

A photograph showing a cross-section of a soil bank. The top layer is dark brown soil with some green grass. Below this is a layer of lighter brown soil containing several small, light-colored rocks. The bottom layer is a mix of brown soil and yellowish-brown material, possibly a geotextile or a different soil type. The text "Geoenvironmental Appraisal" is overlaid in white on the left side of the image.

Geoenvironmental Appraisal

Land at Lundhill Road, Wombwell For Persimmon Homes West Yorkshire

Report no: 2409/2A

Date: December 2017



SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2409	Site area/ha	4.9ha (12.1 acres)
Client:	Persimmon Homes West Yorkshire	NGR:	SE 403 019
Site:	Lundhill Road, Wombwell	Nearest postcode:	S73 0QZ

The site is located off Lundhill Road to the west, approximately 1km south-east of Wombwell town, and currently comprises two adjoining, overgrown fields (west and east), with areas of dense vegetation (bushes, brambles etc) predominantly in the western field.

The western field slopes relatively steeply down to the south with a paddock and rudimentary shelter for horses at the eastern end. The eastern field slopes down more gently and is typically covered in long grass.

Lithos were commissioned by Persimmon to provide a geoenvironmental appraisal of the site. It is understood that the site is to be redeveloped with housing; an illustrative layout has been prepared.

Lithos' investigation included a review of the site's history and environmental setting, and a ground investigation comprising 26 trial pits, 30 deep rotary probeholes to investigate mineworkings, and 10 shallow rotary probeholes with monitoring well installations.

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

Issue	Remarks
Made ground	None encountered.
Natural ground	Topsoil (typically 300mm to 400mm in thickness), covers the entire site. Underlying sequence of Residual Soils (stiff sandy gravelly clay), over Weathered Coal Measures (clay with lithorelicts) and Coal Measures (sandstone, siltstone & mudstone) depending on the degree of weathering. Rockhead was typically encountered between 2m and 3m depth. Coal was encountered in 4 of the 26 trial pits (recovered as clayey interlaminated mudstone and coal) and in 14 of the 16 deep probeholes.
Contamination	No visual or olfactory evidence of hydrocarbon contamination. Existing Topsoil is therefore considered suitable for re-use.
Mining & quarrying	The majority of the 30 deep probeholes encountered solid coal. However, soft and broken ground with <10x competent cover was identified in 5 probeholes. Further soft and broken ground with >10 times competent cover also recorded in 2 probeholes. The soft/broken ground was typically accompanied by an absence of solid coal, and triangulation shows the depth of soft/broken ground at the expected depth of the coal seam. Consequently, mitigation of risks to surface stability is considered necessary; likely via drilling and grouting.
Hazardous gas	No radon protection measures are required. Monitoring for hazardous gas is ongoing and will be reported in April 2018.
Preparatory works	Clearance of vegetation and unprotected trees with stockpiling of topsoil for subsequent re-use. Localised site re-grade likely in south-west.
Foundations	Reinforced strip/trenchfill footings are considered the most suitable foundation solution for 2 to 3 storey properties constructed at this site.
Groundwater & excavations	Groundwater levels recorded in monitoring wells typically lie at between 2m and 4m bgl. Shallow excavations should remain stable during the construction phase in the short term.
Flooding & drainage	The far south-east of the site, adjacent to the canal, lies within Flood Zone 2. Soakaways are highly unlikely to provide a suitable means of surface water disposal at the site. Consequently, there is likely to be a need for surface water balancing.
Highways	The Residual Soils and Weathered Coal Measures strata should provide a CBR value of at least 2%. This value should be verified prior to or during construction.
Development constraints	Overhead power lines on timber telegraph poles cross the centre of the site from north to south, with further power lines on the southern boundary of the eastern field. The final layout will need to consider the position of the power lines if they cannot be diverted. A cast iron access chamber was noted in the centre of the site which is not shown on any statutory plans. Lifting the cover identified a drain of around 150mm diameter flowing from north to south.

