regarded as suitable for soakaways, due to the potential for inundation settlement and the leaching of contaminants.

Chalk: CIRIA C574:2002 notes that concentrated ingress of water into the chalk can initiate dissolution, particularly in low-density chalk. For this reason, soakaways should be sited well away from foundations for structures, roads or railways:-

- in areas where dissolution features are known to be prevalent, soakaways should be avoided but, if unavoidable, should be sited at least 20m away from foundations etc
- where the chalk is of low density (weak), or where density is not known, soakaways should be sited at least 10m away from foundations
- where the chalk is of medium density, or higher (moderately weak), soakaways should be sited at least 5m away from foundations

Test methodology

Lithos undertake soakaway tests in general accordance with BRE Digest 365 "Soakaway Design". The BRE Digest recommends that each soakaway pit is filled and allowed to drain three times to near empty; the three fillings to be on the same or consecutive days. However, each test can take over 2 hours to complete and therefore pits are often only filled and allowed to drain on one occasion, due to the time constraints imposed on the investigation

Three filling\drainage cycles are more important where drainage is primarily via fissures, most notably within a rock mass. Initial drainage within the rock mass may be high, as the fissures fill with water, giving the impression (if only one cycle is undertaken) that soakaways would be a suitable drainage solution. If infiltration through the matrix of the rock is low, then drainage from the test pit becomes slow as the fissures become saturated.

For non-fissile, granular soils infiltration is via the matrix, and consequently one filling\drainage cycle is generally considered sufficient. Soakaway pits are typically excavated to a depth of about 2.5m using a mechanical excavator equipped with a 0.3m wide bucket. The soakaway test pits are rapidly filled with water to the top of the test section. The fall in water level is then monitored at regular intervals.

Infiltration rates

Infiltration rates for each soakaway test are calculated (where possible) in accordance with BRE Digest 365. This design takes into account the time of emptying the soakaway pit between 25% and 75% of its effective depth. The effective depth is calculated from the starting water level to the soakaway pit base. Where the water level did not fall to 25% effective depth, the data was interpolated in order to obtain a representative infiltration rate.

Soakaway design

Soakaway design should be carried out by a suitably qualified and experienced Drainage Engineer, in accordance with BRE Digest 365 using the infiltration rates calculated from soakaway testing during a ground investigation.

It is generally assumed that soakaways become impracticable on residential developments when:

- A chamber type design requires a square pit with side length in excess of 1.8m, or an effective depth greater than 1.5m.
- A trench type design requires a length greater than about 10m, or an effective depth greater than 1.5m.

Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

- Standing groundwater level
- Depth to base of permeable strata
- Cost of excavation

Soakaway percolation in some rock types is predominately via the vertical joints within the rock mass. The relatively small-scale soakaway test pits may not intercept such joints and this can result in variable test results. However, it is likely that the larger surface area of a completed soakaway within the development will intercept such joints.

Appendix B

Drawings

Reproduced from OS Explorer map 1:25,000 scale by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office. Crown copyright. All rights reserved. Licence number 100049696.

LITHOS CONSULTING
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Tel 01937 545330

CLIENT	ROUSE HOMES
JOB TITLE	EAST BIERLEY
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	JBR
DATE	29/11/2018
CHECKED	MJT
DATE	29/11/2018
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
SCALE	1:25,000
SHEET	A4
DRAWING NO.	3233/1
REVISION	

NOTES

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM ROUSE HOMES DRAWING REFERENCE SK01, DATED SEPTEMBER 2018

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

EAST BIERLEY

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
JBR	29/11/2018	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	29/11/2018	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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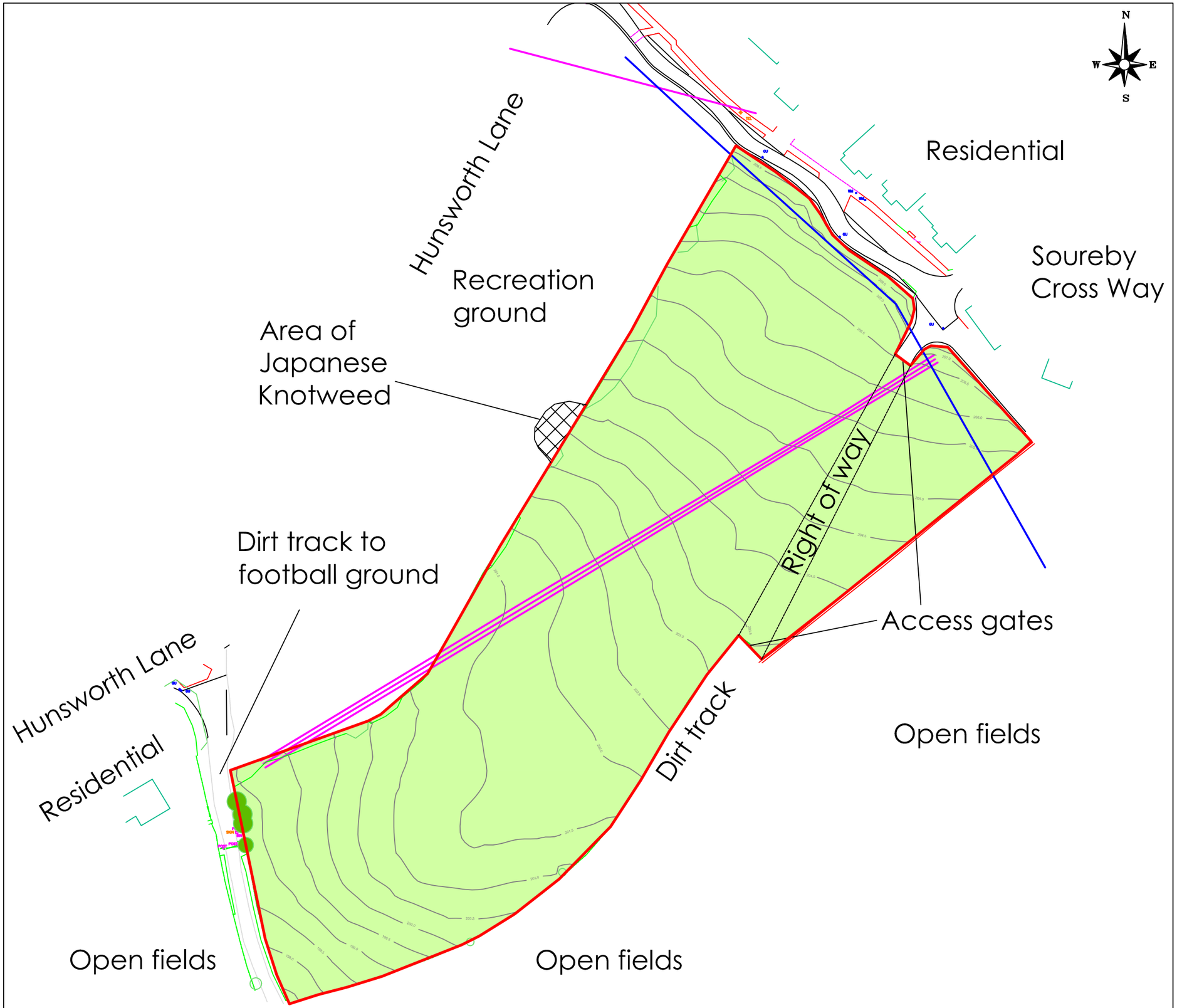

NOTES

- GRASS & OVERGROWN AREAS
- AREA OF JAPANESE KNOTWEED
- APPROXIMATE LINE OF OVERHEAD ELECTRICITY UTILITY
- APPROXIMATE LINE OF WATER UTILITY

NOTE THAT UTILITY LOCATIONS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION PURPOSES, NOR SHOULD IT BE ASSUMED THAT ALL UTILITIES BENEATH THE SITE ARE SHOWN ON THIS PLAN. THERE MAY BE UTILITIES UNKNOWN TO LITHOS. THIS DRAWING IS NOT AN ALTERNATIVE TO VISUAL INSPECTION, USE OF A CAT DETECTION TOOL AND CAREFUL EXCAVATION.

- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

EAST BIERLEY

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
JBR	29/11/2018	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	29/11/2018	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	3233/3	

N
W E
S

NOTES

GRASS & OVERGROWN AREAS

APPROXIMATE SITE BOUNDARY

LOCATION & ORIENTATION OF PHOTOGRAPH

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

EAST BIERLEY

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
JBR	29/11/2018	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	29/11/2018	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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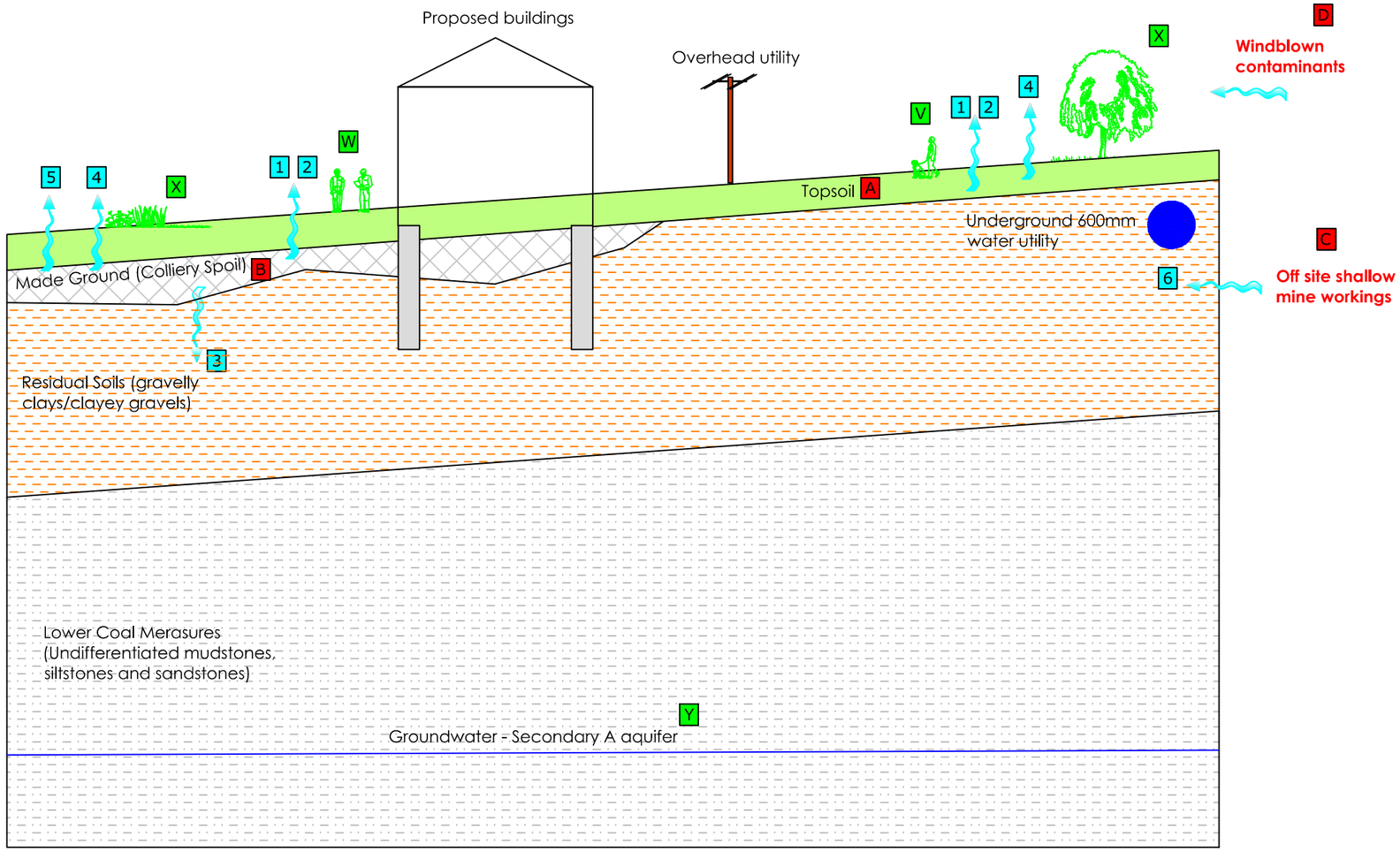

SOURCES	
A	TOPSOIL (INORGANICS)
B	MADE GROUND (INORGANICS AND ORGANICS)
C	OFF SITE SHALLOW MINE WORKINGS (HAZARDOUS GAS)
D	WINDBLOWN CONTAMINANTS (INORGANICS)

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION/INHALATION
3	LEACHING OF CONTAMINANTS
4	UPTAKE BY PLANTS
5	VOLATILISATION
6	MIGRATION OF GAS

RECEPTORS	
V	END USERS (RESIDENTS)
W	SITE WORKERS
X	VEGETATION
Y	GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

EAST BIERLEY

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
JBR	29/11/2018	FOR COMMENT ☐
		FOR APPROVAL ☐
		DRAFT ☐
CHECKED	DATE	FINAL ☑
MJT	29/11/2018	

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	3233/5	

NOTES

- TRIAL PIT LOCATION
- SOAKWAY PIT LOCATION
- WINDOW SAMPLE LOCATION
- PROBEHOLE LOCATION
- LINE OF ELECTRICITY UTILITY
- LINE OF WATER UTILITY

NOTE THAT UTILITY LOCATIONS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION PURPOSES, NOR SHOULD IT BE ASSUMED THAT ALL UTILITIES BENEATH THE SITE ARE SHOWN ON THIS PLAN. THERE MAY BE UTILITIES UNKNOWN TO LITHOS. THIS DRAWING IS NOT AN ALTERNATIVE TO VISUAL INSPECTION, USE OF A CAT DETECTION TOOL AND CAREFUL EXCAVATION.

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

EAST BIERLEY

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
JBR	05/12/2018	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	05/12/2018	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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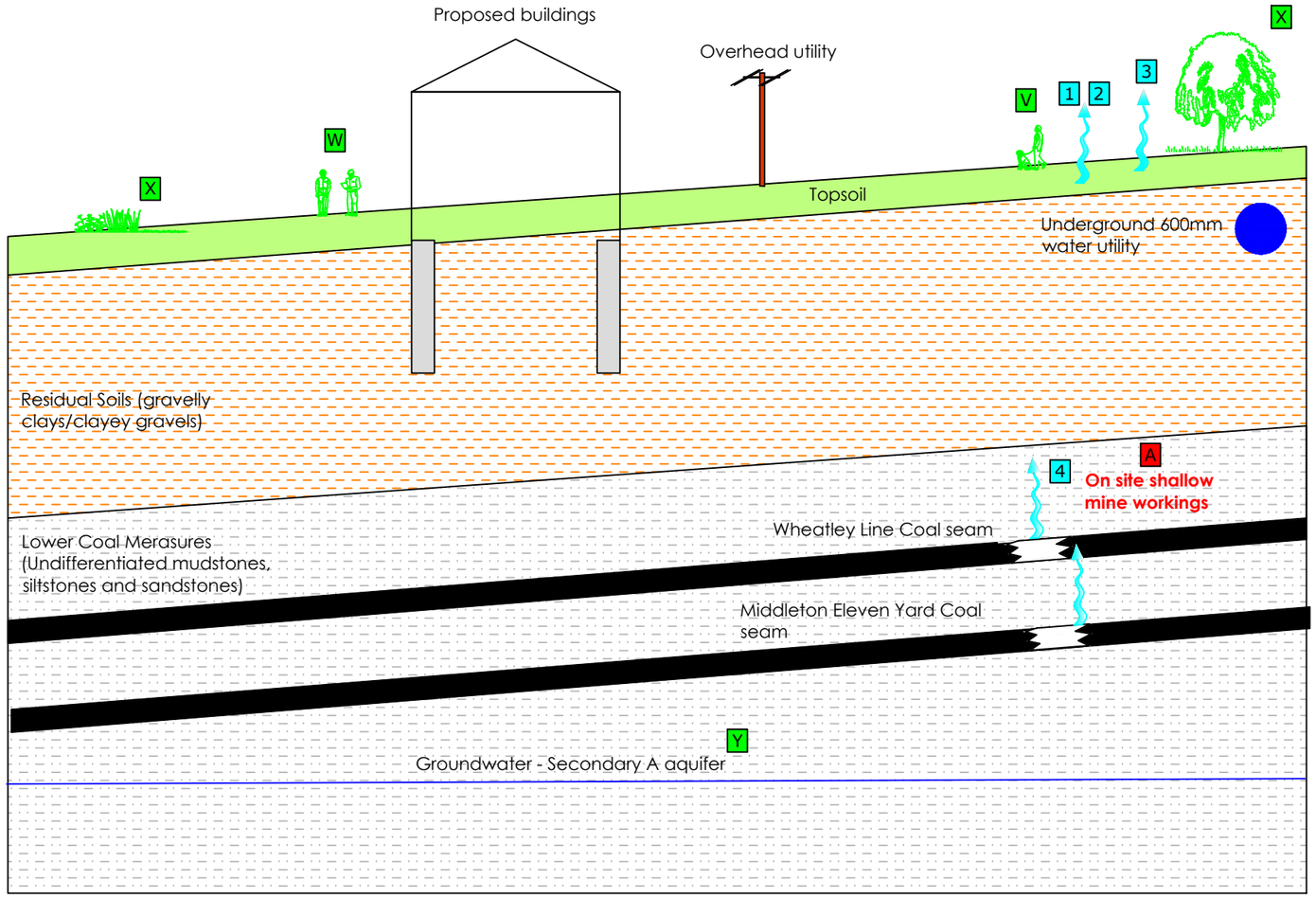

SOURCES	
A	ON SITE SHALLOW MINE WORKINGS (HAZARDOUS GAS)

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION/INHALATION
3	UPTAKE BY PLANTS
4	MIGRATION OF GAS

RECEPTORS	
V	END USERS (RESIDENTS)
W	SITE WORKERS
X	VEGETATION
Y	GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

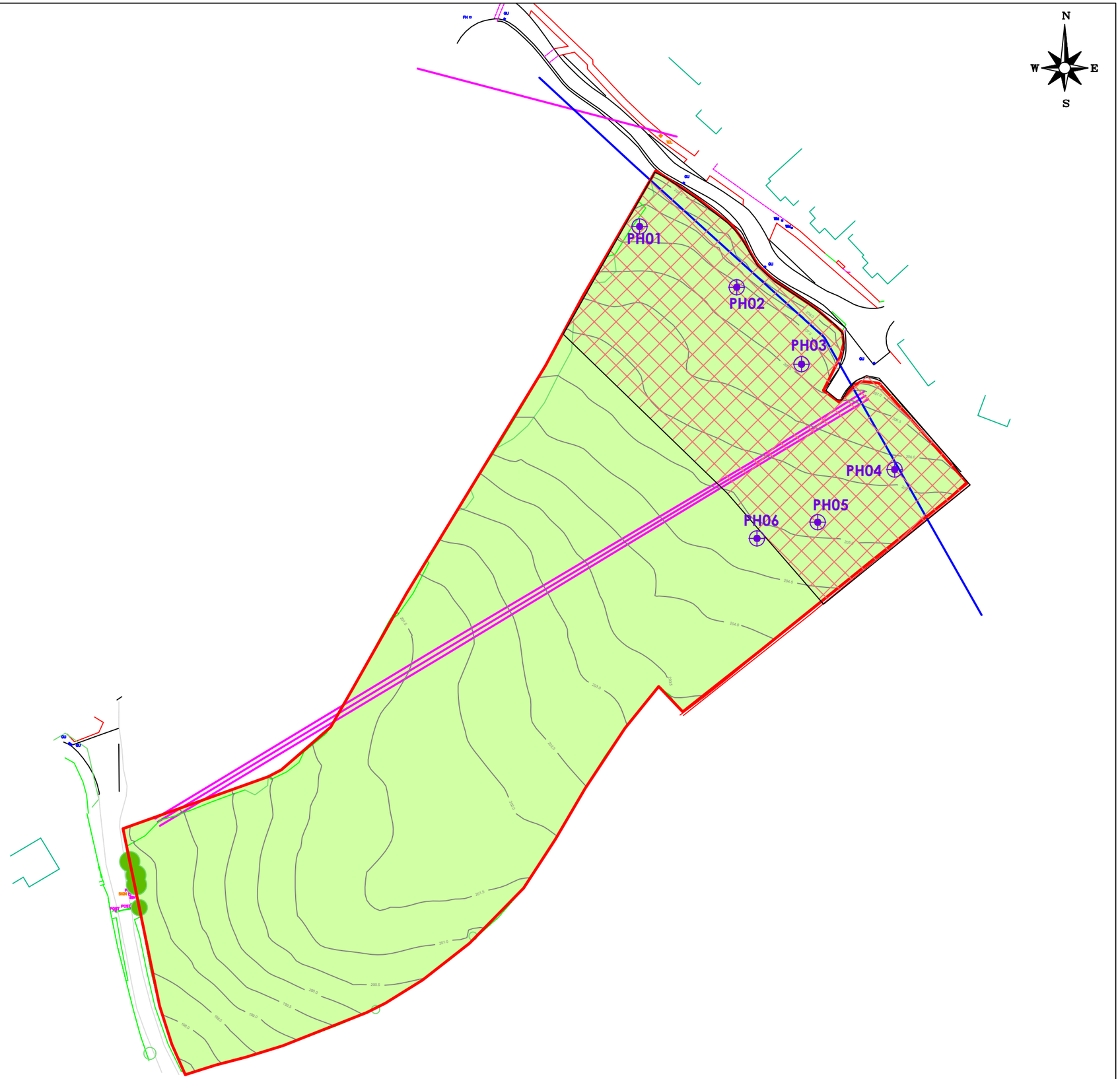
EAST BIERLEY

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
JBR	18/02/2019	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	18/02/2019	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	3233/7	



NOTES

- PROBEHOLE LOCATION
- PROPOSED AREA FOR DRILLING AND GROUTING
- LINE OF ELECTRICITY UTILITY
- LINE OF WATER UTILITY

NOTE THAT UTILITY LOCATIONS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION PURPOSES, NOR SHOULD IT BE ASSUMED THAT ALL UTILITIES BENEATH THE SITE ARE SHOWN ON THIS PLAN. THERE MAY BE UTILITIES UNKNOWN TO LITHOS. THIS DRAWING IS NOT AN ALTERNATIVE TO VISUAL INSPECTION, USE OF A CAT DETECTION TOOL AND CAREFUL EXCAVATION.