Developer abnormalities relating to geoenvironmental issues at the site are:

- Localised site re-grade
- Requirement for consolidation of mineworkings via drilling and grouting

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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APPENDICES

Appendix A - General notes

01	Environmental setting
02	Ground investigation fieldwork
03	Geotechnical testing
04	Contamination laboratory analysis & interpretation
05	Hazardous gas

Appendix B - Drawings

Drawing	Revision	Title
2409/1	-	Site location plan
2409/2	-	Proposed layout
2409/3	-	Site features
2409/4	-	Site photographs
2409/5	-	Published geology
2409/6	-	Preliminary conceptual site model
2409/7	A	Exploratory hole location plan
2409/8	-	Revised conceptual site model
2409/9	A	Areas of shallow coal & identified workings

Appendix C - Commission

Appendix D - Historical OS plans

Appendix E - Search responses

From	Date	Content
Landmark	23 rd August 2016	Environmental search data
Coal Authority	23 rd August 2016	Mining report
Coal Authority	20 th June 2017	Permit to enter or disturb Coal Authority mining interests

Appendix F & G - Exploratory records

Appendix F	TP1 to TP26
Appendix G	PHs 1 to 11 & 14 to 18 PHs 2a, 4a, 5a, 6a, 7a, 8a, 9a, 11a, 12a & 14a PHs 101 to 114

Appendix H - Chemical test results

Appendix I - Geotechnical test results

Appendix J - Gas monitoring results

Some of this data is not included within the paper or PDF copies of this report; it is all included on the 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 only included on the accompanying 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. All 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
LUNDHILL ROAD, WOMBWELL

1 INTRODUCTION

1.1 The commission and brief

- 1.1.1 Lithos Consulting Limited were commissioned by Persimmon Homes West Yorkshire to carry out a geoenvironmental appraisal of land at Lundhill Road, Wombwell.
- 1.1.2 This document is a revision of the Geoenvironmental Appraisal (Report 2409/2) issued by Lithos in November; Report 2409/2 is now superseded. This document now includes the findings of additional rotary probing undertaken at the site, with the only significant revisions to 2409/2 having been made in Sections 6, 7.8, 12.2, 12.4, 14.2 and Drawings 2409/6 & 2409/9 in Appendix B.
- 1.1.3 Additional groundwater and hazardous gas monitoring results have also been included in Sections 7.6.2, 10.3 and Appendix J.
- 1.1.4 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:
- 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 26 trial pits, 30 deep rotary probeholes, and 10 shallow rotary probeholes with monitoring well installations
 - Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
 - A qualitative assessment of contamination risks
 - Recommendations for the necessary site preparatory works
- 1.1.5 Primary aims of this exploratory phase of investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable Persimmon 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 165 traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A site layout has been provided by Persimmon (Drawing reference Lundhill Road Illustrative Layout, dated June 2016) which is reproduced as Drawing 2409/2 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

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.

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 2409/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	1 km south-east of Wombwell town centre
NGR	SE 403 019
Approximate area	4.9ha (12.1 acres)
Known services	Overhead telecom and electric

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on 17th August 2016.

2.2.2 Existing salient features, at the time of the walkover are presented on Drawing 2409/3 in Appendix B to this report, and summarised in the table below.

Feature	Remarks
Current Access	Off Lundhill Road to the west
Topography	West of site slopes down from northern boundary towards south, south-west and south-east. East of site more gently sloping, again falling down to the south-east. Steep embankment of around 1m height on southern boundary (with canal immediately beyond).
Approximate areas	Western Field = 2.8ha Eastern Field = 2.1ha
Nature of boundaries	North and east - trees, hedges and various garden fencing. South – trees and post & wire fencing. Open to canal in south-east. West bushes and trees in south-west, timber fencing to north-east and Lundhill Road.
Surrounding land uses	North & east – existing residential (Lundhill Grove, Dove Road & Grantley Close). South – single storey dwelling and farm buildings (appeared vacant). Canal to south-east with A6195 Dearne Valley Parkway and commercial/retail units beyond. Fields and pond to south-west. West – Lundhill Road with open fields beyond.

2.2.3 A selection of site photographs is included on Drawing 2409/4.

- 2.2.4 The site comprises two overgrown fields (west and east) with areas of dense vegetation (bushes, brambles etc) predominantly in the western field.
- 2.2.5 Access is from Lundhill Road in the west, with timber gates in the north-west and south-west corners of the western field. A separate access track runs along the southern boundary of the site providing access to a single storey residential dwelling (appeared vacant) farm buildings and the eastern field (along an overgrown track).
- 2.2.6 Trees are typically located around the site boundaries with a row of mature poplars (12m to 14m high) on the southern boundary of the western field, adjacent to the overgrown track.

Western Field

- 2.2.7 Typically, the western field slopes down from the northern boundary towards the south, south-west and south-east (creating a central ridge) at around 1 in 14 before steepening on the southern boundary to around 1 in 7.
- 2.2.8 The eastern end of the field slopes more gently down to the south-east at around 1 in 17 before levelling off slightly.
- 2.2.9 The remains of a dilapidated timber fence running north to south divides the western field with a further fenced/paddock area at the eastern end.
- 2.2.10 Rudimentary shelters constructed from timber, corrugated steel and plastic sheeting are located adjacent to the paddock providing shelter for horses.
- 2.2.11 An overhead powerline crosses the paddock from north to south.
- 2.2.12 Occasional piles of timber (old fencing) and bricks/blocks are located in the centre of the field.
- 2.2.13 On the southern boundary, a ponded/ boggy area was noted.

Eastern Field

- 2.2.14 The eastern field is more gently sloping at around 1 in 25 down to the south-east and is typically covered in long grass with trees and bushes on the northern, eastern and western boundaries.
- 2.2.15 The southern boundary is open and is bounded with a steep embankment of around 1m height with a canal immediately beyond running the length of the boundary.
- 2.2.16 Overhead power lines cross the extreme south of the field from east to west with additional power lines crossing the site on timber poles from north to south (extending through the paddock in the western field).
- 2.2.17 Access to the eastern field is from the north-west corner at the eastern end of the overgrown track leading to Lundhill Road.

2.3 Site operations

- 2.3.1 The fields at the site are typically overgrown, however at the time of the walkover horses were kept in the east within paddocks, with associated rudimentary shelters fashioned from timber, corrugated steel sheeting and plastic sheeting.
- 2.3.2 At the time of the recent intrusive works the horses had been removed from the site.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1854 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
1854	Site comprises separate fields ; the western field and eastern field. North-east corner comprises part of another field located to the north-east.	' Coal Pit ' immediately beyond south-west boundary. ' Dearne and Dove Canal ' immediately beyond southern boundary. Lundhill Road on western boundary. 'Lund Ponds' to south-west beyond Lundhill Road
1892	No significant changes	' Engine House – Pumping ' immediately south with railway and sidings along south-western boundary. ' Coke Ovens ' 200m to the south with ' Cortonwood Colliery ' immediately beyond. ' Lundhill Colliery ' 300m to west. Ponds to south-west absent. Lundhill Tavern public house on Lundhill Road to south-west.
1905		Sewage works to south-west. Lundhill Colliery labelled as 'Old Coal Pit'.
1930		Extensive residential development of the town of Wombwell to the north-west. Railway, sidings and engine house to the south all absent. Canal to south still present but now labelled as 'dis-used'.
1938		Further residential development of the town of Wombwell to the north.
1956		Colliery spoil heaps to west of Cortonwood Colliery, approximately 400m to south of site.
1966		Residential development to north, approximately 150m from site boundary. Residential expansion of village of Brampton around 400m south-east.
1980		Playing fields to west immediately beyond Lundhill Road. Residential development to north-east of site. ' Shaft ' labelled around 50m beyond southern site boundary adjacent to canal. Extensive expansion of colliery spoil tips to east and west of Cortonwood Colliery.
1982		Residential development immediately beyond northern boundary. Cortonwood Colliery absent, associated infrastructure (railways etc) dismantled, spoil heaps remain.
1999		'Greenlands Farm' immediately to south-west. Large pond beyond in area of former sewage works. Construction of Dearne Valley by-pass to south immediately beyond the canal. Development of former Cortonwood Colliery with commercial and retail units.
2006		Further expansion of commercial and retail units to the south.

3.3 No former uses of the site are shown on historical OS plans other than open fields, with recent grazing and stabling of horses.