REV.	DESCRIPTION	DATE

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CLIENT

ROUSE HOMES

JOB TITLE

EAST BIERLEY

DRAWING TITLE

DRILLING & GROUTING LOCATION PLAN

DRAWN	DATE	STATUS
JBR	22/02/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	22/02/19	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	3233/8	

Appendix C

Commission

002/3233/REG

16th October 2018

Mr A Spiers
Rouse Homes Ltd
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LS12 3AL

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Dear Andrew

East Bierley

Further to your recent invitation, please find attached our proposal for undertaking a site investigation on the above land. We understand that your proposed development will include traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; a sketch layout showing 43 units has been provided.

Review of the information supplied suggests that the site consists of a single parcel of land of approximately 1.8 hectares between Soureby Cross Way and Hunsworth Way. Review of the Curtins Desk Study, and our own research suggests the site:

- Appears to have remained undeveloped throughout its history.
- Is not located within 250m of a known landfill site.
- Is not within a groundwater source protection zone.
- Is underlain by Coal Measures bedrock, overlain by a veneer of residual soil (firm clays).
- Is located within a Coal Mining Development Low Risk Area (within the defined coalfield, but no known defined risks have been recorded by the Coal Authority; there may still be unrecorded issues). However, adjacent land to the north is classed as a High Risk Area.

It is understood that Rouse might obtain the benefit of reliance on data within the Curtins report. If this is likely, we will not obtain 'new' environmental search data from Landmark or a Consultant's mining report from the Coal Authority, resulting in a saving of £ on Item A.

BGS exploratory hole logs suggest bedrock is likely to be encountered from depths of around 2m, and comprise mudstone and/or sandstone.

The scope of works outlined in this letter should enable us to assess abnormal development issues, associated with ground. However, the nature of site investigation is such that it is not always possible to foresee all the potential issues. Consequently, it is sometimes necessary to recommend additional work, but where this occurs we will inform you immediately, provide costs, and seek your further instruction.

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, CLR11 etc). Our Report may not be fully compliant with Eurocode 7 (EC7) and will not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. Our ground appraisal is intended to assist others as they proceed with design of the proposed development.

Quality Assured ACL Avalon Certification ISO 9001 UKAS MANAGEMENT SYSTEMS 4565
CHAS Accredited Contractor www.chas.gov.uk
CQMS Safety Scheme
Constructionline A UK GOVERNMENT CERTIFICATION SERVICE
AGS Association of Geotechnical & Geoenvironmental Specialists

This proposal allows for the following works:

Desk study: Environmental search data and historical maps (obtained from Landmark or Groundsure), will be reviewed in order to determine whether past land uses have had any effect on the proposed development. In addition, published geological plans of the area will be examined.

We will also visit site to undertake a walkover survey.

We will complete a more detailed review of the Curtins report and obtain 'new' environmental search data and a Consultant's mining report (TBC).

Fieldwork: We have allowed for a day's trial pitting and a day's dynamic sampling using a mini percussion drilling rig. All trial pits and boreholes will be supervised and logged by an experienced geoenvironmental engineer.

We understand that Rouse are able to supply a mechanical excavator, with driver/fuel, and equipped with a breaker to enable excavation where necessary in bedrock (for soakaway tests).

Soakaway testing will also be carried out in at least 5 pits in order to assess suitability of the ground for house and highway surface water drainage.

In line with current UK guidance, (most notably BRE365 and CIRIA C697:2007) soakaways should not be advocated where the seasonally high groundwater table lies within 1m of the soakaway base. Consequently, if the initial soakaway tests yield satisfactory results, it will be necessary to install groundwater monitoring wells to depths of around 5m in at least 3 boreholes. Given the anticipated depth to bedrock, these boreholes might need to be advanced by rotary probing. The wells should then be monitored on at least 6 occasions over about a year.

Representative soil samples of natural and man-made ground, including any contaminated samples, will be taken during the works. In-situ shear strengths of any cohesive soils encountered will be determined by the use of a hand-held shear vane.

We will make every effort to compact arisings and 'sweep' them over each pit. However, you should be aware that on completion of the investigation, "graves" of spoil (each about 3m long by 1m wide) unsuitable for trafficking, will be left up to 400mm proud at each trial pit location. At this stage, no allowance has been made for any further reinstatement such as removal of excess arisings, replacement of turf.

If the pitting encounters significant thicknesses of made ground or very soft/loose deposits (neither considered likely), boreholes may be required to obtain geotechnical data from greater depth. We will advise you of any need for boreholes within 2 days of completion of the pitting.

This investigation should yield sufficient data to enable a foundation zoning plan, and possibly a detailed Foundation Schedule. However, if ground conditions are found to be more variable than anticipated, a 'tighter' grid of pits will be necessary prior to preparation of a detailed Foundation Schedule. This proposal does not allow for the preparation of a detailed Foundation Schedule, but we will provide a quote on completion of the site investigation if requested.

At this stage, given the likely presence of shallow mineworkings beneath adjacent land to the north (and in line with Curtins' recommendations), we have allowed for the installation of wells in 6 boreholes and monitoring for hazardous gas (and any shallow groundwater).

The generation potential of this gas source is considered likely to be Very Low. Therefore, in accordance with CIRIA Report C665, we have initially allowed for 6 visits over a 3-month period. A hazardous gas risk assessment will be issued on completion of monitoring.

An alternative approach would be to adopt simple gas measures in all new build (i.e. a vented sub-floor void and lapped/sealed membrane); this would negate the need for Items D & H within the

attached breakdown. However, the local authority might not accept this approach, and insist on a period (min. 3 months) of gas monitoring.

This proposal has been put together without a visit to the site and it has been assumed that access is available for a JCB-type excavator.

Testing: This will comprise routine geotechnical soils analysis, including 10 moisture content & Atterberg limits, and 10 pH & water-soluble sulphate.

This site is greenfield and therefore we could obtain in-situ CBR values from plate tests on site. However, at this stage routes, formation level and total length, of proposed estate roads are unknown. Consequently, we will simply estimate CBR values from strata descriptions and classification test results.

The site is understood to be essentially Greenfield, and therefore testing of potentially contaminated samples should only be required if made ground is encountered in the exploratory holes. However, we have allowed for analysis of topsoil (6 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH. If required, visible contaminants, sharps and the clay/sand/silt content of topsoil samples could be determined to check compliance with BS3882 requirements at a cost of £ per sample.

Within in our proposal we have allowed for the screening (ID) of 6 samples for asbestos. In the event that positive IDs are reported, it is likely that we will need to schedule further analysis (asbestos quantification), in order to determine the significance of the results. Asbestos quantification is currently a relatively expensive test and consequently we have not allowed for it at this stage. We will inform you immediately after receipt of results if we consider asbestos quantification is required.

Reporting & timescales: In order to provide you with sufficient information to enable assessment of abnormal costs at the earliest opportunity we will issue a concise overview report within 3 days of fieldwork completion.

On completion of the desk study, fieldwork and laboratory testing a comprehensive bound, factual and interpretative report will be issued. This will contain detailed engineering records, laboratory test results, copies of all relevant correspondence and drawings of the site. The report will include qualitative risk assessment with respect to both controlled waters and human health. The report will also include consideration of foundation types.

Fieldwork could be commenced within 3 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion. This report will comment on issues associated with hazardous gas, but the gas risk assessment will not be issued until monitoring is completed.

A copy of the final report will be issued to the relevant regulatory authorities on receipt of written instruction from yourselves.

Invoicing: The attached proposal provides a breakdown of the costs associated with this project. This breakdown is for information only and the proposal can be regarded as a lump sum price of £ plus VAT. Variation will only occur in the event that a given item is not undertaken or that substantial additional works are recommended, in which case we will inform you immediately, provide costs for the required works, and seek your prior consent.

Our proposal allows for submission of the report to the Local Authority and NHBC, and for submission of a single piece of subsequent correspondence with each regulator to address any queries they may have. Any further meetings, correspondence etc, would be chargeable.

We will submit invoices for this project on completion of each Item(s) instructed.

Health, safety & welfare: The works outlined above will be carried out in accordance with Lithos' task- and site- specific Risk Assessments and Method Statements.

Details of welfare will be included within the Method Statements, however, this investigation is expected to be completed within a working day and therefore it is not considered reasonably practicable to provide formal welfare facilities, and our proposal makes no allowance for so doing.

Utility plans are required in order to protect operatives from the hazards associated with striking buried services and avoid potentially substantial disruption\repair costs. We will make every effort not to damage any services (including review of utility plans and use of a CAT detector). However, Lithos cannot accept liability for damage to any underground services that are not accurately marked on plans made available to us prior to commencement of our field investigation, or have not been accurately marked on the ground by a responsible third party (e.g. utility company, site owner).

Most developers have copies of the necessary utility plans (including electricity, gas, water, drainage & telecom), and it would be appreciated if you could forward these prior to the proposed fieldworks. However, if you do not have the necessary plans, Lithos will obtain them direct from each of the utility companies.

Under the CDM Regulations 2015, Lithos must be provided with pre-construction information already in your possession, or information that can reasonably be obtained through sensible enquiry. This information must be relevant to the project, have an appropriate level of detail, and be proportionate to the nature of the risks.

Terms & conditions: This work will be undertaken in accordance with our Standard Terms and Conditions, a copy of which are enclosed.

It is hoped the above is sufficient for your present needs. However, should you require any further information, please contact the undersigned.

Yours sincerely

Mark Perrin
Director
for and on behalf of
LITHOS CONSULTING LIMITED

Terms and Conditions for the Appointment of Lithos Consulting Limited

V006.18

1 DEFINITIONS AND INTERPRETATION

1.1 In this Agreement, unless the context otherwise requires, the following words and expressions have the following meanings:

"Agreement" shall mean these Terms (entitled "Terms and Conditions for the Appointment of Lithos Consulting"), the Proposal, any document recording the Client's unequivocal acceptance of the Proposal and any other documents or parts of other documents expressly referred to in any of the foregoing:

"Client" shall mean the party for whom the Services are being provided by Lithos;

"Documents" shall mean all documents of any kind and includes plans, drawings, reports, programmes, specifications, Bills of Quantities, calculations, letters, e-mails, faxes, memoranda, films and photographs (including negatives), or any other form of record prepared or provided or received by, or on behalf of Lithos, and whether in paper form or stored electronically or on disk, or otherwise;

"Lithos" shall mean Lithos Consulting Limited whose registered office is at Parkhill, Walton Road, Wetherby, West Yorkshire, LS22 5DZ.

"Intellectual Property" includes all rights to, and any interests in, any patents, designs, trade marks, copyright, know-how, trade secrets and any other proprietary rights or forms of intellectual property (protectable by registration or not) in respect of any technology, concept, idea, data, programme or other software (including source and object codes), specification, plan, drawing, schedule, minutes, correspondence, scheme, programme, design, system, process logo, mark, style, or other matter or thing, existing or conceived, used, developed or produced by any person;

"Parties" shall mean the Client and Lithos

"Project" shall mean the project described in the Proposal and any enquiry from the Client on which Lithos has based its Proposal;

"Proposal" means the offer document prepared by Lithos in response to an enquiry or otherwise, in connection with the proposed provision of the Services;

"Services" means the work and services relating to the Project to be provided by Lithos pursuant to the Agreement and as set out in the Proposal and shall include any additions or amendments thereto made in accordance with these Terms;

"Terms" means these terms entitled "Lithos Consulting Terms of Appointment".

1.2 Words importing the singular only shall also include the plural and vice versa, where the context requires.

1.3 Words importing persons or parties shall include firms, corporations and any organisation having legal capacity and vice versa, where the context requires; and words importing a particular gender include all genders.

1.4 The sub-headings to the clauses of these Terms are for convenience only and shall not affect the construction of the Agreement.

1.5 A reference to legislation includes that legislation as from time to time amended, re-enacted or substituted and any Orders in Council, orders, rules, regulations, schemes, warrants, by-laws, directives or codes of practice issued under any such legislation.

1.6 In the event of conflict between the documents forming part of the Agreement, the Proposal shall prevail, followed by the Terms.

2 APPOINTMENT

2.1 The Client agrees to engage Lithos and Lithos agrees to provide the Services in accordance with the provisions of the Agreement.

3 OBLIGATIONS OF LITHOS

3.1 Lithos shall perform the Services using the reasonable standard of skill and care normally exercised by similar professional Environmental firms in performing similar services under similar conditions.

3.2 Lithos shall use all reasonable endeavours to perform the Services in accordance with all relevant environmental and safety legislation.

4 OBLIGATIONS OF THE CLIENT

4.1 Throughout the period of this Agreement the Client shall afford to Lithos or procure the affording to Lithos of access to any site where access is required for the performance of the Services.

4.2 The Client accepts responsibility for ensuring that Lithos is notified in writing of all special site and/or plant conditions, including without prejudice to the generality of the foregoing, the existence and precise location of all underground services, cables, pipes, drains or underground buildings, constructions or any hazards known or suspected by the Client, which the Client shall clearly mark on the ground or identify on accurate location plans supplied to Lithos prior to the commencement of the Services. The Client shall also inform Lithos in writing of any relevant operating procedures including any site safe operating procedures and any other regulations relevant to the carrying out of the Services. The Client shall indemnify Lithos against all costs, claims, demands and expenses arising as a result of any non-disclosure in this respect, including but not limited to indemnification against any action brought by the owner of the land or otherwise.

4.3 If the Client discovers any conflict, defect or other fault in the information or designs provided by Lithos pursuant to the Agreement, he will advise Lithos in writing of such defect, conflict or other fault and Lithos shall have the right to rectify the same or where necessary, to design the solution for rectification of any works carried out by others pursuant the conflicting, defective or in any other way faulty information or designs.

5 INTELLECTUAL PROPERTY

5.1 The copyright in all Intellectual Property prepared by or on behalf of Lithos in connection with the Project for delivery to the Client shall remain vested in Lithos.

5.2 The Client shall have a non-exclusive licence to copy and use such Intellectual Property for purposes directly related to the Project. Such licence shall enable the Client to copy and use the Intellectual Property but solely for its own purposes in connection with the Project and such use shall not include any licence to reproduce any conceptual designs or professional opinions contained therein nor shall it include any license to amend any drawing, design or other Intellectual Property produced by Lithos.

5.3 Should the Client wish to use such Intellectual Property in connection with any other works or for any other purpose not directly related to the Project or wish to pass any Intellectual Property to any third party, it must obtain the prior written consent of Lithos. The giving of such consent shall be at the discretion of Lithos and shall be upon such terms as may be required by Lithos. Lithos shall not be liable for the use by any person of such Intellectual Property for any purpose other than that for which the same were prepared by or on behalf of Lithos.

5.4 Ownership of any proposals submitted to the Client that are not subsequently confirmed as part of the Services to be provided for the Client remain with Lithos and such proposals must not be used as the basis for any future work undertaken by the Client or a third party and no liability can be accepted howsoever arising from such proposals.

5.5 In the event of the Client being in default of payment of any fees or other amounts due, Lithos may suspend further use of the licence on giving 2 days' notice of the intention to do so. Use of the licence may be resumed on receipt of the outstanding amounts.

6 TITLE

6.1 Lithos shall transfer only such title or rights in respect of the Documents as it has, and if any part is purchased from a third party Lithos shall transfer only such title or rights as that party had and has transferred to Lithos.

6.2 Title in the Documents shall remain with and shall not pass to the Client until the amount due under the invoice(s) (including interest and costs) has been paid in full.

6.3 Until title passes, the Client shall hold the Documents as bailee for Lithos and shall store or mark them so that they can at all times be identified as the property of Lithos.

6.4 At any time before title passes (save and except where payment is not due), but only after prior consultation with the Client, Lithos may without any liability to the Client repossess and use or sell all or any of part of the Documents and by doing so terminate the right of the Client to use, sell or otherwise deal in the Documents.

6.5 Lithos may maintain an action for the price of the Documents notwithstanding that title in them has not passed to the Client.

7 CONFIDENTIALITY AND DATA PROTECTION

7.1 Lithos undertakes not to divulge or disclose to any third party without the written consent of the Client information which is designated confidential by the Client or which can reasonably be considered to be confidential and arises during the performance of the Services unless required to do so by law or necessary in the proper performance of its duties in relation to the Project, or in order to make full frank and proper disclosure to its insurers or intended insurers, or to obtain legal or accounting advice.

7.2 Subject to the above and Lithos' Privacy Policy which can be found on www.lithos.co.uk, Lithos shall be permitted to use information related to the Services it provides in connection with the Project for the purposes of marketing its services and in proposals for work of a similar type.

8 THIRD PARTIES

8.1 The Agreement or any part thereof or any benefit or interest thereunder may not be assigned by the Client without the prior written consent of Lithos. The giving of such consent shall be at the discretion of Lithos and Lithos will only agree to an assignment on its terms and in return for payment of a fee by the Client to Lithos to cover Lithos' legal and other costs associated with any assignment.

8.2 The Agreement shall not confer and shall not purport to confer on any third party any benefit or any right to enforce any term of this Agreement for the purposes of the Contracts (Rights of Third Parties) Act 1999 or otherwise.

8.3 Lithos will consider and may consent to any request from the Client for Lithos to enter a collateral warranty with a third party with regard to the Services provided under the Agreement. The giving of such consent shall be at the discretion of Lithos and Lithos will only enter a collateral warranty on its terms and in return for payment of a fee by the Client to Lithos to cover Lithos' legal and other costs associated with any collateral warranty.

9 INSURANCE

9.1 Lithos warrants to the Client that there is in force a policy of Professional Indemnity insurance covering its liabilities for negligence under this Agreement, with a limit of indemnity of £5,000,000 (FIVE MILLION POUNDS) any one claim, save for pollution and contamination claims and asbestos claims both of which carry £2,000,000 (TWO MILLION) in the aggregate cover. This policy is annually renewable and whilst renewal is not automatic, Lithos agrees to use reasonable endeavours to maintain such insurance at all times until six years from the date of the completion (or termination) of the Services under the Agreement, provided such insurance is available at commercially reasonable rates having regard, inter alia, to premiums required and policy terms obtainable.

9.2 If for any period such insurance is not available at commercially reasonable rates, Lithos shall forthwith inform the Client and shall obtain in respect of such period such reduced level of Professional Indemnity insurance as is available and as would be fair and reasonable in the circumstances for Lithos to obtain.

10 LIMITATIONS ON LIABILITY

10.1 Unless otherwise agreed in writing, Lithos' liability under or in connection with the Agreement whether in contract, tort, negligence, breach of statutory duty or otherwise (other than in respect of personal injury or death) shall be limited to and shall not exceed the lesser of either five million pounds in the aggregate (unless it is a pollution, contamination or asbestos claim in which case it is two million pounds in the aggregate) or 10 times the total value of invoices issued to the Client for consultancy work instructed under the Agreement.

10.2 No action or proceedings under or in respect of the Agreement whether in contract, tort, negligence, under statute or otherwise shall be commenced against Lithos after the expiry of a period of six years from the date of the completion (or termination) of the Services under the Agreement.

10.3 Whilst Lithos will scan all potential exploratory locations with a Cable Avoidance Tool, Lithos shall not be liable for any damage to underground services, cables, pipes, drains or underground buildings, constructions and the like which were either not marked on site or for which accurate plans were not provided.

10.4 Lithos shall not be liable for the cost of rectifying any defect, conflict or other fault in the information or designs provided by Lithos or for the cost of designing a solution for and rectifying any subsequent works carried out by others pursuant to the conflicting, defective or in any other way faulty information or designs, unless Lithos has been advised in writing of the same by the Client and has been given the opportunity to rectify the same or where necessary, to design the solution for rectification of any subsequent works carried out by others pursuant to the same.

11 PAYMENT

11.1 Invoices for services rendered will be submitted for payment in accordance with the Proposal.

11.2 The due date for payment is the date of the invoice and the final date for payment is 28 days from the date of the invoice.