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 responses from the Coal Authority, the BGS and the Environment Agency 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 87) 1:10,000 BGS map (Sheet SE 40 SW)	Drift – none. Solid – Middle Coal Measures (mudstone, siltstone and sandstone strata) with sandstone units in north (western field) and south (eastern field). Faults – running north-east to south-west with downthrow to south-east, roughly along the boundary between the western and eastern fields. Shallowest coal seam – Eastern fault block : Swinton Pottery Coal (0.3m to 1.2m thick) outcrops in far north of eastern field and dips to the north-east. Underlain by Newhill coal (1.0m to 3.0m thick) at around 35m below the Swinton Pottery Coal. Both seams shown to include relatively thick argillaceous partings. Western Fault Block : Newhill coal outcrops on the southern boundary and dips towards the north-east. Strata Dip – around 4 degrees to north-east (southern fault block).
Mining	Coal Authority	This site is located within a Coal Mining Development Low Risk Area, but with localised areas of High Risk associated with the outcrops of the Newhill and Swinton Pottery Coals. Further information is provided in Section 4.3 below.
Quarrying	Historical OS plans	There are no known quarries at or adjacent to the site.
Radon	Public Health England	The site lies in an area where between 1% and 3% of homes are estimated to be above the action level.
Hydrogeology	Environment Agency	Groundwater Source Protection Zone? No. Aquifer? Secondary A (Solid). Groundwater abstractions? None within 1km of the site. Soil leaching potential – Low
Hydrology	Envirocheck	Nearest watercourse(s) – Elsecar canal on southern boundary. Water quality - E. Pollution incidents? Nearest 80m to the south-west involving discharge of landfill leachate to streams. Abstractions? Nearest 125m to south-east, licence revoked. Discharge consents? Nearest 140m to south for discharge of sewage.
Flood risk	Environment Agency	The far south-east adjacent to the canal lies in Flood Zone 2, land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding. 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 where new development lies within Flood Zones 2 and 3.

4.2 Landfills

4.2.1 Known or suspected areas of landfill in the vicinity of the proposed development site are summarised below:

Location	NGR (proximity to site)	Remarks	Source of data
Lundhill Tavern (Beach House Road, Wombwell)	SE 404 018 (20m south)	No dates of backfilling or material types provided.	EA Landmark
Lundhill Road	SE 405 018 (70m south-west)	Inert, industrial, commercial, household and liquid/sludge wastes deposited between 30 th November 1977 and 2 nd August 1988.	
V H E Construction Plc - Former Cortonwood Colliery	SE 408 014 (125m south)	Inert and industrial wastes deposited from 12 th December 1992 as part of Cortonwood Colliery Reclamation Scheme. No end date provided, however, site now redeveloped with commercial and retail park.	

4.2.2 It is considered that the above sources have the potential to generate hazardous gas which may affect the development site, most notably the landfills at Lundhill Tavern to the south and Lundhill Road to the south-west.

4.3 Coal & mining

4.3.1 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. This Section provides the necessary mining risk assessment required by the proposed planning application.

4.3.2 Geological maps suggest that two coal seams underlie the site at shallow depth. These are the:

- Swinton Pottery Coal, 0.3 to 1.2m thick, outcropping on the northern boundary of the eastern fault block (underlying approximately 800m² of the site)
- The Newhill Rider coal, a discontinuous seam of thin coal, may lie beneath the site, recorded at around 3m to 6m above the Newhill Coal. The Newhill Rider is recorded as being worked by opencast methods together with the Newhill Coal around 270m to the south-east. The outcrop of the Newhill Rider is not recorded much beyond the area of opencast on the BGS plan
- Newhill Coal, 1.0m to 3m thick including argillaceous partings outcropping on the southern boundary of the western fault block (underlying around 25,000m²) and around 125m south of the site on the eastern fault block (underlying an area of around 23,100m²)

4.3.3 Approximate outcrops are shown on Drawing 2409/5 in Appendix B to this report.

4.3.4 Given its dip and topography, the Newhill seam is expected to underlie the west of the site at shallow depth (<30m) and the east of the site from around 10m to 20m on the southern boundary. The next underlying significant coal seam is the Meltonfield Coal (0.5m to 1.6m thick) which underlies the Newhill Coal by around 30m.

4.3.5 It should be noted that seam outcrops plotted on geological maps have been known to be inaccurate by distances in excess of 100m.