11.3 If the Client disputes the amount included for payment in an invoice a written notice must be served on Lithos by the Client not later than 14 days before the final date for payment. If no notice is given the amount due shall be the amount stated in the invoice.

11.4 In the event of failure on the part of the Client to pay any monies in accordance with the foregoing payment provisions, Lithos will be entitled to charge interest on any monies owed to it by the Client, such interest to be at a rate of 8% above the base rate of a clearing bank from time to time calculated from the final date for payment to the date of actual payment on a compound basis.

12 DELAY

12.1 Lithos will comply with any timescale agreed for completion of the Services unless delayed or prevented by circumstances beyond its reasonable control and in the event of any such circumstances arising Lithos undertakes to complete the Services within a reasonable period, but will not be liable to the Client for any delay as a result.

13 TERMINATION

13.1 The Agreement may be terminated by either party in the event of the other making a composition or arrangement with its creditors, becoming bankrupt, or being a company, making a proposal for a voluntary arrangement for a composition of debts, or has a provisional liquidator appointed, or has a winding-up order made, or passes a resolution for voluntary winding-up (except for the purposes of a bona fide scheme of amalgamation or reconstruction), or has an administrator or an administrative receiver appointed to the whole or any part of its assets. Notice of termination must be given to the party which is insolvent by the other party.

13.2 If for any reason the performance of the Services by Lithos is suspended for a period in excess of three calendar months then Lithos shall be entitled to terminate its appointment in respect of the Services by seven days written notice to the Client.

13.3 If the Client shall fail to pay in full any sum due under the terms of the Agreement by the final date for payment for that sum and no effective notice of intention to withhold payment has been issued, Lithos may serve written notice on the Client demanding payment within 14 days of such notice. If the Client shall fail to comply with such notice, Lithos shall be entitled to terminate its employment under the Agreement forthwith.

13.4 Any termination of the appointment of Lithos howsoever caused shall be without prejudice to the right of Lithos to require payment for all services performed up to the date of such termination including but not limited to payment of a fair and reasonable proportion of any figure identified in the Proposal or otherwise for fees in respect of a particular service which Lithos has started, but not completed.

14 NOTICES

14.1 Any notice provided for in the Agreement shall be in writing and shall be deemed to be properly given if delivered by hand or sent by first class post to the address of the relevant party as may have been notified by each party to the other or, in the absence of notification, to the address of Lithos set out above or to the registered address of the Client.

14.2 Such notice shall be deemed to have been received on the day of delivery if delivered by hand or on the second working day after the day of posting if sent by first class post.

15 ENTIRE AGREEMENT

15.1 The Agreement constitutes the complete and entire agreement between the Client and Lithos with respect to the Services and supersedes any prior oral and/or written warranties, terms, conditions, communications and representations, whether express or implied and any claim against Lithos in respect of the Services can only be made in contract under the provisions of the Agreement and not otherwise under the law or tort or otherwise.

15.2 No amendments, modifications or variation of the Agreement shall be valid unless made in writing and agreed to by both the Client and Lithos; such agreement must be recorded in writing by at least one of the Parties.

15.3 Lithos will not be bound by any standard or printed terms or conditions furnished by the Client in any of its documents unless Lithos specifically states in writing separately from such documents that it intends such terms and conditions to apply.

16 DISPUTES AND GOVERNING LAW

16.1 The Agreement shall be governed by and construed in accordance with English law and the Parties irrevocably and unconditionally submit to the jurisdiction of the English Courts.

16.2 Where the Housing Grants, Construction and Regeneration Act 1996 applies, any dispute between the Parties may be referred to adjudication in accordance with The Scheme for Construction Contracts Regulations 1998 or any amendment or modification thereof being in force at the time of the dispute, as applicable to England, Wales, Scotland and Northern Ireland.

From: Andrew Spiers
To: Reg
Cc: James Kitchen
Subject: RE: Residential development East Bierley
Date: 09 November 2018 13:58:54
Attachments: image003.jpg
image004.jpg
image005.jpg

Reg

Congratulations crack on.

Please start the Landmark/coal enquiries for the stage 1. I will forward next week service info (James please can you compile all info we have and forward to Reg on Monday).
There are overhead powerlines crossing the site and an underground high pressure water main. The land owner is particularly concerned re not digging near the water main.

Please can you advise on the anticipated dates on site so I can arrange the man/machine and access onto site.

Any queries please contact me,

With kind regards

Andrew Spiers
Technical Director

ROUSE HOMES LTD
8 CARR CROFTS DRIVE
ARMLEY
LEEDS
LS12 3AL
Office : 0113 204 6900
Direct : 0113 204 6912
Mobile : 07734 234532
Andrew.Spiers@rousehomes.co.uk
www.rousehomes.co.uk

RH_logo_dec16_400x143

From: Reg [mailto:Reg@lithos.co.uk]
Sent: 16 October 2018 15:54

To: Andrew Spiers <Andrew.Spiers@rousehomes.co.uk>
Subject: Residential development East Bierley

Andy

SI quote (£) as promised.

As discussed, there are potential savings of £ (Curtins Desk Study, but not recommended) and £ if no gas monitoring.

We understand that you can supply JCB with driver etc. We will supply a water bowser for soakaway tests (BGS BHs suggest bedrock at about 2m depth). We'll also supply drill rig to install gas monitoring wells.

As requested, if required, we will provide a separate Remediation Statement, and complete the YW Contaminated Land Assessment Form.

Any queries, please call.

Regards

Mark Perrin
Lithos Consulting Ltd
M 07703 396 635
DD 01937 545 331
www.lithos.co.uk

From: Andrew Spiers
Sent: 11 October 2018 15:01
To: Reg <Reg@lithos.co.uk>
Cc: James Kitchen <James.Kitchen@krouse.co.uk>
Subject: Residential development east Bierley

Reg

As discussed please provide your fee for a stage 2 site investigation at the above.

My layout/the topo attached. I have a stage 1 site investigation by Curtins. Its 58 meg and too big to e mail.

I will have a word with my colleague as to the best way to issue.

We will supply man and machine and can carry out work on site as soon as practicable.

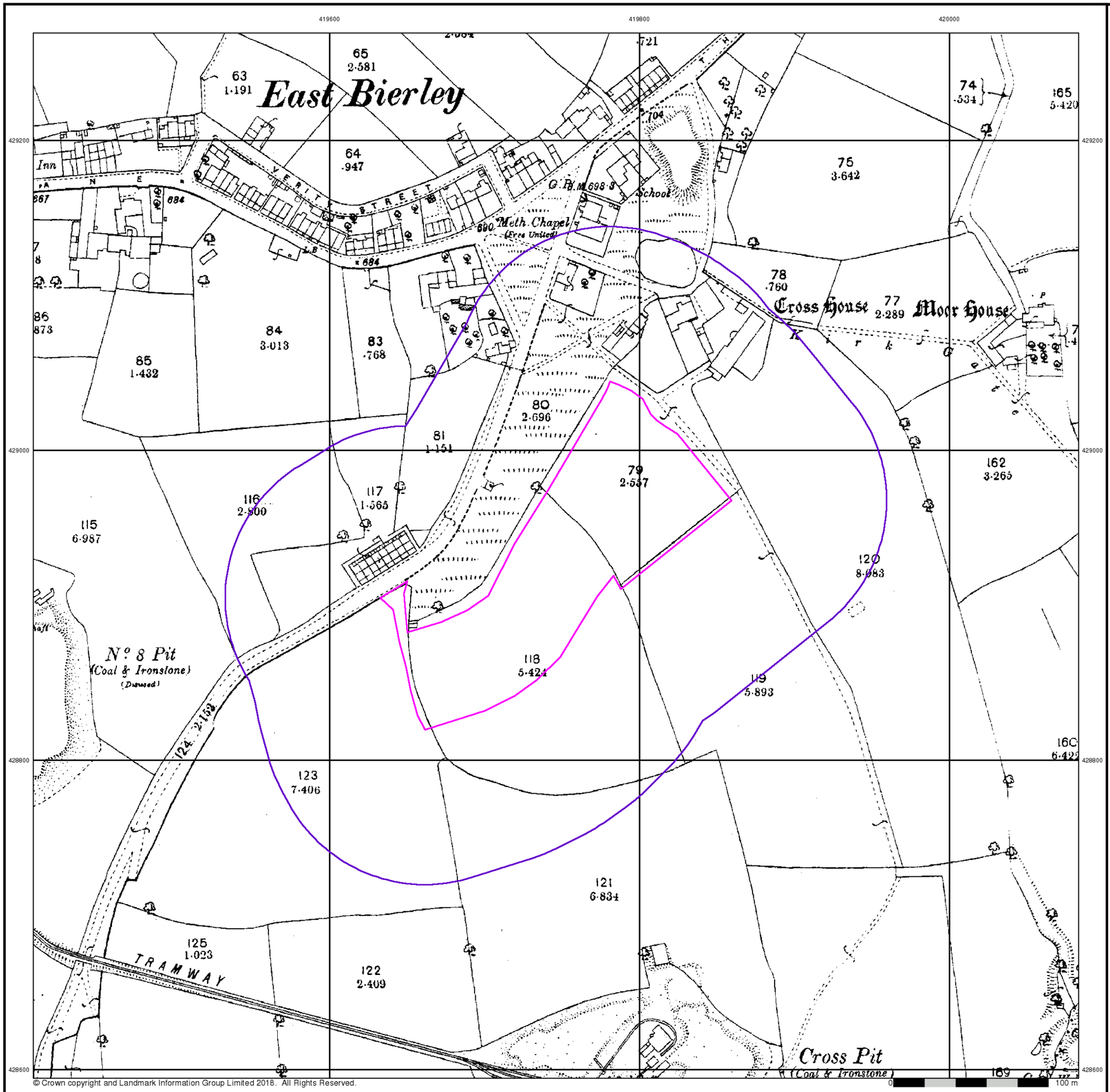
With kind regards

Andrew Spiers
Technical Director

ROUSE HOMES LTD
8 CARR CROFTS DRIVE
ARMLEY
LEEDS
LS12 3AL
Office : 0113 204 6900

Appendix D

Historical OS Plans



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LITHOS CONSULTING

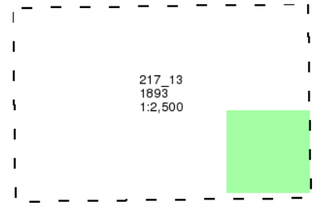
Yorkshire

Published 1893

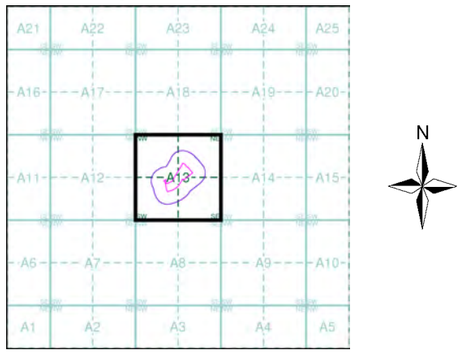
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



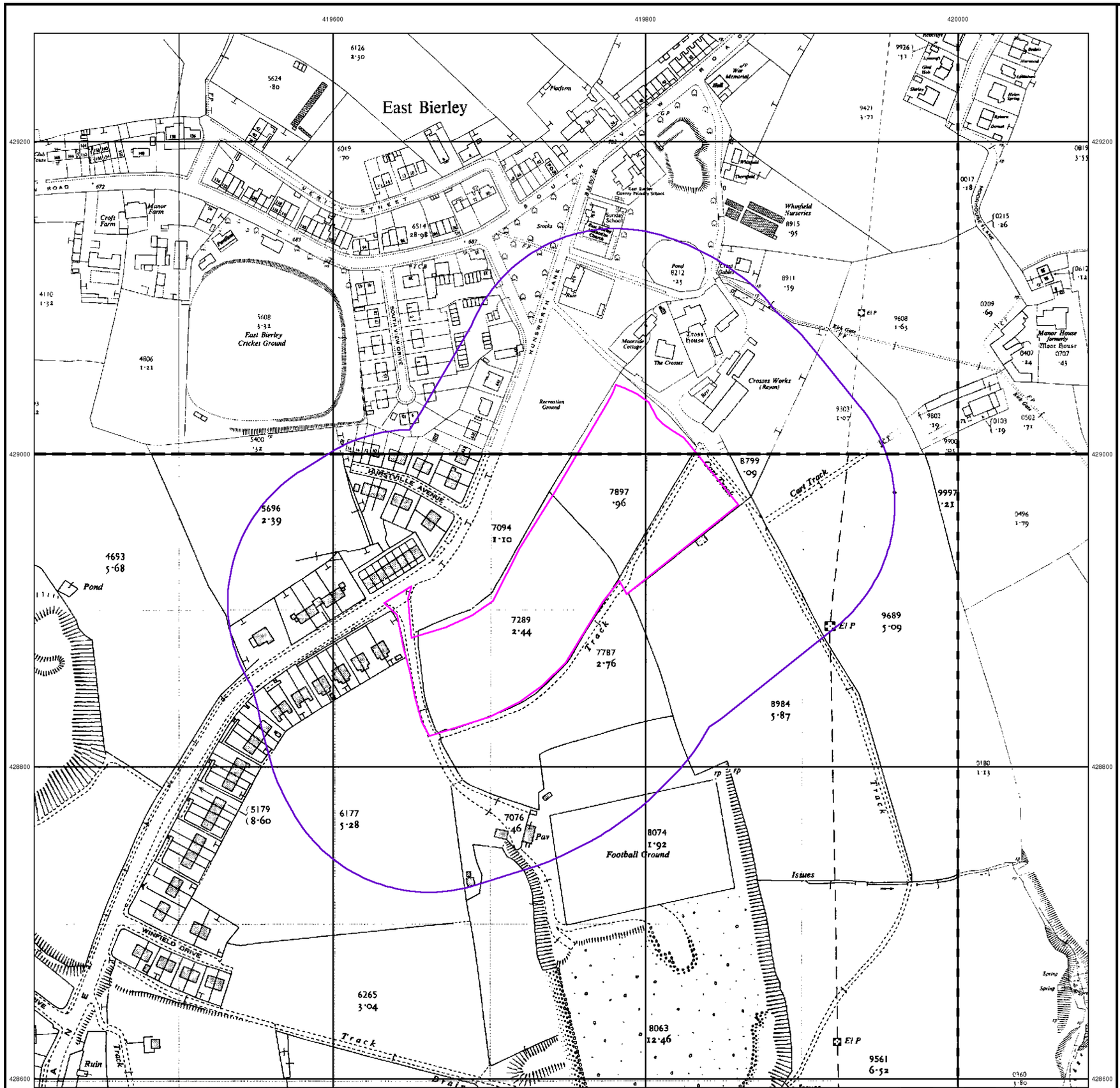
Order Details

Order Number:	185873497_1_1
Customer Ref:	PO13821/JW/3233
National Grid Reference:	419740, 428930
Slice:	A
Site Area (Ha):	1.83
Search Buffer (m):	100

Site Details

East Bierley, Birkenshaw, BD4 6PZ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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LITHOS CONSULTING

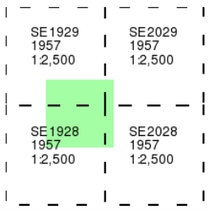
Ordnance Survey Plan

Published 1957

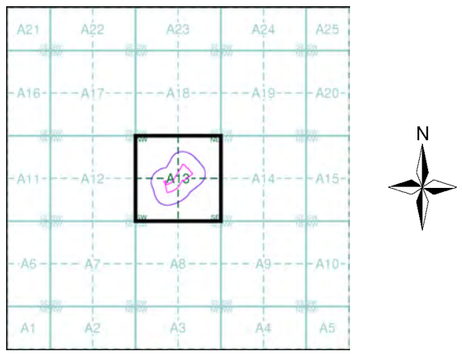
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



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Slice:	A
Site Area (Ha):	1.83
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Site Details

East Bierley, Birkenshaw, BD4 6PZ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Appendix E

Search Responses & other Correspondence

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
185873497_1_1

Customer Reference:
PO13821/JW/3233

National Grid Reference:
419740, 428930

Slice:
A

Site Area (Ha):
1.83

Search Buffer (m):
1000

Site Details:

East Bierley
Birkenshaw
BD4 6PZ

Client Details:

Mr M Perrin
Lithos Consulting Ltd
Parkhill
Walton Road
Wetherby
LS22 5DZ

Prepared For:

LS22 5DZ

Contents

Report Section	Page Number
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Agency & Hydrological	1
Waste	15
Hazardous Substances	-
Geological	19
Industrial Land Use	36
Sensitive Land Use	43
Data Currency	44
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Useful Contacts	51

Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination.
For this reason, Landmark's Site Sensitivity maps and Datasheet(s) place great emphasis on statutory data provided by the Environment Agency/Natural Resources Wales and the Scottish Environment Protection Agency; it also incorporates data from Natural England (and the Scottish and Welsh equivalents) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the Landmark database to a distance defined by the client from a site boundary provided by the client.
In this datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers.

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Report Version v53.0

LITHOS CONSULTING

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes	Yes	Yes	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 1			3	4
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 3			1	1
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 3		Yes		
Pollution Incidents to Controlled Waters	pg 3			1	7
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality					
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register	pg 5				2
Water Abstractions	pg 5				(*1)
Water Industry Act Referrals					
Groundwater Vulnerability	pg 5	Yes	n/a	n/a	n/a
Drift Deposits			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 5	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
OS Water Network Lines	pg 6		2	21	56

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites	pg 15			1	
Historical Landfill Sites	pg 15			2	3
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)					
Local Authority Landfill Coverage		1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 16		3	10	20
Potentially Infilled Land (Water)	pg 18		1	2	7
Registered Landfill Sites					
Registered Waste Transfer Sites					
Registered Waste Treatment or Disposal Sites					
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					

LITHOS CONSULTING

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Geological					
BGS 1:625,000 Solid Geology	pg 19	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 19	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 27		5	10	22
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 33	Yes	n/a	n/a	n/a
Mining Instability	pg 33	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 33	Yes	Yes	n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 34		Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 34	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 34		Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 35	Yes	Yes	n/a	n/a
Radon Potential - Radon Affected Areas			n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 36			7	21
Fuel Station Entries	pg 38			1	1
Points of Interest - Commercial Services	pg 38			2	8
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 39		1	2	16
Points of Interest - Public Infrastructure	pg 41			1	13
Points of Interest - Recreational and Environmental	pg 42				2
Gas Pipelines					
Underground Electrical Cables					

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Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland					
Areas of Adopted Green Belt	pg 43	1			3
Areas of Unadopted Green Belt	pg 43	1			
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves	pg 43			1	
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 43	1			
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					

LITHOS CONSULTING

Groundwater Vulnerability

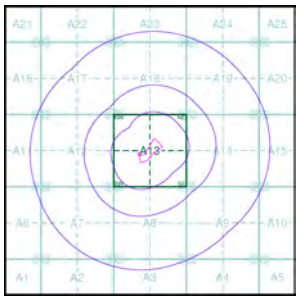
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes	Soil Classes
Major Aquifer (Highly Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Minor Aquifer (Variably Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Non Aquifer (Negligibly Permeable)	
Water or Sea	
Drift Deposit	