- 4.3.6 Those areas of the site close to outcrop of both the Newhill and Swinton Pottery coal seams are shown to lie within High Risk Areas - areas with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc, typically the western fault block and north-west corner of the eastern fault block.
- 4.3.7 The remainder of the site, predominantly the eastern fault block and far north of the western fault block, lies within a Low Risk Area - within the defined coalfield, but no known defined risks have been recorded by the CA; there may still be unrecorded issues.
- 4.3.8 The CA mining report states that:
- *The property is in a surface area that could be affected by underground mining in 5 seams of coal at 50m (likely the Meltonfield Coal) to 570m depth, and last worked in 1962*
 - *Any movement due to coal mining activity should have stopped by now*
 - *In addition, the property is in an area where the Coal Authority believes there is coal at or close to the surface. This coal may have been worked at some time in the past. This comment probably relates to the Swinton Pottery and Newhill coals.*
 - *The property is not in the likely zone of influence of any present underground coal workings.*
 - *The property is not in an area for which the Coal Authority is determining whether to grant a licence to remove coal using underground methods.*
 - *There are no known mine entries within, or within 20 metres of, the boundary of the property.*
 - *The Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining. This confirms the absence of any known significant geological faults below the site.*
 - *The property is not within 800 metres of the boundary of an opencast site for which the Coal Authority is determining whether to grant a licence to remove coal by opencast methods.*
 - *There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property.*
- 4.3.9 A damage notice or claim for alleged subsidence damage was made in August 2002 for 8 Lundhill Grove located immediately north of the site, however, the claim was rejected.

4.4 Mineral safeguarded areas

- 4.4.1 The site is underlain by Newhill Coal, with the Swinton Pottery coal underlying the far north-east and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).
- 4.4.2 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.
- 4.4.3 Specialist guidance on Mineral Safeguarding "A Guide to Mineral Safeguarding in England" has been produced by The Coal Authority and the British Geological Survey.

- 4.4.4 Paragraph 143 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.
- 4.4.5 NPPF Paragraph 144 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.
- 4.4.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require Persimmon 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
- 4.4.7 The viability of coal extraction at this site is considered later in this Report (Section 13.56) in light of the findings of Lithos' intrusive mining investigation, which comprised the drilling of 16 deep rotary probeholes to depths of between 12m and 33m (see Section 7.8).

4.5 Barnsley Council Policy

- 4.5.1 Barnsley Council has to comply with national planning policy to extract coal where it is feasible in order to avoid sterilisation caused by building over it.
- 4.5.2 The Council have a Local Development Framework (LDF) which consists of a series of documents intended to guide the use of land and new development throughout the district until 2033. The Core Strategy (adopted in September 2011) is the overarching document which brings together all the strategic elements of the LDF.
- 4.5.3 Barnsley Council's approach, in their Local Plan Publication Draft 2016, states that shallow coal extraction by opencast methods may occur before some other form of development takes place on a site, whether greenfield or during reclamation of a brownfield site.
- 4.5.4 Most former colliery sites have now been reclaimed in the Borough but shallow coal extraction can provide an opportunity to work other economic minerals such as fireclay and brick clay.
- 4.5.5 The Council also consider it important to avoid unnecessary sterilisation of coal and associated mineral resources by other forms of development where these can be extracted, within a reasonable timescale and in an environmentally friendly way or where local or community benefits clearly outweigh the likely impacts to justify the grant of planning permission.
- 4.5.6 Review of Barnsley Council's local development map shows the site to be allocated for residential development, although this does not necessarily mean that assessment of the viability of coal extraction will not be required prior to development.

5 GROUND INVESTIGATION DESIGN

5.1 Anticipated ground conditions & potential issues

5.1.1 Based on the data reviewed in Section 4 (Environmental Setting), anticipated ground conditions are expected to comprise:

Anticipated condition	Remarks
Made ground	No significant made ground anticipated.
Natural soils	Shallow residual soils from the weathering of bedrock.
Bedrock	Coal Measures strata from shallow depth.
Mineworkings	Possible unrecorded shallow workings underlying the majority of the site. Recorded workings at sufficient depth (50m) not to have any significant impact on surface stability.
Groundwater	Likely to lie at depth in the coal measures strata.

5.1.2 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. none identified	1. no former uses recorded at the site
Potential off-site contamination sources	1. surrounding historical industry	1. airborne contaminants
Potential geotechnical hazards	1. shallow mineworkings	1. possible unrecorded coal workings
Other potential constraints	1. overhead utilities	1. power lines on timber poles crossing the site

5.2 Preliminary conceptual site model

5.2.1 A preliminary conceptual site model, presented as Drawing 2409/6 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 5.1 inclusive of this report.

5.2.2 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, nitrates, oxygen depletion
Crop & animal protection	Pesticides & herbicides
Soil conditioners	Metals, sulphates, PAH
Naturally occurring contaminants	Arsenic, metals

5.2.3 Potential pollutant linkages are shown on the preliminary conceptual site model.

5.2.4 The most significant receptors include:

- The environment – Secondary A (solid) aquifer and the adjacent watercourse (canal), vegetation (proposed and existing planting)
- End users of the site (residents)

5.2.5 The most significant pathways include:

- Ingestion
- Dermal contact
- Inhalation of contaminated particulates
- Surface water run-off, including existing drainage infrastructure
- Downward infiltration of leachable/mobile contaminants to groundwater

5.2.6 Historical plans show no potentially contaminative uses at the site.

5.3 Ground investigation design & strategy

5.3.1 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
About 30 Trial 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
About 15 probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings and to install monitoring wells across the site in order to monitor for hazardous gas
About 10 probeholes	To allow the installation of shallow gas/groundwater monitoring wells

5.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site. A nominal 60m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

5.3.3 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.

6 FIELDWORK

6.1 Objectives

- 6.1.1 The original investigation strategy is outlined in Section 5.3 above.
- 6.1.2 PHs 12 & 13 were not advanced as no significant coal seams were encountered in the eastern field. However, a shallow monitoring well was drilled at the location of PH12, labelled PH12A.
- 6.1.3 The additional exploratory holes listed below were advanced in light of ground conditions actually encountered.

Exploratory holes	Purpose
PHs 16, 17 & 18	To enable better delineation of shallow coal and broken ground
PHs 101 to 114	

6.2 Exploratory hole location constraints

- 6.2.1 Access was restricted around the area of the paddock due to existing buildings and adjacent to existing overhead power lines. However, ground conditions are unlikely to vary significantly from those encountered across the remainder of the site.

6.3 Scope of works

- 6.3.1 Fieldwork was supervised by Lithos between the 25th and 27th September and 7th & 8th December 2017 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 1 to 26	1.1m to 2.8m	Trial pits typically terminated in coal measures strata.
Rotary openhole probeholes	PHs 1 to 11 & 14 to 18	12m to 33m	Deep probeholes to identify underlying coal seams
	PHs 2a, 4a, 5a, 6a, 7a, 8a, 9a, 11a, 12a & 14a	6m	Shallow probeholes to allow the installation of monitoring wells
	PHs 101 to 114	12m to 30m	Deep probeholes to identify underlying coal seams

- 6.3.2 Notes describing ground investigation techniques, in-situ testing and sampling are included in Appendix A to this report.
- 6.3.3 Exploratory hole logs are presented in Appendices F & G 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
- 6.3.4 Exploratory hole locations are shown on Drawing 2409/7 presented in Appendix B.

7 GROUND CONDITIONS

7.1 General

- 7.1.1 A complete record of strata encountered beneath the proposed development site is given on the various exploratory hole records, presented in Appendices F & G.
- 7.1.2 The site can be divided into two areas based on existing use and geology, each area roughly divided by a geological fault. These areas are shown on Drawings 2409/3 and are summarised below:

Site area	General location & description	Area (ha)
West	West of site, locally steeply sloping, overgrown, with paddocks and outbuildings	2.8
East	East of site, relatively level grassed field	2.1

- 7.1.3 Typical ground conditions encountered at the site are described below in Sections 7.2 (made ground) and 7.4 (natural ground), with a summary provided in the table on page 13.

7.2 Made ground

- 7.2.1 No significant made ground was encountered in any of the exploratory holes.

7.3 Obstructions

- 7.3.1 It is apparent from a review of historical OS Plans (see Section 3) and the site visit that no significant previous development has taken place at the site.
- 7.3.2 Consequently, no man-made obstructions were anticipated and none were encountered.