Site Sensitivity Context Map - Slice A



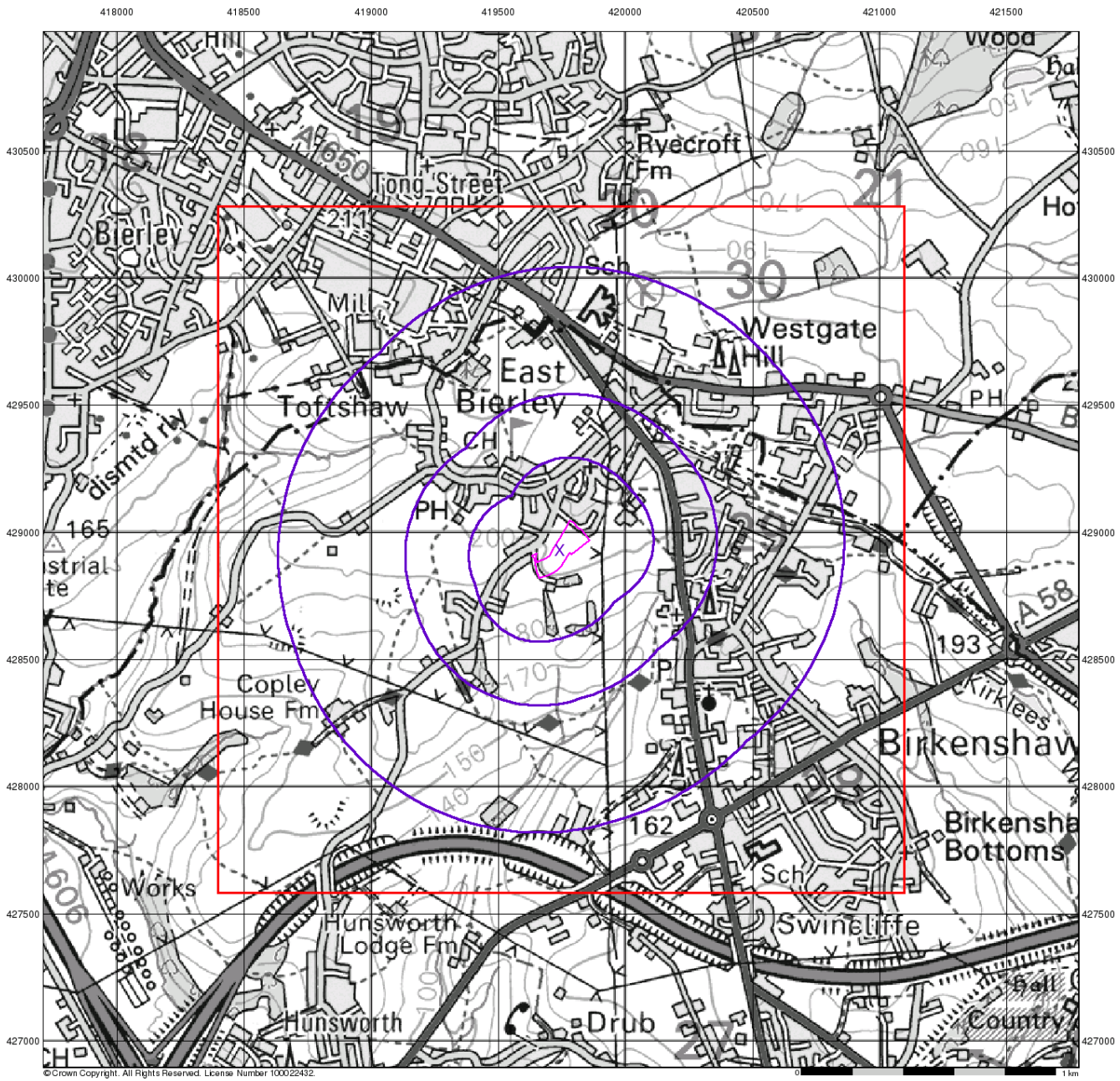
Order Details

Order Number:	185873497_1_1
Customer Ref:	PO13821/JW/3233
National Grid Reference:	419740, 428930
Slice:	A
Site Area (Ha):	1.83
Search Buffer (m):	1000

Site Details

East Bierley, Birkenshaw, BD4 6PZ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LITHOS CONSULTING

Source Protection Zones

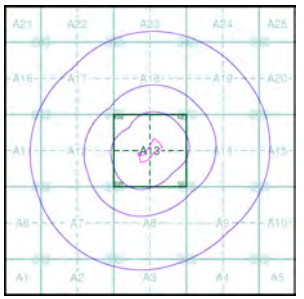
General

Specified Site | Specified Buffer(s) | Bearing Reference Point
Slice | Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A

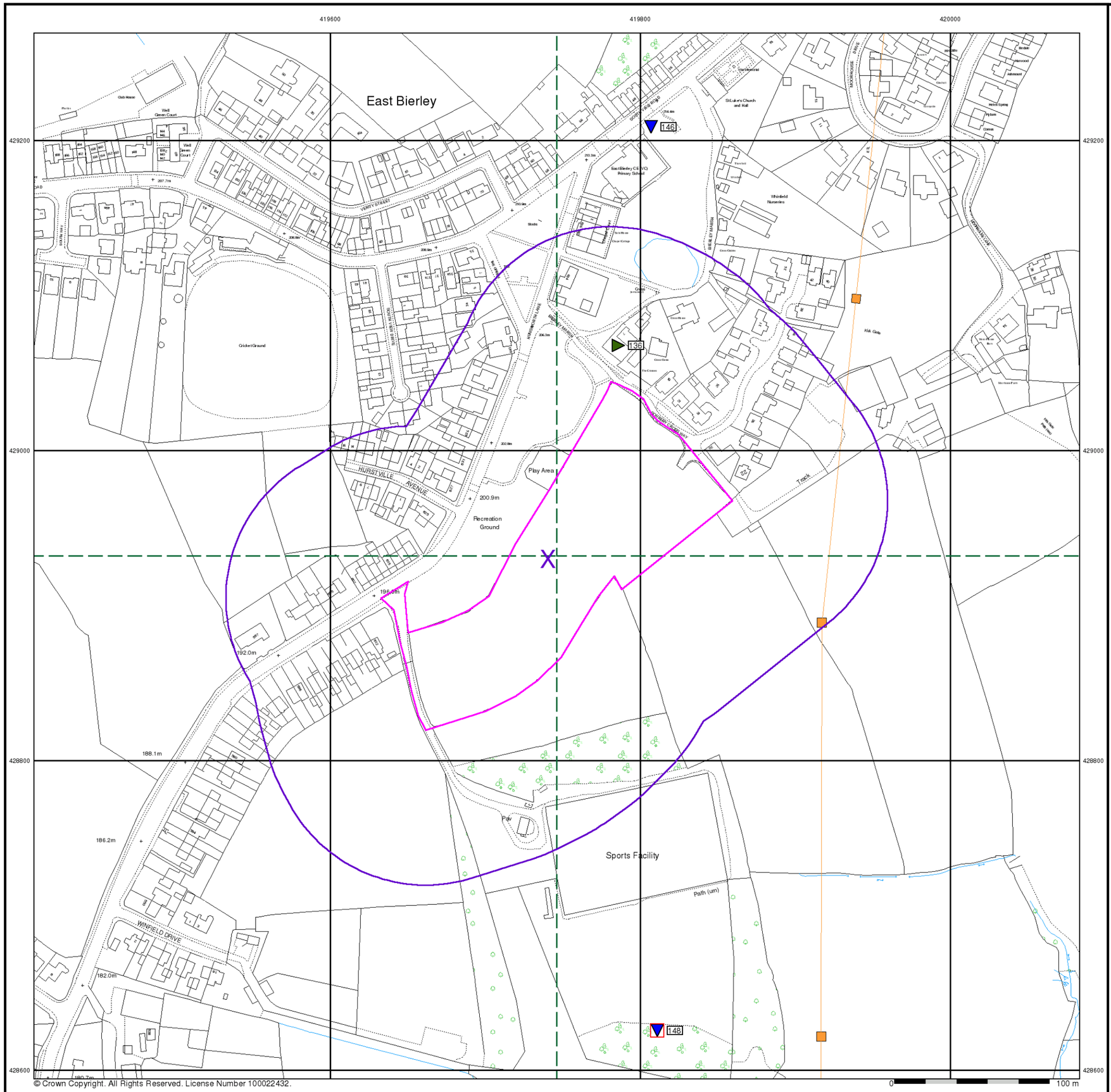


Order Details

Order Number:	185873497_1_1
Customer Ref:	PO13821/JW/3233
National Grid Reference:	419740, 428930
Slice:	A
Site Area (Ha):	1.83
Search Buffer (m):	1000

Site Details

East Bierley, Birkenshaw, BD4 6PZ



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LITHOS CONSULTING

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID
- Several of Type at Location
- Pylon
- Overhead Transmission Line

Agency and Hydrological

- Contaminated Land Register Entry or Notice (Location)
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Local Authority Integrated Pollution Prevention and Control
- Local Authority Pollution Prevention and Control
- Local Authority Pollution Prevention and Control Enforcement
- Pollution Incident to Controlled Waters
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Registered Radioactive Substance
- River Network or Water Feature
- River Quality Sampling Point
- Substantiated Pollution Incident Register
- Water Abstraction
- Water Industry Act Referral

Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

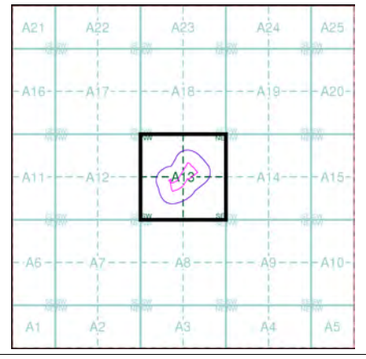
Geological

- BGS Recorded Mineral Site

Waste

- BGS Recorded Landfill Site (Location)
- BGS Recorded Landfill Site
- EA Historic Landfill (Buffered Point)
- EA Historic Landfill (Polygon)
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facility (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Local Authority Recorded Landfill Site (Location)
- Local Authority Recorded Landfill Site
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Segment A13



Order Details

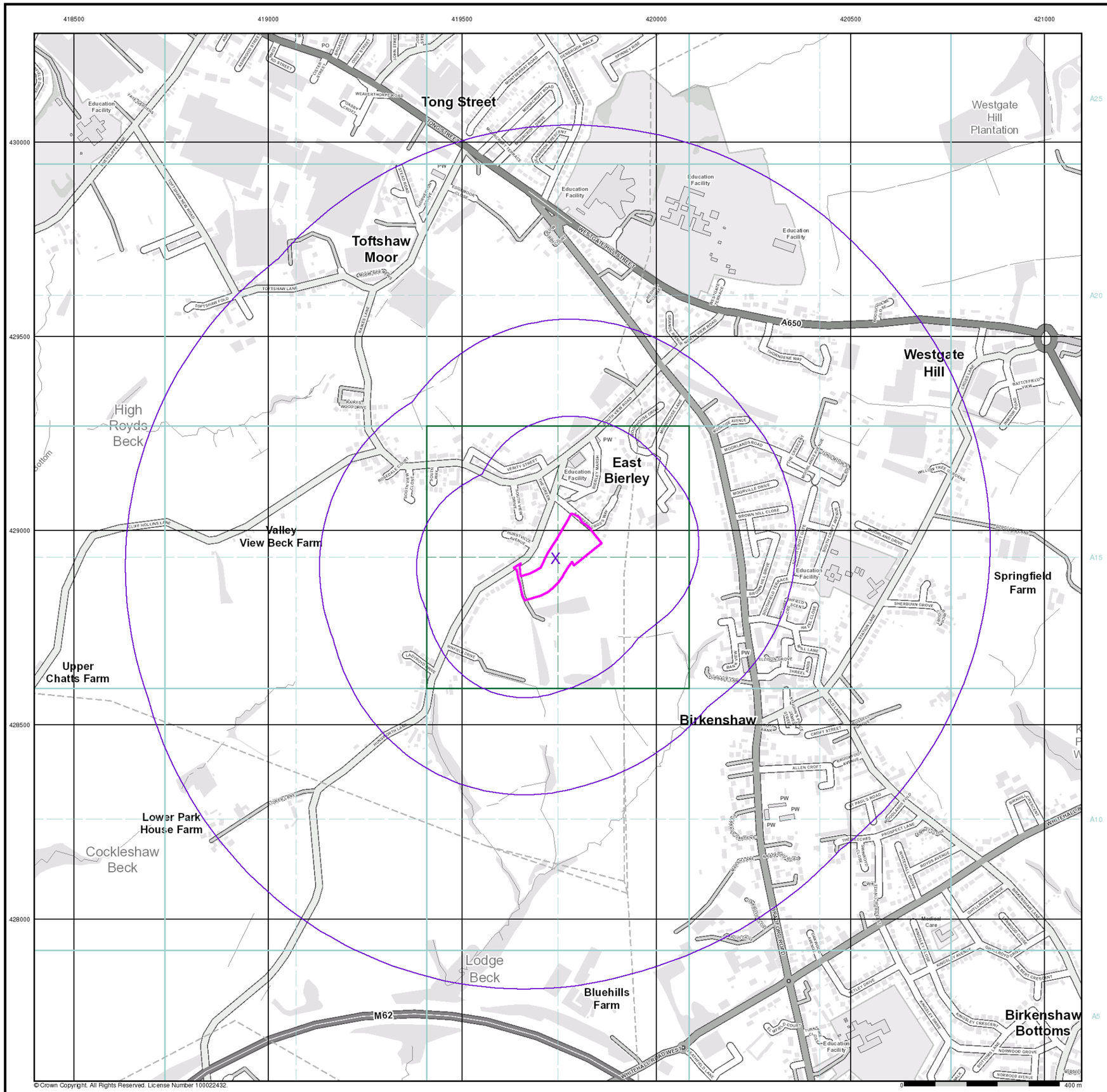
Order Number:	185873497_1_1
Customer Ref:	PO13821/JW/3233
National Grid Reference:	419740, 428930
Slice:	A
Site Area (Ha):	1.83
Plot Buffer (m):	100

Site Details

East Bierley, Birkenshaw, BD4 6PZ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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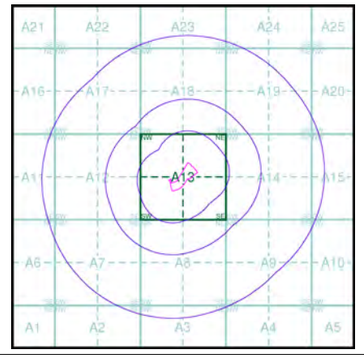
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



Order Details

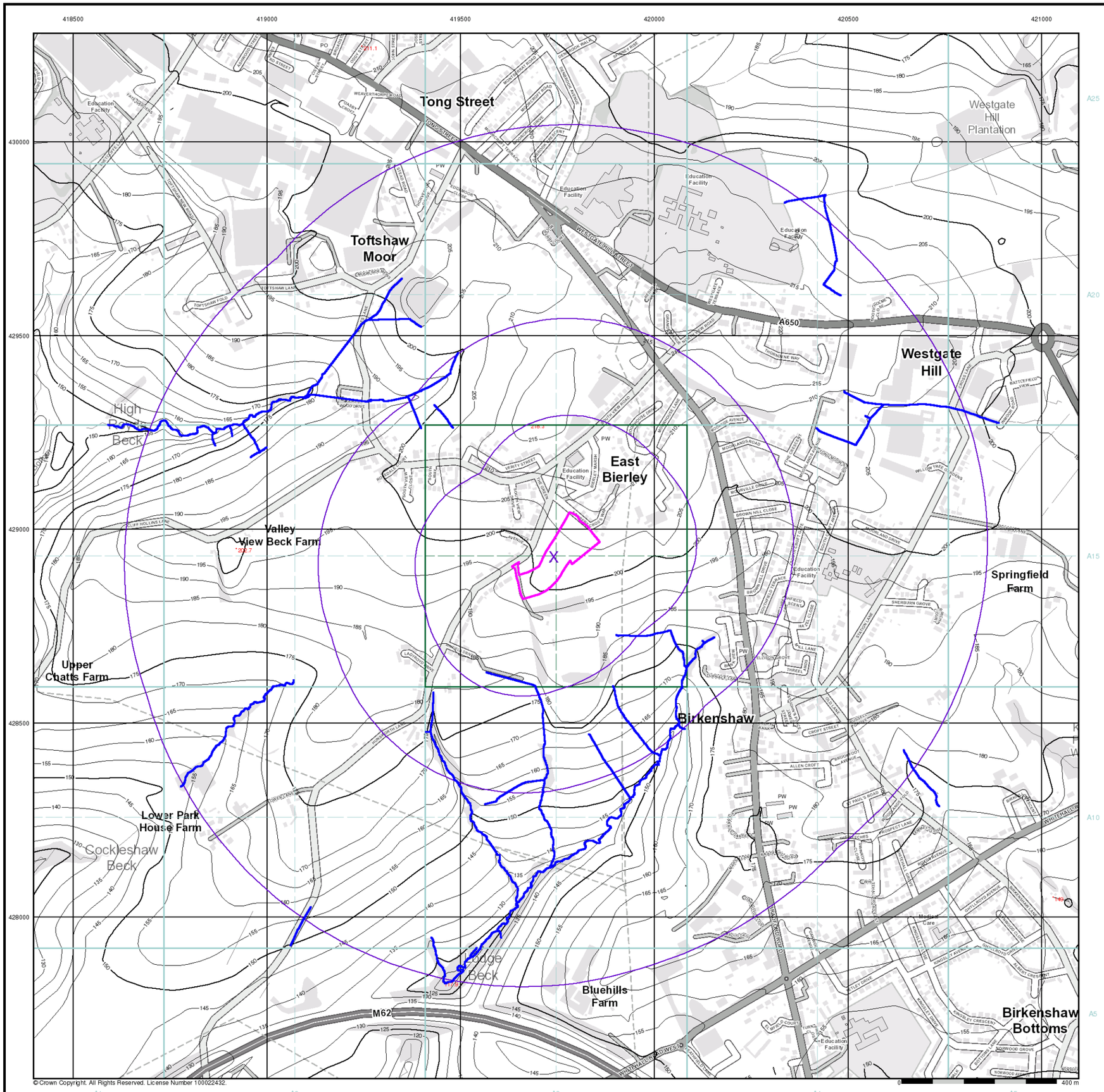
Order Number:	185873497_1_1
Customer Ref:	PO13821/JW/3233
National Grid Reference:	419740, 428930
Slice:	A
Site Area (Ha):	1.83
Search Buffer (m):	1000

Site Details

East Bierley, Birkenshaw, BD4 6PZ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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LITHOS CONSULTING

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

OS Water Network Data

- Canal
- Reservoir
- Foreshore
- Marsh
- Tidal River
- Inland River
- Drain
- Other
- Lake
- Transfer
- Lock Or Flight Of Locks
- Sea

Contours (height in meters)

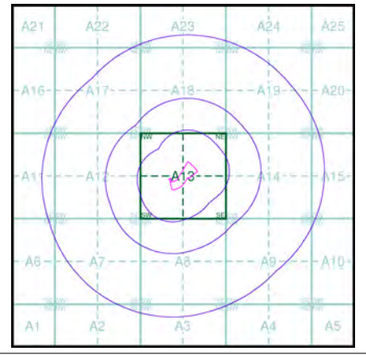
Standard Contour 105 100 95

Master Contour

Spot Height 167.3

- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



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Customer Ref:	PO13821/JW/3233
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Slice:	A
Site Area (Ha):	1.83
Search Buffer (m):	1000

Site Details

East Bierley, Birkenshaw, BD4 6PZ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

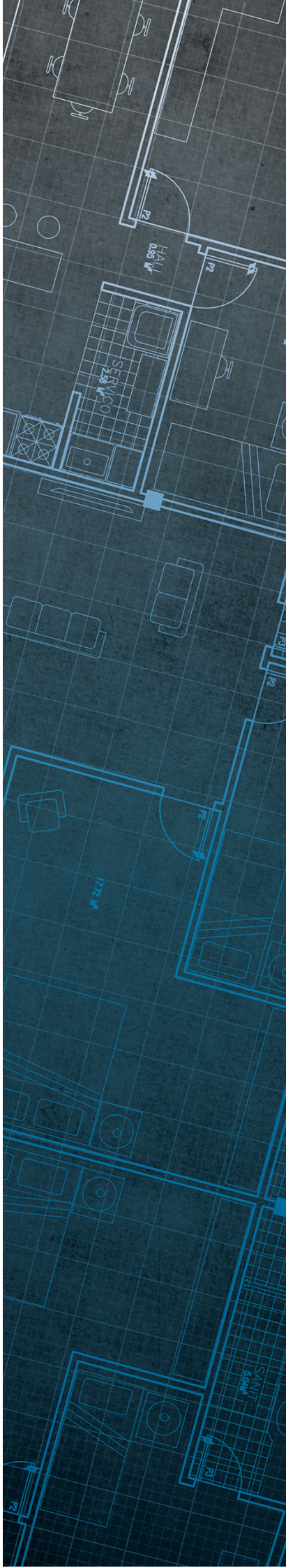
The Coal Authority

Consultants

Coal Mining Report

East Bierley
Birkenshaw
BD4 6PZ

Date of enquiry:	**12 November 2018**
Date enquiry received:	**12 November 2018**
Issue date:	**12 November 2018**
Our reference:	**51001962497001**
Your reference:	**PO13822/JW/3233**



Consultants

Coal Mining Report

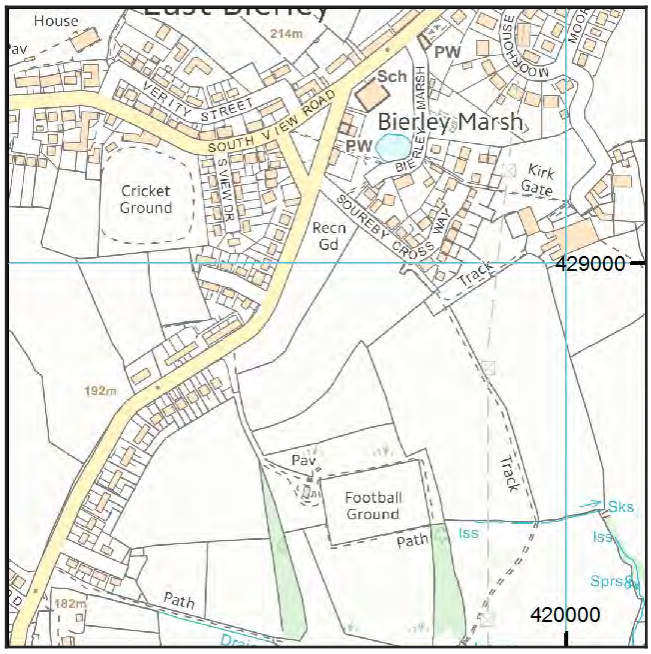
This report is based on and limited to the records held by the Coal Authority at the time the report was produced.

Client name

LITHOS CONSULTING LTD

Enquiry address

East Bierley
Birkenshaw
BD4 6PZ



Approximate position of property

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How to contact us

0345 762 6848 (UK)
+44 (0)1623 637 000 (International)

200 Lichfield Lane
Mansfield
Nottinghamshire
NG18 4RG

www.groundstability.com

@coalauthority
/company/the-coal-authority
/thecoalauthority
/thecoalauthority

Section 1 – Mining activity and geology

Past underground mining

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
unnamed	WHINMOOR	Coal	6O28	80	Beneath Property	1.5	North-East	69	1910
unnamed	WHINMOOR	Coal	601R	86	Beneath Property	2.0	South-East	69	1906
unnamed	BLACK BED	Coal	6O2G	139	Beneath Property	0.9	North-East	209	1892
unnamed	BETTER BED	Coal	6O2K	160	Beneath Property	2.4	North	46	1892
unnamed	BLACK BED	Coal	6O1Z	162	Beneath Property	1.9	East	170	1892
unnamed	BETTER BED	Coal	6O22	187	Beneath Property	2.4	South-East	46	1892
unnamed	BLACK BED	Coal	6HO7	228	East	1.9	East	170	1892

Probable unrecorded shallow workings

None.

Spine roadways at shallow depth

No spine roadway recorded at shallow depth.

Mine entries

None recorded within 100 metres of the enquiry boundary.

Abandoned mine plan catalogue numbers

The following abandoned mine plan catalogue numbers intersect with some, or all, of the enquiry boundary:

FGB381	FGB660	GCR52
M31	GCR50	FGB335
5833	2805	GCR20

Our records show we have more plans than those shown above which could affect the enquiry boundary.

Please contact us on 0345 762 6848 to determine the exact abandoned mine plans you require based on your needs.

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Outcrops
No outcrops recorded.

Geological faults, fissures and breaklines
No faults, fissures or breaklines recorded.

Opencast mines
None recorded within 500 metres of the enquiry boundary.

Coal Authority managed tips
None recorded within 500 metres of the enquiry boundary.

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Section 2 – Investigative or remedial activity

Please refer to the 'Summary of findings' map (on separate sheet) for details of any activity within the area of the site boundary.

Site investigations
None recorded within 50 metres of the enquiry boundary.

Remediated sites
None recorded within 50 metres of the enquiry boundary.

Coal mining subsidence
The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.

There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Mine gas
None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes
None recorded within 500 metres of the enquiry boundary.

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Section 3 – Licensing and future mining activity

Future underground mining
None recorded.

Coal mining licensing
None recorded within 200 metres of the enquiry boundary.

Court orders
None recorded.

Section 46 notices
No notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

Withdrawal of support notices
The property is not in an area where a notice to withdraw support has been given.

The property is not in an area where a notice has been given under section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.

Payments to owners of former copyhold land
The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

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Section 4 – Further information

The following potential risks have been identified and as part of your risk assessment should be investigated further.

Development advice

The site is within an area of historical coal mining activity. Should you require advice and/or support on understanding the mining legacy, its risks to your development or what next steps you need to take, please contact us.

For further information on specific site or ground investigations in relation to any issues raised in Section 4, please call us on 0345 762 6848 or email us at groundstability@coal.gov.uk.

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Section 5 – Data definitions

The datasets used in this report have limitations and assumptions within their results. For more guidance on the data and the results specific to the enquiry boundary, please **call us on 0345 762 6848** or **email us at groundstability@coal.gov.uk.**

Past underground coal mining

Details of all recorded underground mining relative to the enquiry boundary. Only past underground workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination, will be included.

Probable unrecorded shallow workings

Areas where the Coal Authority believes there to be unrecorded coal workings that exist at or close to the surface (less than 30 metres deep).

Spine roadways at shallow depth

Connecting roadways either, working to working, or, surface to working, both in-seam and cross measures that exist at or close to the surface (less than 30 metres deep), either within or within 10 metres of the enquiry boundary.

Mine entries

Details of any shaft or adit either within, or within 100 metres of the enquiry boundary including approximate location, brief treatment details where known, the mineral worked from the mine entry and conveyance details where the mine entry has previously been sold by the Authority or its predecessors British Coal or the National Coal Board.

Abandoned mine plan catalogue numbers

Plan numbers extracted from the abandoned mines catalogue containing details of coal and other mineral abandonment plans deposited via the Mines Inspectorate in accordance with the Coal Mines Regulation Act and Metalliferous Mines Regulation Act 1872. A maximum of 9 plan extents that intersect with the enquiry boundary will be included. This does not infer that the workings and/or mine entries shown on the abandonment plan will be relevant to the site/property boundary.

Outcrops

Details of seam outcrops will be included where the enquiry boundary intersects with a conjectured or actual seam outcrop location (derived by either the British Geological Survey or the Coal Authority) or intersects with a defined 50 metres buffer on the coal (dip) side of the outcrop. An indication of whether the Coal Authority believes the seam to be of sufficient thickness and/or quality to have been worked will also be included.

Geological faults, fissures and breaklines

Geological disturbances or fractures in the bedrock. Surface fault lines (British Geological Survey derived data) and fissures and breaklines (Coal Authority derived data) intersecting with the enquiry boundary will be included. In some circumstances faults, fissures or breaklines have been known to contribute to surface subsidence damage as a consequence of underground coal mining.

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Opencast mines
Opencast coal sites from which coal has been removed in the past by opencast (surface) methods and where the enquiry boundary is within 500 metres of either the licence area, site boundary, excavation area (high wall) or coaling area.

Coal Authority managed tips
Locations of disused colliery tip sites owned and managed by the Coal Authority, located within 500 metres of the enquiry boundary.

Site investigations
Details of site investigations within 50 metres of the enquiry boundary where the Coal Authority has received information relating to coal mining risk investigation and/or remediation by third parties.

Remediated sites
Sites where the Coal Authority has undertaken remedial works either within or within 50 metres of the enquiry boundary following report of a hazard relating to coal mining under the Coal Authority's Emergency Surface Hazard Call Out procedures.

Coal mining subsidence
Details of alleged coal mining subsidence claims made since 31 October 1994 either within or within 50 metres of the enquiry boundary. Where the claim relates to the enquiry boundary confirmation of whether the claim was accepted, rejected or whether liability is still being determined will be given. Where the claim has been discharged, whether this was by repair, payment of compensation or a combination of both, the value of the claim, where known, will also be given.

Details of any current 'Stop Notice' deferring remedial works or repairs affecting the property/site, and if so the date of the notice.

Details of any request made to execute preventative works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991. If yes, whether any person withheld consent or failed to comply with any request to execute preventative works.

Mine gas
Reports of alleged mine gas emissions received by the Coal Authority, either within or within 500 metres of the enquiry boundary that subsequently required investigation and action by the Coal Authority to mitigate the effects of the mine gas emission.

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Mine water treatment schemes
Locations where the Coal Authority has constructed or operates assets that remove pollutants from mine water prior to the treated mine water being discharged into the receiving water body.

These schemes are part of the UK's strategy to meet the requirements of the Water Framework Directive. Schemes fall into 2 basic categories: Remedial – mitigating the impact of existing pollution or Preventative – preventing a future pollution incident.

Mine water treatment schemes generally consist of one or more primary settlement lagoons and one or more reed beds for secondary treatment. A small number are more specialised process treatment plants.

Future underground mining
Details of all planned underground mining relative to the enquiry boundary. Only those future workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination will be included.

Coal mining licensing
Details of all licenses issued by the Coal Authority either within or within 200 metres of the enquiry boundary in relation to the under taking of surface coal mining, underground coal mining or underground coal gasification.

Court orders
Orders in respect of the working of coal under the Mines (Working Facilities and Support) Acts of 1923 and 1966 or any statutory modification or amendment thereof.

Section 46 notices
Notice of proposals relating to underground coal mining operations that have been given under section 46 of the Coal Mining Subsidence Act 1991.

Withdrawal of support notices
Published notices of entitlement to withdraw support and the date of the notice. Details of any revocation notice withdrawing the entitlement to withdraw support given under Section 41 of the Coal Industry Act 1994.

Payment to owners of former copyhold land
Relevant notices which may affect the property and any subsequent notice of retained interests in coal and coal mines, acceptance or rejection notices and whether any compensation has been paid to a claimant.

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VAT receipt

Issued by	The Coal Authority 200 Lichfield Lane Mansfield Nottinghamshire NG18 4RG
Tax point date	12 November 2018
Issued to	LITHOS CONSULTING LTD PARKHILL WALTON ROAD WETHERBY LEEDS LS22 5DZ
Property search for	EAST BIERLEY BIRKENSHAW BD4 6PZ
Reference number	51001962497001
Date of issue	12 November 2018
Cost	£106.79
VAT @ 20%	£21.36
Total received	£128.15
VAT registration	598 5850 68

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The Coal Authority

Summary of findings

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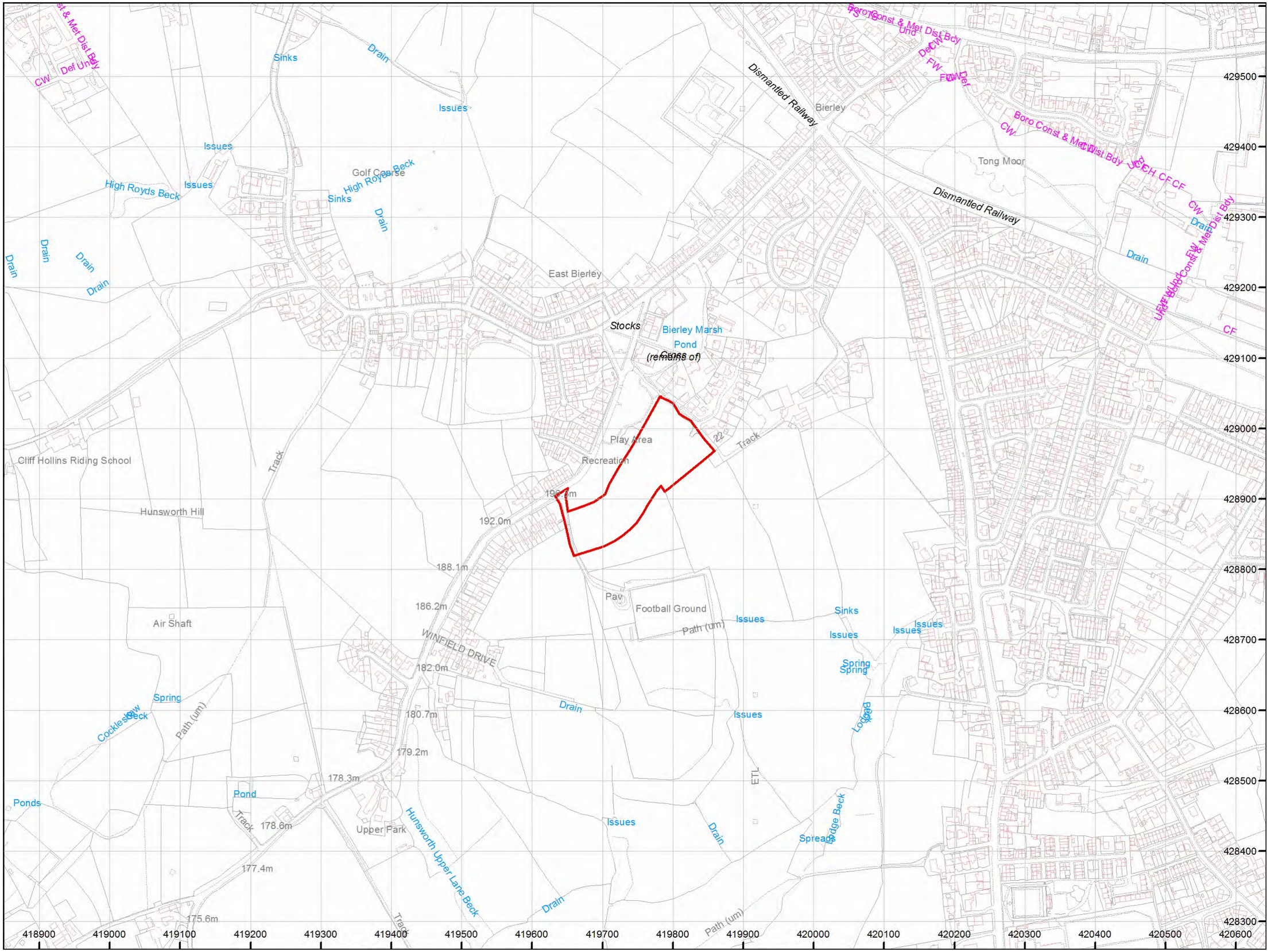
The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

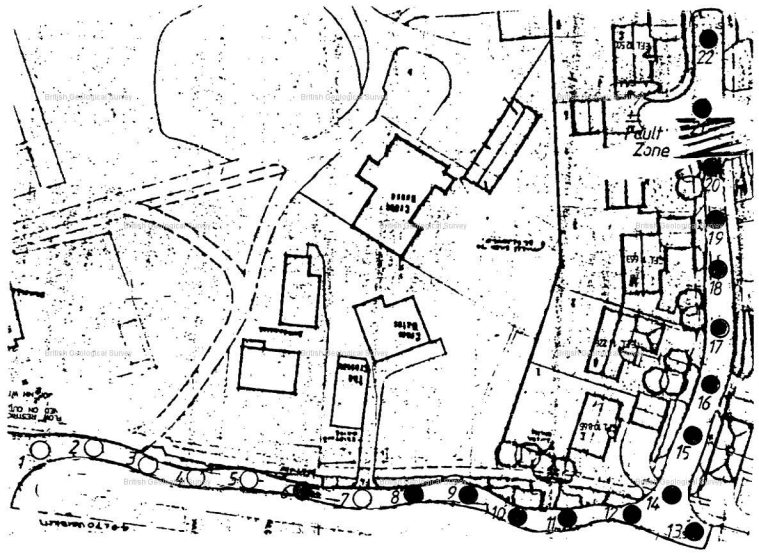
Approximate position of the enquiry boundary shown



How to contact us
0345 762 6848 (UK)
+44 (0)1623 637 000 (International)
www.groundstability.com

PLAN REFERRED TO

Borehole Location Plan



SE12NE. 1:1234 - 655

Location of boreholes shewn thus — ●

Old workings encountered ——— ●

HETS

WEST YORKSHIRE HIGHWAYS ENGINEERING AND TECHNICAL SERVICES JOINT COMMITTEE

Director: W.F. COTTON, B.A., D.M.S., C.Eng., F.I.C.E., M.I.H.T

PROJECT: Crosses Works E. Bierley Adoptable Highway		
UNIT: Mining	DRAWN: A D	TRACED: AD
SCALE: 1/1000	DATE: Oct 1989	DRG. No.: 89/75

Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP01
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419814.00 - 428953.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6 Depth 2.00	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
	0.60	D	HVP=86 HVP=84	0.90			Firm light brown mottled light grey and orangish brown CLAY. (COHESIVE RESIDUAL SOIL)
	1.80	T		1.40			Light grey very clayey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.00			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION) End of pit at 2.00 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP02
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419765.00 - 428992.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.20	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
	0.70	D	HVP=70				Stiff light brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
▼	1.10	D	HVP=134	1.00			Stiff light grey gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
				1.60			Weak thinly bedded light grey stained black SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.20			*2.20m: Refusal on bedrock. Unable to excavate further with machine on site.* End of pit at 2.20 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was apparent at 1.50m as a water seepage. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

Trial Pit Log

Trialpit No **TP03**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419756.00 - 428913.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.30	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
			HVP=92				Stiff light grey mottled orangish brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	0.90	D	HVP=132	1.10			
	1.20	D	HVP=90				Stiff light grey mottled brown gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	2.30	T		2.30			*2.30m: Refusal on bedrock. Unabale to excavate further with machine on site.* End of pit at 2.30 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

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Trial Pit Log

Trialpit No **TP04**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419696.00 - 428888.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.30	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown sandy CLAY. (TOPSOIL)
	0.60	D	HVP=78				Stiff light grey mottled light brown CLAY. (COHESIVE RESIDUAL SOIL)
	1.10	D	HVP=150	0.90			Stiff light grey gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
				1.80			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.30			*2.30m: Refusal on bedrock. Unable to excavate further with machine on site.* End of pit at 2.30 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP05
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419683.00 - 428835.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.10	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
			HVP=68				Stiff light brown mottled light grey slightly gravelly CLAY (COHESIVE RESIDUAL SOIL)
	0.80	D	HVP=150	1.10			Light grey clayey angular and subangular fine to coarse lithorelict GRAVEL of siltstone with a low siltstone cobble content. (GRANULAR RESIDUAL SOIL)
	1.30	T		1.80			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.10			*2.10m: Refusal on bedrock. Unable to excavate further with machine on site.* End of pit at 2.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP06**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419661.00 - 428876.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): Depth 2.50 — 4 × 0.6	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
	0.80	T	HVP=124	1.20			Stiff light brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	1.40	D		2.00			Stiff light grey mottled orangish brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
				2.50			Light grey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.60			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION) *2.60m: Refusal on bedrock. Unable to excavate further with machine on site.* End of pit at 2.50 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP07**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419697.00 - 428864.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.20	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
	0.50	T	HVP=85	0.70			Stiff light brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
			HVP=128				Stiff light grey gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	1.40	D		1.50			Light grey slightly clayey angular and subangular fine to coarse lithorelict GRAVEL of siltstone with a low siltstone cobble content. (GRANULAR RESIDUAL SOIL)
				1.90			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.20			*2.20m: Refusal on bedrock. Unable to excavate further with machine on site.* End of pit at 2.20 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP08
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419736.00 - 428875.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6 Depth 2.80	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			Soft dark brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine to coarse mudstone. (TOPSOIL) *0.20m: Boulder in sidewall causing overbreak.*
			HVP=68	0.50			Firm brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	1.10	D	HVP=150 HVP=102				Stiff light grey mottled orangish brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	2.00	T		1.90			Light grey clayey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.60			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION) *2.80m: Refusal on bedrock. Unable to excavate further with machine on site.*
				2.80			End of pit at 2.80 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP09**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419772.00 - 428911.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6 Depth 2.30	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Soft dark brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine to coarse mudstone. (TOPSOIL)
			HVP=86				Stiff light grey mottled light brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	0.80	D	HVP=146	0.90			Stiff light grey gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	1.30	T					*1.30m: Too gravelly for vanes.*
				2.00			Weak thinly bedded dark brown SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.30			*2.30m: Refusal on bedrock. Unable to excavate further with machine on site.*
							End of pit at 2.30 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP10**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419740.00 - 428955.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.20	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			Soft dark brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine to coarse mudstone. (TOPSOIL)
▼			HVP=100	0.70			Stiff light brown mottled orangish brown slightly sandy slightly gravelly CLAY with a low subangular siltstone cobble content. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
			HVP=136				*0.40m: Slight overbreak of sidewall.*
	0.90	D					Stiff light grey mottled orangish brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	1.40	D					*1.40m: Becoming gravelly.*
				1.50			Light grey stained black clayey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.00			Weak thinly bedded light grey stained black SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.20			*2.20m: Refusal on bedrock. Unable to excavate further with machine on site.*
							End of pit at 2.20 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was apparent at 0.60m as a water seepage. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP11**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419785.00 - 429028.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.50	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.40			Soft dark brown sandy slightly gravelly CLAY. Gravel is angular and subangular fine and medium mudstone. (TOPSOIL)
▼			HVP=59	0.70			Firm orangish brown sandy slightly gravelly CLAY with a low subangular siltstone cobble content. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	0.90	T	HVP=111	1.00			Stiff light grey mottled orangish brown slightly gravelly CLAY. Gravel is angular and subangular fine to coarse lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
	1.50	D		1.70			Stiff light grey mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine to coarse siltstone lithorelicts. (COHESIVE RESIDUAL SOIL) *1.00-1.10m: Thin bed of weak siltstone.* *1.10m: Too gravelly for vanes*
				2.40			Light grey clayey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.50			Weak thinly bedded light grey SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION) *2.50m: Refusal on bedrock. Unable to excavate further with machine on site.* End of pit at 2.50 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was apparent at 0.70m as a water seepage. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP12
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419802.00 - 428984.00 Level:	Date 03/12/2018
Location: East Bierley		Dimensions (m): 4 × 0.6, Depth 2.30	Scale 1:25
Client: Rouse Homes			Logged JBR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Soft dark brown sandy slightly gravelly CLAY. Gravel is angular and subangular fine to coarse mudstone and sandstone. (TOPSOIL)
				0.30			Firm light grey mottled orangish brown slightly gravelly slightly sandy CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
			HVP=136				
	1.00	D	HVP=150				
	1.20	D					*1.10m: Becoming gravelly. Too gravelly for vanes.*
				1.60			Weak thinly bedded light grey stained black SILTSTONE. Recovered as angular and subangular fine to coarse gravel and cobbles of weathered siltstone. (WEATHERED COAL MEASURES FORMATION)
				2.30			*2.30m: Refusal on bedrock. Unable to excavate further with machine on site.*
							End of pit at 2.30 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