7.4 Natural ground

- 7.4.1 Natural ground was encountered each of the exploratory holes, and typically comprised the following sequence of strata:
- **Topsoil:** sandy gravelly clay identified across the site, typically 300mm to 400mm thick
 - **Residual Soils:** completely weathered bedrock, comprising stiff sandy gravelly clay
 - **Weathered Coal Measures** and **Weathered Sandstone:** comprising clay with structured lithorelicts of mudstone and clay with structured lithorelicts of sandstone
 - **Coal Measures:** comprising sandstone, siltstone & mudstone. Typically encountered between 2m and 3m depth.
- 7.4.2 Newhill Coal (typically around 1.0m thick) was encountered in one of the 26 trial pits (TP1, recovered as clayey interlaminated mudstone and coal or gravelly clay) and in 13 of the 30 deep probeholes.
- 7.4.3 Likely Newhill Rider Coal (0.1m to 1.0m thick) was also identified in two trial pits (TPs 5 & 8) and 4 probeholes.
- 7.4.4 The Swinton Pottery Coal was recorded in one trial pit (TP20).

7.5 Stability

- 7.5.1 Stability of excavations within the natural ground was generally good.

Summary of Ground Conditions (Trial Pits)

Hole ID	Final Depth (m)	Depth to base of (m)										Remarks
		Topsoil	Residual Soils	Weathered Coal Measures	Coal				Weathered Coal Measures	Coal Measures (Bedrock)		
			Stiff sandy/ gravelly CLAY	(Clay with lithorelicts)	Swinton Pottery Coal	Newhill Rider Coal	Newhill Coal	Seatearth (Clay)	(Clay with lithorelicts)	Sandstone	Mudstone / Siltstone	
TP01	2.4	0.1	0.5	-	-	-	1.0	2.0	-	-	>2.4	
TP02	1.3	0.4	0.8	>1.3	-	-	-	-	-	-	-	Unable to excavate >1.3m depth
TP03	2.6	0.4	1.7	-	-	-	-	-	-	-	>2.6	
TP04	2.3	0.3	1.6	-	-	-	-	-	-	-	>2.3	
TP05	2.6	0.2	0.6	1.4	-	1.7	-	-	-	-	>2.6	
TP06	1.2	0.2	0.6	-	-	-	-	-	-	>1.2	-	Unable to excavate >1.2m depth
TP07	1.1	0.3	0.9	>1.1	-	-	-	-	-	-	-	Unable to excavate >1.1m depth
TP08	2.8	0.3	1.2		-	1.3	-	1.6	2.5	-	>2.8	
TP09	2.5	0.2	1.4	2.1	-	-	-	-	-	-	>2.5	
TP10	2.6	0.2	0.6	2.4	-	-	-	-	-	-	>2.6	
TP11	2.2	0.3	1.3	-	-	-	-	-	-	>2.2	-	Unable to excavate >2.2m depth
TP12	2.5	0.3	2.0	>2.5	-	-	-	-	-	-	-	
TP13	2.6	0.2	1.2	-	-	-	-	-	-	-	>2.6	
TP14	2.4	0.3	>2.4	-	-	-	-	-	-	-	-	
TP15	2.5	0.3	2.0	-	-	-	-	-	-	-	>2.5	
TP16	2.6	0.2	2.1	-	-	-	-	-	-	-	>2.6	
TP17	2.5	0.25	1.7	2.3	-	-	-	-	-	-	>2.5	
TP18	2.3	0.2	1.6	-	-	-	-	-	-	-	>2.3	
TP19	2.5	0.3	1.7	2.3	-	-	-	-	-	-	>2.5	
TP20	2.2	0.25	0.8	-	0.9	-	-	-	-	-	>2.2	Unable to excavate >2.2m depth
TP21	1.9	0.2	>1.9	-	-	-	-	-	-	-	-	
TP22	2.2	0.2	1.9	-	-	-	-	-	-	-	>2.2	
TP23	2.5	0.3	2.2	-	-	-	-	-	-	>2.5	-	
TP24	2.3	0.2	1.9	-	-	-	-	-	-	-	>2.3	
TP25	2.6	0.2	1.2	-	-	-	-	-	(2.2)	1.3	>2.6	Clay underlying sandstone strata.
TP26	2.6	0.2	1.6	1.9	-	-	-	-	-	-	>2.6	

7.6 Groundwater

- 7.6.1 No significant inflows of groundwater were encountered within the trial pits during the investigation.
- 7.6.2 Groundwater levels recorded in the monitoring wells (2 visits to date on 6th & 26th October 2017) are summarised in the table below.