Appendix G

Borehole Logs

Borehole Log

Project Name: East Bierley	Project No. 3233	Co-ords: 419838.00 - 428962.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Borehole No. **WS01**

Sheet 1 of 1

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
								Soft dark brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine and medium sandstone. (TOPSOIL)
					0.40			Firm light grey mottled orangish brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
					0.70			Stiff light brown mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL) *0.75m: Too gravelly for vanes.*
					1.40			*1.35-1.40m: Refusal on sandstone obstruction (bedrock or subangular lithorelict cobble).* End of borehole at 1.40 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

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Borehole Log

Borehole No.
WS02
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419798.00 - 429014.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Soft dark brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine and medium sandstone. (TOPSOIL)
					0.30			Firm brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine to medium mudstone and sandstone. (COHESIVE RESIDUAL SOIL)
					0.50			Firm light grey mottled orangish brown CLAY. (COHESIVE RESIDUAL SOIL)
				HVP=81				*0.80m: Becoming stiff.*
					1.10			Stiff light grey mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
					1.80			*1.75-1.80m: Refusal on weak siltstone bedrock.* End of borehole at 1.80 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

AGS

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Borehole Log

Borehole No.
WS03
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419766.00 - 428969.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
				HVP=58	0.30			Soft dark brown slightly sandy CLAY. (TOPSOIL)
					1.10			Firm light grey mottled orangish brown CLAY. (COHESIVE RESIDUAL SOIL)
					1.50			Stiff light grey mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
								1.45-1.50m: Refusal on weak siltstone bedrock.
								End of borehole at 1.50 m

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Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

AGS

Borehole Log

Borehole No. **WS04**

Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419785.00 - 428935.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
				HVP=56	0.40			Soft dark brown slightly sandy slightly gravelly CLAY. Gravel is angular and subangular fine and medium mudstone. (TOPSOIL)
					0.75			Firm light brown mottled orangish brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
					1.20			Stiff light grey mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
					1.40			Light grey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL) *1.35-1.40m Refusal on weak siltstone bedrock.* End of borehole at 1.40 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

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Borehole Log

Borehole No.
WS05
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419738.00 - 428900.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Soft dark brown slightly sandy CLAY. (TOPSOIL)
					0.20			Firm light grey mottled orangish brown CLAY. (COHESIVE RESIDUAL SOIL)
				HVP=56				
								0.80m: Thin bed of weak brown siltstone.
				HVP=57				
					1.00			Stiff light grey mottled light brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
								1.00m: Too gravelly for vanes.
					1.50			*1.45-1.50m: Refusal on weak siltstone bedrock.*
								End of borehole at 1.50 m

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Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

AGS

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Borehole Log

Borehole No.
WS06
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419668.00 - 428852.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Soft dark brown slightly sandy CLAY. (TOPSOIL)
					0.30			Firm light grey mottled orangish brown CLAY. (COHESIVE RESIDUAL SOIL)
				HVP=65				
					0.80			Stiff light grey mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
					1.50			Light grey and grey angular and subangular fine to coarse lithorelict GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
					2.00			*1.95-2.00m: Refusal on weak siltstone bedrock.* End of borehole at 2.00 m

1 2 3 4

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

AGS

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Borehole Log

Borehole No.
WS07
Sheet 1 of 1

Project Name: East Bierley	Project No. 3233	Co-ords: 419714.00 - 428853.00	Hole Type WS
Location: East Bierley		Level:	Scale 1:20
Client: Rouse Homes		Dates: 04/12/2018 - 04/12/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Soft dark brown slightly sandy CLAY. (TOPSOIL)
					0.30			Stiff light grey mottled orangish brown gravelly CLAY. Gravel is angular and subangular fine and medium lithorelicts of siltstone. (COHESIVE RESIDUAL SOIL)
					1.60			Grey angular and subangular fine to coarse lithorelicts of siltstone. (GRANULAR RESIDUAL SOIL)
					1.80			*1.75-1.80m: Refusal on weak siltstone bedrock.* End of borehole at 1.80 m

1
2
3
4

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS (c.3m).

AGS

Appendix H

Rotary Open Probehole Logs

LITHOS CONSULTING

Borehole Log

Borehole No.
PH01
Sheet 1 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419777.00 - 429031.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 04/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Topsoil (TOPSOIL)
					0.50			Light orange slightly gravelly CLAY (COHESIVE RESIDUAL SOIL)
					0.80			Light grey SILTSTONE (COAL MEASURES)
								Light grey SILTSTONE (COAL MEASURES)
					4.50			Light grey MUDSTONE (COAL MEASURES)
					9.10			Soft light orange clayey MUDSTONE (COAL MEASURES)
					9.40			*Between 9.1m and 9.4m, easy to drill.*
					9.70			Light grey MUDSTONE (COAL MEASURES)
					9.90			Dark grey MUDSTONE with traces of coal
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

AGS

Borehole Log

Borehole No. **PH01**
Sheet 2 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419777.00 - 429031.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 04/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								(COAL MEASURES)
								Light grey MUDSTONE (COAL MEASURES)
					13.30			Dark grey MUDSTONE (COAL MEASURES)
					14.10			Black COAL (COAL MEASURES)
					14.40			Light grey MUDSTONE (COAL MEASURES)
								From 14.4m, harder to drill.
					18.00			End of borehole at 18.00 m

11 12 13 14 15 16 17 18 19 20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH02
Sheet 1 of 3

Project Name: East Bierley	Project No. 3233	Co-ords: 419802.00 - 429016.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 04/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Topsoil (TOPSOIL)
								Orange and grey mottled gravelly CLAY. (COHESIVE RESIDUAL SOIL)
					2.10			Light grey SILTSTONE (COAL MEASURES)
					4.90			Light grey clayey MUDSTONE (COAL MEASURES)
					9.20			Soft Light grey clayey MUDSTONE (COAL MEASURES) *Between 9.2m and 10.0m, easy to drill*
					10.00			Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost at 30.0m

AGS

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Borehole Log

Borehole No.
PH02
Sheet 2 of 3

Project Name: East Bierley	Project No. 3233	Co-ords: 419802.00 - 429016.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 04/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey MUDSTONE with traces of coal (COAL MEASURES)
					10.50			Dark grey MUDSTONE (COAL MEASURES)
					15.20			Black COAL (COAL MEASURES)
					15.60			Dark grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

11 12 13 14 15 16 17 18 19 20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost at 30.0m

AGS

LITHOS CONSULTING

Borehole Log

Borehole No. **PH02**

Sheet 3 of 3

Project Name: East Bierley	Project No. 3233	Co-ords: 419802.00 - 429016.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 04/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					21.40			Dark grey MUDSTONE interbedded with light brown SANDSTONE (COAL MEASURES)
								From 21.4m, hard to drill.
					30.00			End of borehole at 30.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost at 30.0m

AGS

Borehole Log

Borehole No. **PH03**

Sheet 1 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419818.00 - 428977.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 05/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Topsoil (TOPSOIL)
								Light orange and grey mottled gravelly CLAY. (COHESIVE RESIDUAL SOIL)
					2.00			Light grey SILTSTONE (COAL MEASURES)
					4.50			Light grey MUDSTONE (COAL MEASURES)
					8.60			Soft light grey clayey MUDSTONE (COAL MEASURES)
					9.00			*Between 8.6m and 9.0m, easy to drill* Light grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

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Borehole Log

Borehole No.
PH03
Sheet 2 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419818.00 - 428977.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 04/02/2019 - 05/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					10.10			Soft light grey clayey MUDSTONE (COAL MEASURES) *Between 10.1m and 10.8m, easy to drill*
					10.80			Dark grey MUDSTONE with traces of coal (COAL MEASURES)
					11.30			Light grey MUDSTONE (COAL MEASURES)
					15.10			Black COAL (COAL MEASURES)
					15.60			Dark grey MUDSTONE (COAL MEASURES)
					18.00			End of borehole at 18.00 m

11 12 13 14 15 16 17 18 19 20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

AGS

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Borehole Log

Borehole No.
PH04
Sheet 1 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419841.00 - 428971.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 05/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Topsoil (TOPSOIL)
								Light orange and grey mottled gravelly CLAY (COHESIVE RESIDUAL SOIL)
					1.60			Light grey SILTSTONE (COAL MEASURES)
					4.10			Dark grey MUDSTONE interbedded with light brown SANDSTONE (COAL MEASURES)
					5.20			Light grey clayey MUDSTONE (COAL MEASURES)
					6.40			Dark grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost from 14.8m to 16.5m.

AGS

Borehole Log

Borehole No. **PH04**
Sheet 2 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419841.00 - 428971.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 05/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					14.20			Black COAL (COAL MEASURES)
					14.60			Dark grey MUDSTONE (COAL MEASURES)
					14.80			Void (lost flush) (COAL MEASURES) *From 14.8m, lost flush*
					16.50			End of borehole at 16.50 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost from 14.8m to 16.5m.

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Borehole Log

Borehole No.
PH05
Sheet 1 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419822.00 - 428958.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 11/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Topsoil (TOPSOIL)
								Light orange and grey mottled CLAY (COHESIVE RESIDUAL SOIL)
					1.40			Light grey gravelly CLAY (COHESIVE RESIDUAL SOIL)
					4.20			Dark grey MUDSTONE (COAL MEASURES)
					6.90			Soft ground (little flush) (COAL MEASURES) *Between 6.9 and 9.0m little flush, easy to drill.*
					9.00			Void (no returns) (COAL MEASURES) *Between 9.0-11.5m, fast drilling with rod dropping down.*
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost from 6.9m to 11.5m.

AGS

Borehole Log

Borehole No. **PH05**

Sheet 2 of 2

Project Name: East Bierley	Project No. 3233	Co-ords: 419822.00 - 428958.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 11/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					11.50			Likely weathered mudstone. (COAL MEASURES) *From 11.5m easy to drill. No return, getting lost in void above.*
					15.00			End of borehole at 15.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost from 6.9m to 11.5m.

Borehole Log

Borehole No. **PH06**

Sheet 1 of 3

Project Name: East Bierley	Project No. 3233	Co-ords: 419807.00 - 428954.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 11/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.40			Topsoil (TOPSOIL)
					1.80			Light orange sandy slightly gravelly CLAY (COHESIVE RESIDUAL SOIL)
					4.20			Light orange SILTSTONE (COAL MEASURES)
					8.00			Light grey MUDSTONE (COAL MEASURES)
								Slightly damp light grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 8.0m. 3. Flush returns were lost at 30.0m.

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Borehole Log

Borehole No.
PH06
Sheet 2 of 3

Project Name: East Bierley	Project No. 3233	Co-ords: 419807.00 - 428954.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 11/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								11
					11.40			Dark grey MUDSTONE (COAL MEASURES)
								12
					12.70			Black COAL (COAL MEASURES)
					13.20			13
								Dark grey MUDSTONE (COAL MEASURES)
					13.60			Light orange SANDSTONE (COAL MEASURES)
					13.90			Light grey MUDSTONE (COAL MEASURES)
								14
								15
								16
								17
								18
								19
								20
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 8.0m. 3. Flush returns were lost at 30.0m.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH06
Sheet 3 of 3

Project Name: East Bierley	Project No. 3233	Co-ords: 419807.00 - 428954.00	Hole Type PH
Location: East Bierley		Level:	Scale 1:50
Client: Rouse Homes		Dates: 11/02/2019 - 11/02/2019	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								21
								22
					23.00			Light orange SANDSTONE (COAL MEASURES) 23
					23.30			Light grey MUDSTONE (COAL MEASURES)
								24
								25
								26
								27
					27.80			Light orange SANDSTONE (COAL MEASURES) 28
								29
					30.00			End of borehole at 30.00 m 30

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 8.0m. 3. Flush returns were lost at 30.0m.

AGS

Appendix I

Chemical Results

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Amended Report

Report No.:	18-38432-3		
Initial Date of Issue:	13-Dec-2018	**Date of Re-Issue:**	08-Jan-2019
Client	Lithos Consulting		
Client Address:	Walton Road Wetherby LS22 5DZ		
Contact(s):	James Brown Martin Thompson		
Project	3233 East Bierley		
Quotation No.:		**Date Received:**	06-Dec-2018
Order No.:	PO13926/3233/JBR	**Date Instructed:**	06-Dec-2018
No. of Samples:	19		
Turnaround (Wkdays):	21	**Results Due:**	08-Jan-2019
Date Approved:	08-Jan-2019		

Approved By:

Details: Martin Dyer, Laboratory Manager
Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3233 East Bierley

Client: Lithos Consulting					**Chemtest Job No.:**	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432
Quotation No.:					**Chemtest Sample ID.:**	737143	737144	737145	737146	737147	737148	737149	737150	737151
					Sample Location:	TP01	TP02	TP03	TP04	TP05	TP06	TP08	TP09	TP10
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.10
					Date Sampled:	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018
					Asbestos Lab:	DURHAM		DURHAM	DURHAM	DURHAM				DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
ACM Type	U	2192		N/A		-		-	-	-				-
Asbestos Identification	U	2192	%	0.001		No Asbestos Detected		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected				No Asbestos Detected
Moisture	N	2030	%	0.020		13	21	14	15	15	18	16	16	15
Soil Colour	N	2040		N/A		Brown		Brown	Brown	Brown				Brown
Other Material	N	2040		N/A		Stones		Stones	Stones	Stones				Stones
Soil Texture	N	2040		N/A		Sand		Sand	Sand	Sand				Sand
pH	M	2010		N/A		5.5		6.1	7.1	6.5				6.4
Magnesium (Water Soluble)	N	2120	g/l	0.010										
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010										
Chloride (Water Soluble)	M	2220	g/l	0.010										
Nitrate (Water Soluble)	N	2220	g/l	0.010										
Total Organic Carbon	M	2625	%	0.20		7.7		3.8	6.1	5.2				5.5
Arsenic	M	2450	mg/kg	1.0		18	40	41	26	34	39	34	36	46
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40		0.47		0.73	1.0	1.2				0.59
Cadmium	M	2450	mg/kg	0.10		0.17		0.27	0.21	0.28				0.26
Chromium	M	2450	mg/kg	1.0		11		44	36	45				26
Chromium (Trivalent)	N	2490	mg/kg	1.0		11		44	36	45				26
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50		< 0.50	< 0.50	< 0.50				< 0.50
Copper	M	2450	mg/kg	0.50		21		47	35	42				51
Lead	M	2450	mg/kg	0.50		36		94	73	76				120
Mercury	M	2450	mg/kg	0.10		0.13		0.30	0.57	0.32				0.37
Nickel	M	2450	mg/kg	0.50		13		25	25	25				26
Selenium	M	2450	mg/kg	0.20		0.42		1.2	0.91	0.97				1.2
Zinc	M	2450	mg/kg	0.50		64		97	100	110				110
Acenaphthene	M	2800	mg/kg	0.10		0.21		1.5	0.69	1.2				0.86
Acenaphthylene	N	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	< 0.10				< 0.10
Anthracene	M	2800	mg/kg	0.10		0.13		1.0	0.35	0.71				0.60
Benzo[a]anthracene	M	2800	mg/kg	0.10		0.43		2.7	0.91	1.3				1.9
Benzo[a]pyrene	M	2800	mg/kg	0.10		0.28		2.0	0.68	0.98				1.5
Benzo[b]fluoranthene	M	2800	mg/kg	0.10		0.59		2.8	1.1	1.6				2.5
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10		0.14		< 0.10	0.38	0.58				< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10		0.10		0.83	0.29	0.49				0.69
Chrysene	M	2800	mg/kg	0.10		0.64		3.4	1.2	1.7				2.6
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	< 0.10				< 0.10
Fluoranthene	M	2800	mg/kg	0.10		1.8		7.6	3.6	4.3				5.6
Fluorene	M	2800	mg/kg	0.10		0.14		0.97	0.39	0.78				0.76
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10		0.11		0.59	0.26	0.29				0.57
Naphthalene	M	2800	mg/kg	0.10		0.37		2.0	0.37	1.5				1.1

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3233 East Bierley

Client: Lithos Consulting					**Chemtest Job No.:**	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432
Quotation No.:					**Chemtest Sample ID.:**	737143	737144	737145	737146	737147	737148	737149	737150	737151
					Sample Location:	TP01	TP02	TP03	TP04	TP05	TP06	TP08	TP09	TP10
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.10
					Date Sampled:	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018
					Asbestos Lab:	DURHAM		DURHAM	DURHAM	DURHAM				DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Phenanthrene	M	2800	mg/kg	0.10		1.5		7.1	3.0	5.1				5.1
Pyrene	M	2800	mg/kg	0.10		1.7		6.9	3.2	3.8				4.9
Total Of 16 PAH's	N	2800	mg/kg	2.0		8.1		39	16	24				29

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3233 East Bierley

Client: Lithos Consulting					**Chemtest Job No.:**	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432
Quotation No.:					**Chemtest Sample ID.:**	737152	737153	737154	737155	737156	737157	737158	737159	737160
					Sample Location:	TP11	TP12	TP01	TP05	TP08	TP03	TP06	TP07	TP09
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.10	0.10	1.80	1.30	2.00	2.30	0.80	0.50	1.30
					Date Sampled:	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018
					Asbestos Lab:	DURHAM								
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
ACM Type	U	2192		N/A	-									
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected									
Moisture	N	2030	%	0.020	13	15	5.6	7.0	7.2	7.4	17	14	10	
Soil Colour	N	2040		N/A	Brown		Brown	Grey	Grey	Grey	Brown	Brown	Brown	
Other Material	N	2040		N/A	Stones		Stones	Stones	Stones	Stones	Stones	Stones	Stones	
Soil Texture	N	2040		N/A	Sand		Sand	Clay	Clay	Clay	Sand	Sand	Sand	
pH	M	2010		N/A	5.0		5.3	6.1	7.0	6.5	7.5	7.3	6.0	
Magnesium (Water Soluble)	N	2120	g/l	0.010			< 0.010							
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010			< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	
Chloride (Water Soluble)	M	2220	g/l	0.010			0.026							
Nitrate (Water Soluble)	N	2220	g/l	0.010			< 0.010							
Total Organic Carbon	M	2625	%	0.20	1.6									
Arsenic	M	2450	mg/kg	1.0	49	39								
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.43									
Cadmium	M	2450	mg/kg	0.10	0.18									
Chromium	M	2450	mg/kg	1.0	21									
Chromium (Trivalent)	N	2490	mg/kg	1.0	21									
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50									
Copper	M	2450	mg/kg	0.50	62									
Lead	M	2450	mg/kg	0.50	110									
Mercury	M	2450	mg/kg	0.10	0.21									
Nickel	M	2450	mg/kg	0.50	26									
Selenium	M	2450	mg/kg	0.20	1.2									
Zinc	M	2450	mg/kg	0.50	82									
Acenaphthene	M	2800	mg/kg	0.10	4.4									
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10									
Anthracene	M	2800	mg/kg	0.10	2.2									
Benzo[a]anthracene	M	2800	mg/kg	0.10	4.4									
Benzo[a]pyrene	M	2800	mg/kg	0.10	2.7									
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	4.4									
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	1.3									
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	1.5									
Chrysene	M	2800	mg/kg	0.10	5.1									
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	0.16									
Fluoranthene	M	2800	mg/kg	0.10	12									
Fluorene	M	2800	mg/kg	0.10	2.8									
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	1.2									
Naphthalene	M	2800	mg/kg	0.10	3.4									

Results - Soil

Project: 3233 East Bierley

Client: Lithos Consulting					**Chemtest Job No.:**	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432	18-38432
Quotation No.:					**Chemtest Sample ID.:**	737152	737153	737154	737155	737156	737157	737158	737159	737160
					Sample Location:	TP11	TP12	TP01	TP05	TP08	TP03	TP06	TP07	TP09
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.10	0.10	1.80	1.30	2.00	2.30	0.80	0.50	1.30
					Date Sampled:	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018	03-Dec-2018
					Asbestos Lab:	DURHAM								
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Phenanthrene	M	2800	mg/kg	0.10		13								
Pyrene	M	2800	mg/kg	0.10		10								
Total Of 16 PAH's	N	2800	mg/kg	2.0		69								

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3233 East Bierley

Client: Lithos Consulting			**Chemtest Job No.:**		18-38432
Quotation No.:			**Chemtest Sample ID.:**		737161
			Sample Location:		TP11
			Sample Type:		SOIL
			Top Depth (m):		0.90
			Date Sampled:		03-Dec-2018
			Asbestos Lab:		
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	
Asbestos Identification	U	2192	%	0.001	
Moisture	N	2030	%	0.020	15
Soil Colour	N	2040		N/A	Brown
Other Material	N	2040		N/A	Stones
Soil Texture	N	2040		N/A	Sand
pH	M	2010		N/A	5.1
Magnesium (Water Soluble)	N	2120	g/l	0.010	< 0.010
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010
Chloride (Water Soluble)	M	2220	g/l	0.010	< 0.010
Nitrate (Water Soluble)	N	2220	g/l	0.010	< 0.010
Total Organic Carbon	M	2625	%	0.20	
Arsenic	M	2450	mg/kg	1.0	
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	
Cadmium	M	2450	mg/kg	0.10	
Chromium	M	2450	mg/kg	1.0	
Chromium (Trivalent)	N	2490	mg/kg	1.0	
Chromium (Hexavalent)	N	2490	mg/kg	0.50	
Copper	M	2450	mg/kg	0.50	
Lead	M	2450	mg/kg	0.50	
Mercury	M	2450	mg/kg	0.10	
Nickel	M	2450	mg/kg	0.50	
Selenium	M	2450	mg/kg	0.20	
Zinc	M	2450	mg/kg	0.50	
Acenaphthene	M	2800	mg/kg	0.10	
Acenaphthylene	N	2800	mg/kg	0.10	
Anthracene	M	2800	mg/kg	0.10	
Benzo[a]anthracene	M	2800	mg/kg	0.10	
Benzo[a]pyrene	M	2800	mg/kg	0.10	
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	
Chrysene	M	2800	mg/kg	0.10	
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	
Fluoranthene	M	2800	mg/kg	0.10	
Fluorene	M	2800	mg/kg	0.10	
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	
Naphthalene	M	2800	mg/kg	0.10	

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3233 East Bierley

Client: Lithos Consulting			**Chemtest Job No.:**		18-38432
Quotation No.:			**Chemtest Sample ID.:**		737161
			Sample Location:		TP11
			Sample Type:		SOIL
			Top Depth (m):		0.90
			Date Sampled:		03-Dec-2018
			Asbestos Lab:		
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Phenanthrene	M	2800	mg/kg	0.10	
Pyrene	M	2800	mg/kg	0.10	
Total Of 16 PAH's	N	2800	mg/kg	2.0	

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measuremernt by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Appendix J

Geotechnical Test Results

LABORATORY REPORT

4043

Contract Number: PSL18/6465

Report Date: 20 December 2018

Client's Reference: 3233

Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Matt Thompson/James Brown

Contract Title: East Bierley

Date Received: 6/12/2018
Date Commenced: 6/12/2018
Date Completed: 20/12/2018

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
L Knight (Senior Technician)	S Eyre (Senior Technician)	A Fry (Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP01	2	D	0.60		Brown slightly sandy silty CLAY.
TP02	2	D	0.70		Brown mottled grey slightly sandy CLAY.
TP03	3	D	1.20		Brown sandy CLAY.
TP04	3	D	1.10		Brown sandy silty CLAY.
TP05	2	D	0.80		Brown mottled grey slightly sandy silty CLAY.
TP07	2	D	1.40		Brown mottled grey sandy silty CLAY.
TP09	2	D	0.80		Brown mottled grey slightly sandy silty CLAY.
TP10	3	D	1.40		Brown mottled grey sandy silty CLAY.
TP11	3	D	1.50		Brown mottled grey sandy silty CLAY.
TP12	2	D	1.00		Brown mottled grey sandy silty CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP01	2	D	0.60		25			54	25	29	100	High plasticity CH.
TP02	2	D	0.70		24			51	23	28	100	High plasticity CH.
TP03	3	D	1.20		19			49	23	26	100	Intermediate plasticity CI.
TP04	3	D	1.10		17			47	25	22	100	Intermediate plasticity CI.
TP05	2	D	0.80		19			55	26	29	100	High plasticity CH.
TP07	2	D	1.40		13			44	23	21	100	Intermediate plasticity CI.
TP09	2	D	0.80		21			57	27	30	100	High plasticity CH.
TP10	3	D	1.40		15			48	25	23	100	Intermediate plasticity CI.
TP11	3	D	1.50		15			47	24	23	100	Intermediate plasticity CI.
TP12	2	D	1.00		15			43	22	21	100	Intermediate plasticity CI.

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL Professional Soils Laboratory

East Bierley

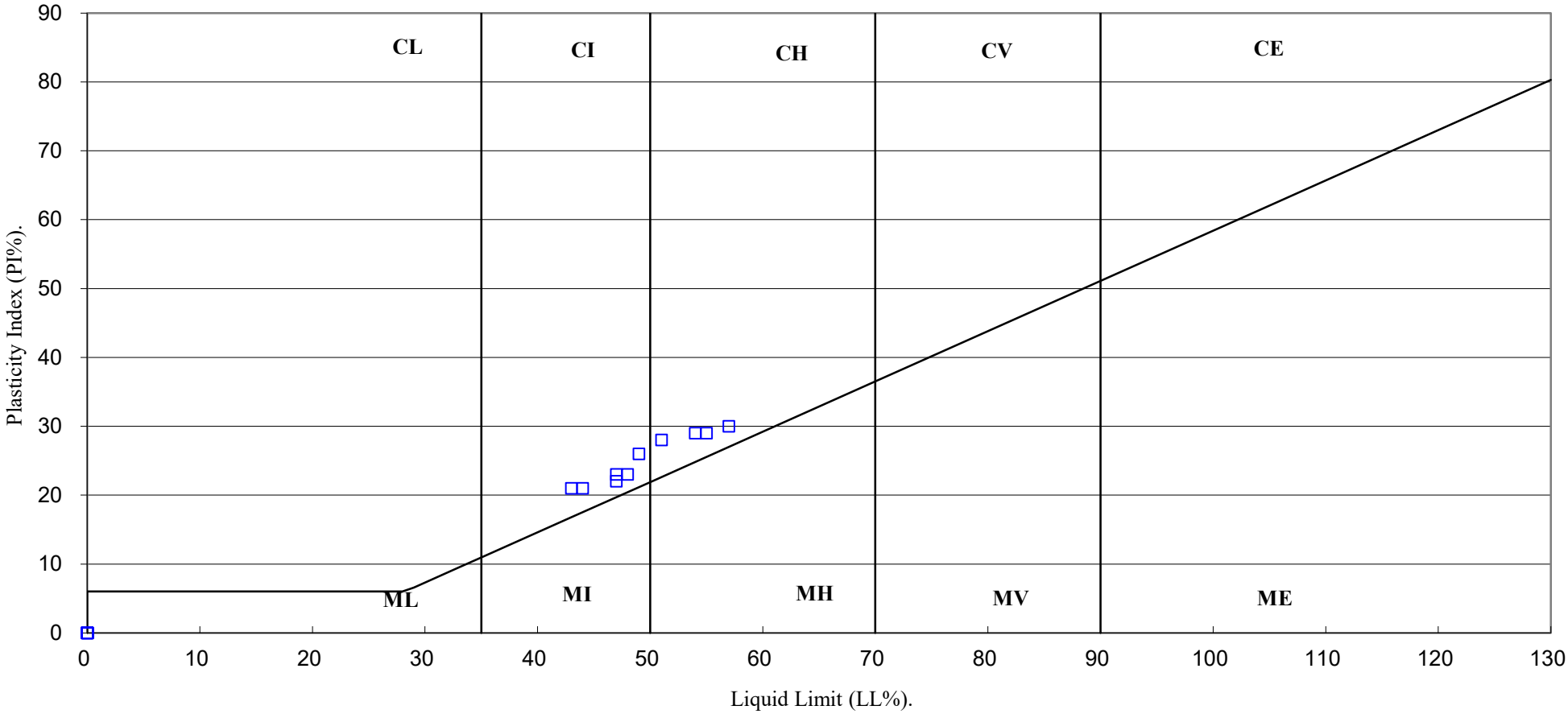
Contract No:

PSL18/6465

Client Ref:

3233

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	East Bierley	Contract No: PSL18/6465 Client Ref: 3233

Certificate of Analysis

Certificate Number 18-29080

14-Dec-18

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 18-29080

Client Reference PSL18/6465

Order No (not supplied)

Contract Title East Bierley

Description 2 Soil samples.

Date Received 11-Dec-18

Date Started 11-Dec-18

Date Completed 14-Dec-18

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 18-29080
Client Ref PSL18/6465
Contract Title East Bierley

			Lab No	1434424	1434425
			Sample ID	TP02	TP10
			Depth	0.70	1.40
			Other ID	2	3
			Sample Type	D	D
			Sampling Date	n/s	n/s
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Inorganics					
pH	DETSC 2008#			5.7	6.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	17	32

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 18-29080
Client Ref PSL18/6465
Contract East Bierley

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1434424	TP02 0.70 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1434425	TP10 1.40 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Appendix K
Gas Monitoring Results

Job Title:				Job No:
East Bierley.				3233
Client:				Sheet :
Rouse Homes.				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
09/01/2019	09:00	10:45	A Taylor.	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	0.0	CO_2:	0.0	O_2:	20.5

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
WS01	1.04	ND	0.4	ND	0.4	20.3	ND	ND	ND	1.47	
WS02	1.59	ND	0.4	ND	0.4	20.2	ND	ND	ND	1.85	
WS03	0.41	ND	0.1	ND	0.1	20.4	ND	ND	ND	1.55	Bailed to 1.45m at 09:46. 3l removed. Remonitored at 10:38.
WS04	0.48	ND	0.6	ND	0.6	20.0	ND	ND	ND	1.40	Bailed to 1.16m at 09:52. 5l removed. Remonitored at 10:40.
WS05	ND	ND	0.6	ND	0.6	20.2	ND	ND	ND	1.56	
WS06	1.74	ND	1.3	ND	1.3	16.6	ND	ND	ND	2.07	

Notes

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	16/01/2019

Key

ND	None Detected
NR	Not Recorded
1.0	Recorded value does not breach trigger levels
5.0	Recorded value breaches trigger level 1
10.0	Recorded value breaches trigger level 2

	Site Data:			Weather Station Data (East Bierley Weather Station)									
	Temp (°C):	2 to 3.		Barometric Pressure Trend:			Steady.						
Time:	09:00	09:20	10:45	00:00	05:00	09:00	09:20	10:40	17:00	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1007	1005	1007	1002.6	1003.2	1004.4	1004.8	1004.6	1004.1	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Cloudy.										
	Surface Ground Conditions:		Dry with frost patches.										

Remarks:

Job Title:				Job No:
East Bierley				3233
Client:				Sheet :
Rouse Homes				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
09/01/2019	09:00	10:45	A Taylor	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	0.0	CO_2:	0.0	O_2:	20.5

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
WS01											
WS02											
WS03	0.65	ND	0.4	ND	0.4	19.5	ND	ND	ND	1.56	Bailed to 1.45m at 09:46. 3l removed. Remonitored at 10:38.
WS04	0.59	ND	0.3	ND	0.3	20.0	58.3	0.0	60.0	1.40	Bailed to 1.16m at 09:52. 5l removed. Remonitored at 10:40.
WS05											
WS06											

Notes

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	16/01/2019

Key

ND	None Detected
NR	Not Recorded
1.0	Recorded value does not breach trigger levels
5.0	Recorded value breaches trigger level 1
10.0	Recorded value breaches trigger level 2

	Site Data:			Weather Station Data (East Bierley Weather Station)									
	Temp (°C):	2 to 3.		Barometric Pressure Trend:			Steady.						
Time:	09:00	09:20	10:45	00:00	05:00	09:00	09:20	10:40	17:00	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1007	1005	1007	1002.6	1003.2	1004.4	1004.8	1004.6	1004.1	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:	Cloudy.											
	Surface Ground Conditions:	Dry with frost patches.											

Remarks:	

Appendix L

Soakaway Results

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Rouse Homes
Engineer	A Taylor
Job Name:	East Bierley
Job No.:	3233

Date:	**03/12/2018**
Trial Pit No.	**SA01**
Test No.	**1**

Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:51	0	1.12	1120
09:52	1	1.12	1120
09:53	2	1.12	1120
09:54	3	1.12	1120
09:55	4	1.12	1120
09:56	5	1.12	1120
10:23	32	1.15	1150
11:45	114	1.20	1200
13:13	202	1.24	1240
14:26	275	1.26	1260
14:52	301	1.27	1270

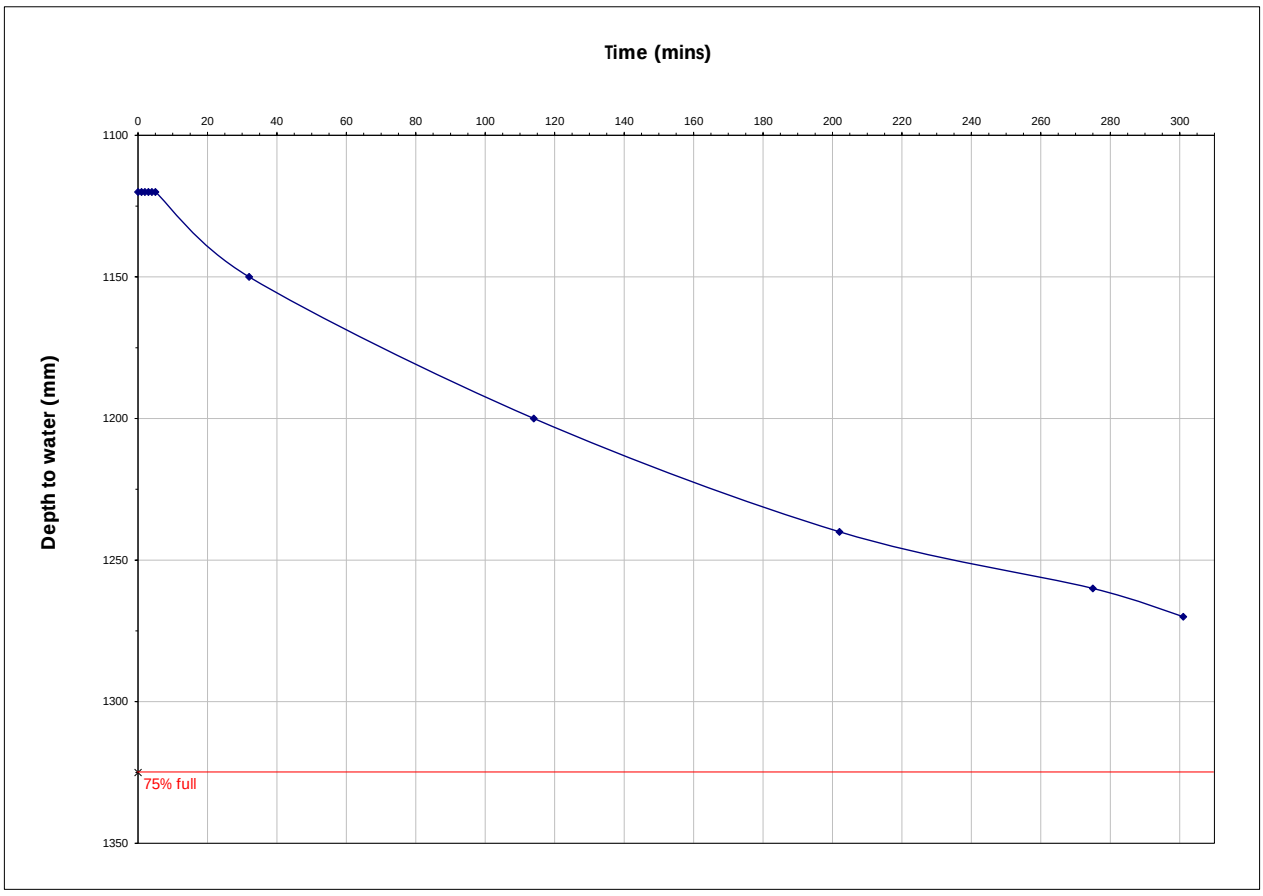
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.40	2400
Width	=	0.70	700
Depth	=	1.94	1940

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1735	1.74
0.50	=	1530	1.53
0.75	=	1325	1.33

Depth at start of test (mm)	=	1120
Depth at end of test (mm)	=	1270

Base area of pit	=	1.68
a_{p50} - 50% internal surface area inc. base	=	4.222
V_{p75-25} - Volume 75 - 25%	=	0.6888

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Rouse Homes
Job Name:	East Bierley
Job No.:	3233

Trial Pit No.	**SA02**
Test No.	**1**

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:12	0	1.26	1260
10:13	1	1.26	1260
10:14	2	1.26	1260
10:15	3	1.26	1260
10:16	4	1.26	1260
10:17	5	1.26	1260
10:50	38	1.25	1250
11:48	96	1.23	1230
13:10	178	1.22	1220
14:25	253	1.19	1190
15:02	290	1.17	1170

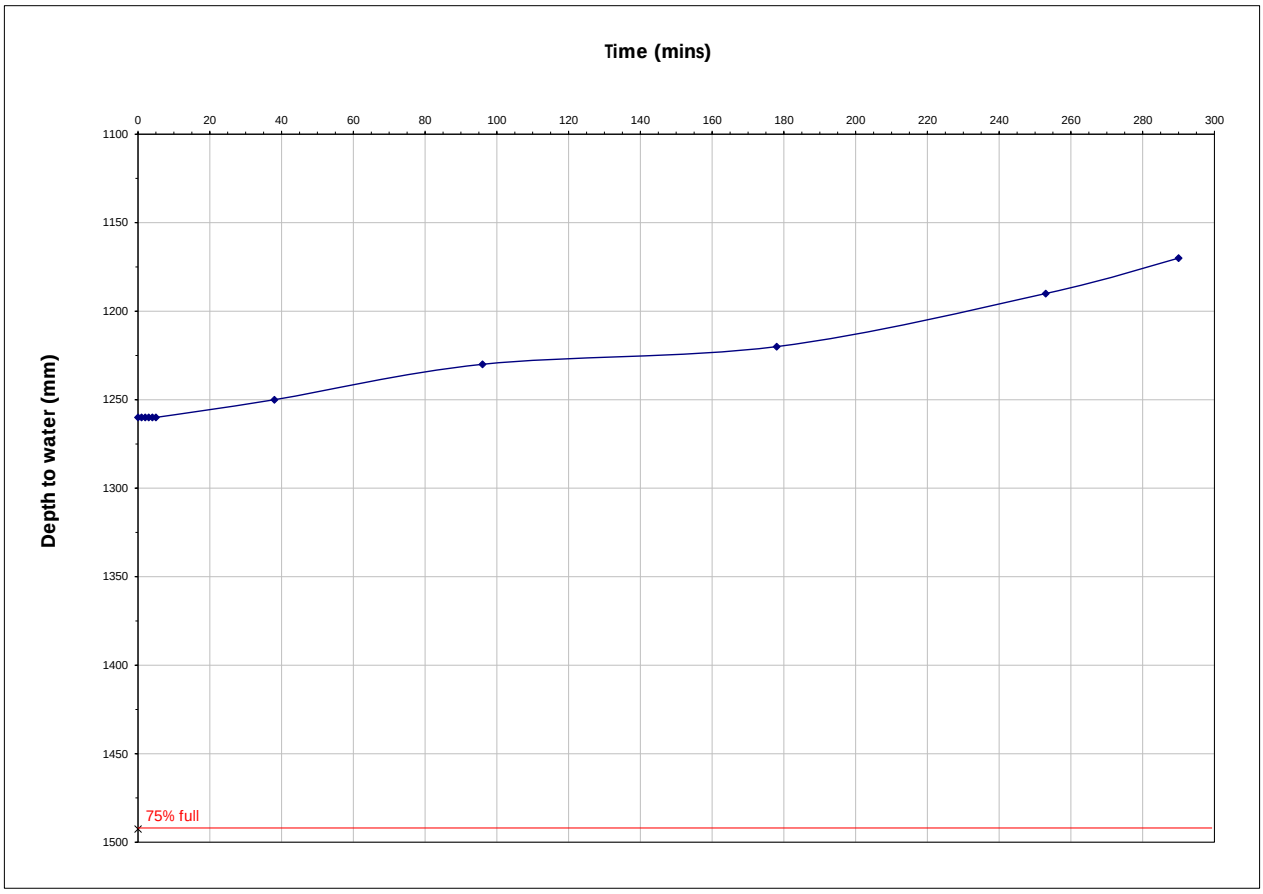
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.80	2800
Width	=	0.70	700
Depth	=	2.19	2190

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1957.5	1.96
0.50	=	1725	1.73
0.75	=	1492.5	1.49

Depth at start of test (mm)	=	1260
Depth at end of test (mm)	=	1260

Base area of pit	=	1.96
a_{p50} - 50% internal surface area inc. base	=	5.215
V_{p75-25} - Volume 75 - 25%	=	0.9114

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Rouse Homes
Job Name:	East Bierley
Job No.:	3233

Trial Pit No.	**SA03**
Test No.	**1**

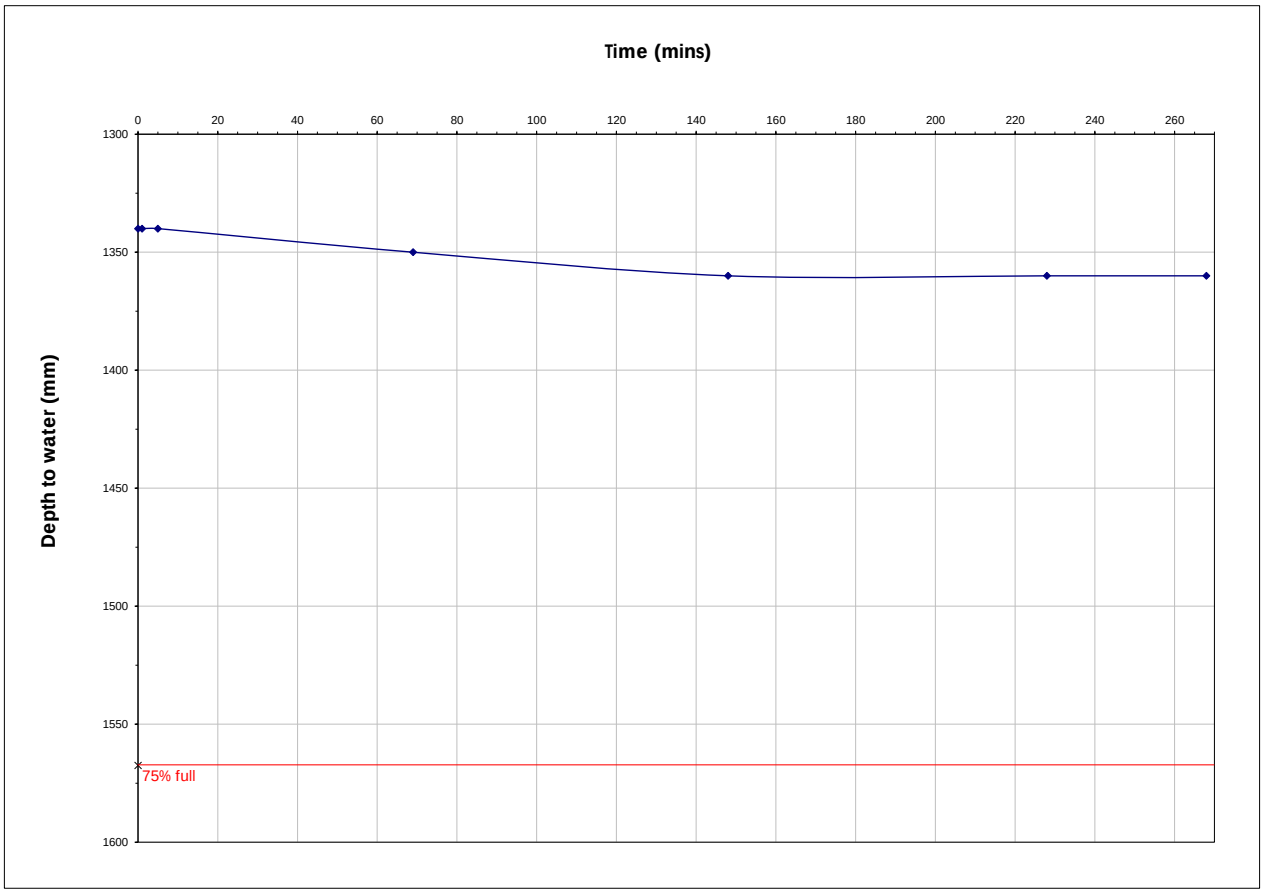
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:39	0	1.34	1340
10:40	1	1.34	1340
10:44	5	1.34	1340
11:53	69	1.35	1350
13:07	148	1.36	1360
14:27	228	1.36	1360
15:07	268	1.36	1360

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.40	2400
Width	=	0.70	700
Depth	=	2.25	2250

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2022.5	2.02
0.50	=	1795	1.80
0.75	=	1567.5	1.57

Depth at start of test (mm)	=	1340
Depth at end of test (mm)	=	1360
Base area of pit	=	1.68
a_{p50} - 50% internal surface area inc. base	=	4.501
V_{p75-25} - Volume 75 - 25%	=	0.7644

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Rouse Homes
Job Name:	East Bierley
Job No.:	3233

Trial Pit No.	**SA04**
Test No.	**1**

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:03	0	1.52	1520
11:04	1	1.52	1520
11:08	5	1.53	1530
12:01	59	1.54	1540
13:05	122	1.54	1540
14:29	206	1.54	1540
15:11	248	1.54	1540

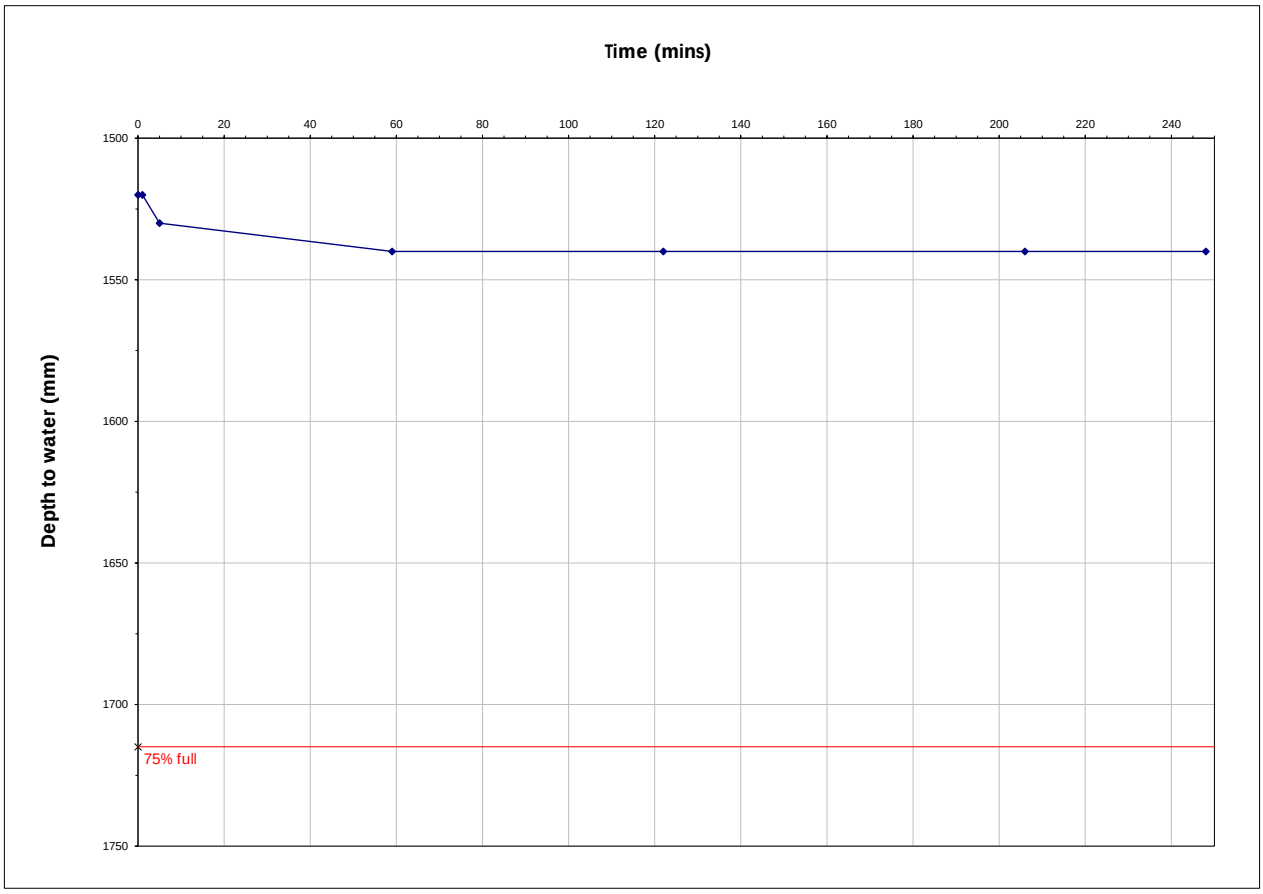
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.60	2600
Width	=	0.70	700
Depth	=	2.30	2300

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2105	2.11
0.50	=	1910	1.91
0.75	=	1715	1.72

Depth at start of test (mm)	=	1520
Depth at end of test (mm)	=	1540

Base area of pit	=	1.82
a_{p50} - 50% internal surface area inc. base	=	4.394
V_{p75-25} - Volume 75 - 25%	=	0.7098

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Rouse Homes
Job Name:	East Bierley
Job No.:	3233

Trial Pit No.	**SA05**
Test No.	**1**

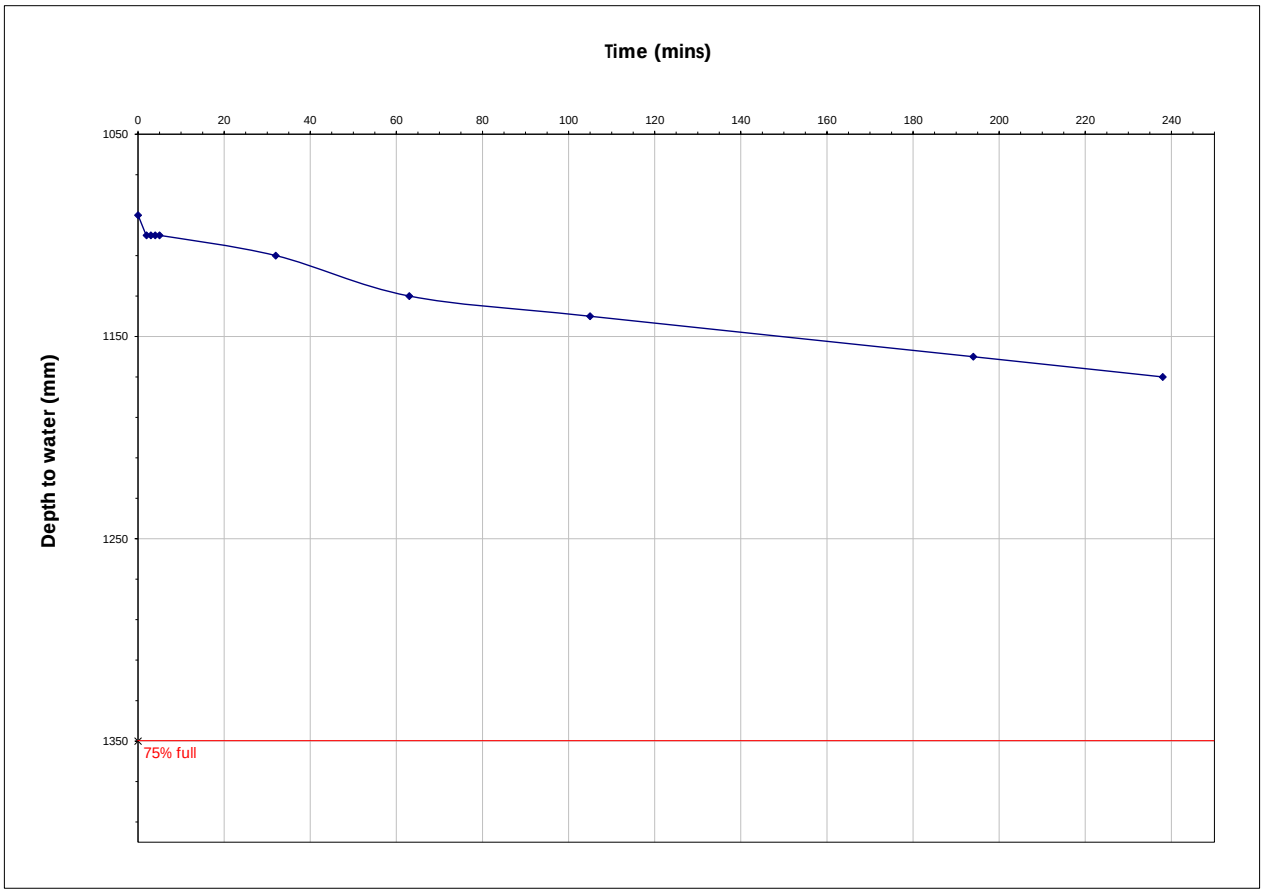
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:18	0	1.09	1090
11:20	2	1.10	1100
11:21	3	1.10	1100
11:22	4	1.10	1100
11:23	5	1.10	1100
11:50	32	1.11	1110
12:21	63	1.13	1130
13:03	105	1.14	1140
14:32	194	1.16	1160
15:16	238	1.17	1170

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	3.00	3000
Width	=	0.70	700
Depth	=	2.13	2130

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1870	1.87
0.50	=	1610	1.61
0.75	=	1350	1.35

Depth at start of test (mm)	=	1090
Depth at end of test (mm)	=	1170
Base area of pit	=	2.1
a_{p50} - 50% internal surface area inc. base	=	5.948
V_{p75-25} - Volume 75 - 25%	=	1.092

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

Appendix M

Yorkshire Water Contaminated Land Assessment Form

Contaminated Land Assessment Form

Introduction

In January 2011, UK Water Industry Research (UKWIR) published “Guidance for the selection of Water Supply Pipes to be used in Brownfield Sites” (UKWIR 2010 Ref 10/WM/03/21). The aim of this publication is to ensure that the correct materials are selected for Water Pipes to be used below ground in Brownfield Sites. It supersedes the Water Regulations Advisory Scheme (WRAS) Information and Guidance Note 9-04-03 “Laying Pipes in Contaminated Land” which has now been withdrawn.

The UKWIR guidance is for use by Water Companies, Self Lay Organisations, Developers and Consultants during the planning, designing and construction of water mains and/or services in Brownfield Sites. The guidance defines a Brownfield Site as “Land or premises that have not previously been used or developed. They may also be vacant or derelict. However, they are not necessarily contaminated.” UKWIR state the guidance does not apply to Greenfield Sites, however YW reserve the right to apply relevant sections of the publication to Greenfield Sites that may potentially be contaminated.

Contamination Risk Assessment

Please complete the form below to allow us to assess the risk of contamination of the drinking water supply from chemicals within the soil. Yorkshire Water now lays all its water mains and service pipes in plastic. Many organic compounds (i.e. Phenols, Fuels and other hydrocarbons) can either permeate through the walls of plastic pipes into the water supply or dissolve and weaken the pipe causing water leaks.

As a minimum a desk top study (Preliminary Risk Assessment) shall be provided to YW that sets out whether the land through which the Water Pipes are to be laid may be affected by contamination. For those sites where land contamination may be present, appropriate testing shall be undertaken on existing ground materials and remediated materials. The testing requirements are as described below:

Testing Requirements

The tests that are required on all sites where the potential for contamination has been established through the desk top study and where water pipes are proposed to be laid must be undertaken by bodies with accreditation from UKAS (United Kingdom Accreditation Service) and where possible MCERTS (Environment Agency’s Monitoring Certification Service).

The tests on soil/water samples shall be those to detect and report on the levels of the following contaminant groups and chemical characteristics: **VOC’s, SVOC’s, Mineral Oil compounds C10-C40, Conductivity, pH** and **Redox potential** (as stipulated in the UKWIR guidance Appendix G).
If the previous function of the site involved the use, storage, manufacture or disposal of any of the following elements, appropriate testing for these substances will be required:

Ethers, Nitrobenzene, Ketones, Aldehydes and Amines. Please note UKWIR guidance states the presence of Amines on any site precludes the use of Polyethylene pipework.

Sufficiency of Testing

Samples taken must be representative of the soil conditions in which the Water Pipes are proposed to be laid (normally Water Pipes are laid at a depth between 0.7m and 1.3m below finished ground level). As a result samples must be taken at least 500mm below the base of the proposed pipe where the proposed location is known. If the proposed location is unknown then samples must be taken at intervals between the surface level and 1.5m from below finished ground level as a minimum. Where appropriate groundwater sampling and groundwater monitoring will also be necessary (see UKWIR guidance).

Further guidance on representative sampling is contained within BS10175:2011 “Code of practice for the Investigation of Potentially Contaminated Sites”.

The table in section 3 lists the contaminants and their respective levels which can permeate or damage plastic water pipes with consequent risk to the water supply. Where soil analysis results indicate levels of these contaminants above the maximum allowable concentration shown, then Yorkshire Water will determine that all mains and service pipes are laid in suitable materials resistant to the risks posed by those contaminants. Where sites have been used for any of the activities listed in Section 2 all mains and services shall be laid in suitable permeation resistant pipe systems due to the high risk of these contaminants being present.

Health & Safety Assessment

The UKWIR guidance does not cover Health & Safety considerations as part of any operational activities undertaken on Brownfield Sites. In order to maintain the safety of our staff, service partners and customers YW will also assess the site based on the EA CLEA (Contaminated Land Exposure Assessment) guidelines.

In order to comply with Yorkshire Water’s Health & safety requirements please review the following information relating to trigger values for Health & Safety considerations when laying Water Pipes in contaminated Land.

	Contaminant	Mg/Kg		Contaminant	Mg/Kg
Inorganic	Arsenic	32	Organic	Benzene	0.33
	Nickel	130		Toulene	610
	Mercury	170		Ethylbenzene	350
	Selenium	35		Xylene	230
	Cadmium	10		Phenol	420

1. Your Details

Company Name	Contact Name
Lithos Consulting	Matt Thompson

Site Address	Contact Number
Soureby Cross Way, East Bierley	01937 545 337

2. The Previous Use of the Site

Please indicate below the previous uses of the site being developed

Greenfield, though BGS maps note made ground present in the south. No evidence of made ground encountered during the ground investigation.

Please indicate if the site (or part of it) has previously been used for any of the following activities:

	Chemicals Manufacture		Paint or Ink Manufacture
	Explosives / Ordnance Manufacture		Railway Land / Railway Engineering
	Fuel Filling Stations / Storage		Scrap metals
	Metal Finishing / Treating		Shipbuilding & Repair
	Mechanical Engineering Works		Vehicle Repair Garages
	Oil & Gas Refineries / Storage		Vehicle Manufacturing

3. Contaminants

Please complete the table below with the highest concentrations in mg/kg of each or any of the contaminants listed. The information should be extracted from your soil reports already undertaken, if any of the contaminants were not tested for, this should be declared on the form along with the reasons for this. If you have any difficulty interpreting the results of your soil sample analyses and transposing them into the table, then you should consult the body who undertook the sampling and reporting. If there are more than 3 sample locations with associated test results please copy the table for each location and label each with the sample reference and its location on a site plan.

Laboratory Name:		Date	Concentration	
Group No.	Parameter group	Unit	Depth (m)	Detection Limit
1	Extended VOC suite (with TIC)	mg/kg	N/A	0.5
1a	BTEX & MTBE	mg/kg	N/A	0.1
2	Extended SVOC suite (with TIC)	mg/kg	Max. benzo(a)pyrene – 2.7mg/kg Max. naphthalene – 3.4mg/kg	2
2e	Phenols	mg/kg	N/A	2
2f	Cresols and chlorinated phenols	mg/kg	N/A	2
3	Mineral Oils C_{11}-C_{20}	mg/kg	N/A	10
4	Mineral Oils C_{21}-C_{40}	mg/kg	N/A	500
5	Corrosive (Conductivity, Redox & pH)		N/A	
	Conductivity	µS/cm	N/A	
	Redox	Volt	N/A	
	pH	pH	5.0 to 7.1	
2a	Ethers	mg/kg	N/A	0.5
2b	Nitrobenzene	mg/kg	N/A	0.5
2c	Ketones	mg/kg	N/A	0.5
2d	Aldehydes	mg/kg	N/A	0.5
6	Amines	mg/kg	N/A	Any presence

At the time of investigation, the proposed route(s), and total length, of pipeline were unknown. Consequently, to date laboratory testing of soil samples in line with UKWIR guidance was not undertaken. Sampling within 15m of proposed water supply pipes could be undertaken, once infrastructure design have been completed. The lab tests summarised above were undertaken on samples of **topsoil** only.

However, given the site's history and the relatively consistent ground conditions reported, the use of 'standard' polyethylene water supply pipes should be acceptable.

DO NOT include a copy of your soil report with your application, if you do not complete the table above your application will be returned to you.

Please include a site plan highlighting the locations of the above sample points.

4. Remediation of the site

Please indicate below any remediation work that will be undertaken on the site to remove / mitigate the effect of any contaminants identified in the soil report. Please include the nature and depth of any remediation work.

No significant contamination identified, therefore no remediation work necessary.

5. Can I use plastic pipe if I undertake remediation works?

Yes, as long as the remediation work either removes the contaminated soil or reduces the level of contaminants below trigger levels. Moving contaminated material so that it is under roads and footpaths is not acceptable as this is the likely location of the water mains.

As water mains are lad to a depth of 0.9m to the top of the pipe, any contaminated soil to a depth of 1.3m must be removed. We will require post remediation sampling results confirming contamination has fallen below the trigger levels prior to releasing any works to our Service Partners.

If contamination is found all water mains and services on the site must be laid in a suitable barrier pipe. Yorkshire Water will not change the agreed mains material after the agreement has been signed by all parties. So please ensure your remediation proposals are made clear at this stage.

6. Declaration

I hereby confirm that the information provided in this form is true and I understand that should the site conditions change from those indicated in this report that I may incur additional costs.

Your Signature	Date
	18th January 2019

Your Name & Title (PLEASE PRINT	Role in organisation
Mr. Matthew Thompson	Associate Director

Please return this completed form with your application to Developer Services, Yorkshire Water Services Ltd, PO Box 52, Bradford BD3 7YD

References

BS10175:2011 “Investigation of Potentially Contaminated Sites Code of Practice

UK Water Industry Research (UKWIR) “ Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites” (Ref 10/WM/03/21)