Hole ID	Response zone (depth range & strata)	Groundwater body	Range of standing water levels	
			m bgl	m AoD [#]
PH2A	3.0m to 6.0m (Mudstone & Coal)	Shallow	3.2 to 3.4	39.8 to 40.0
PH4A	3.0m to 6.0m (Mudstone & Coal)	Shallow	4.7 to 5.7	41.5 to 42.5
PH5A	3.0m to 6.0m (Mudstone with sandstone bands & Coal)	Shallow	1.6 to 1.9	39.8 to 40.1
PH6A	3.0m to 6.0m (Mudstone with sandstone bands)	Shallow	0.7 to 2.3	39.1 to 40.7
PH7A	3.0m to 6.0m (Mudstone)	Shallow	2.8 to 3.0	40.6 to 40.8
PH8A	3.0m to 6.0m (Mudstone with sandstone bands)	Shallow	0.1 to 1.2	39.85 to 40.95
PH9A	3.0m to 6.0m (Mudstone)	Shallow	Dry	
PH11A	3.0m to 6.0m (Mudstone with sandstone bands)	Shallow	3.3 to 3.4	34.45 to 34.55
PH12A	3.0m to 6.0m (Mudstone with sandstone bands)	Shallow	4.1 to 4.3	33.8 to 34.0
PH14A	3.0m to 6.0m (Mudstone with sandstone bands)	Shallow	2.7 to 3.3	32.0 to 32.6

[#] levelled-in by survey

7.7 Visual & olfactory evidence of organic contamination

- 7.7.1 No visual or olfactory evidence of gross organic contamination was noted in any of the holes.
- 7.7.2 Selected samples of existing Topsoil were scheduled for chemical testing to confirm the suitability of existing topsoil for re-use; see Section 8.

7.8 Mining investigation

- 7.8.1 It is clear from the desk study that almost the entire site is likely to be underlain at shallow depth by the Newhill Coal; and associated mineworkings are possible.
- 7.8.2 Furthermore, the Newhill Coal is overlain by:
- The Newhill Rider, a thin, intermittent seam which is not shown to outcrop at the site but is shown as worked by opencast methods around 270m to the south
 - Swinton Pottery Coal (0.3m to 1.2m thick), but only expected to underlie the far north-east
- 7.8.3 The conjectured outcrops of the Newhill and Swinton Pottery seam are shown on Drawing 2409/5 in Appendix B to this report.
- 7.8.4 Consequently, a mining investigation has been undertaken, comprising the drilling of 30 deep rotary open-hole probeholes to determine whether the site is underlain by unrecorded shallow mine workings. The investigation identified coal and broken ground as summarised in the tables on pages 16 & 17.
- 7.8.5 A further 10 probeholes were taken to shallow depth (6m) to enable the installation of gas/groundwater monitoring wells.

- 7.8.6 Analysing the data obtained from the 30 deep mining investigation probeholes, it is apparent that:
- The **Newhill Coal** underlies the majority of the site, outcropping just within the south-west boundary (west of fault); broadly as shown on BGS plans.
 - To the west of the fault the Newhill seam is shallowest in the south-west (min. 0.5m depth), and deeper in the north-east (typically to >12m).
 - To the east of the fault the Newhill seam is downthrown and was only encountered at depths in excess of 25m.
 - Typical seam thickness of the Newhill Coal is 1m; maximum recorded was 2m (PH11 to the east of the fault).
 - Linear triangulation suggests the Newhill seam dips at about 3° to the north-east, and is faulted, with a downthrow to the east of about 15m between PH6 and PH10.
 - Six of the 30 probeholes advanced through the Newhill seam encountered evidence of possible workings - broken ground (c. 1.0m thick) in PHs 4, 109 & 113, and soft ground (c.1.0m thick) in TPs 108, 112 & 114). Triangulation suggest that the broken/soft ground relates to the Newhill seam.
 - The thickness of competent (rock) cover is typically less than 10 times seam thickness in the west of the site, an area of approximately 1.6ha; see Drawing 2409/9.
 - The **Newhill Rider Coal**, an intermittent seam, was likely encountered in 18 of the probeholes (PHs 1, 3 & 101 to 114) to the west of the fault from 4m depth and PHs 10 & 11 to the east of the fault from 15m depth).
 - Typical seam thickness of the Newhill Rider Coal is 0.25m to 0.75m; maximum recorded was 1m (PHs 10 & 11 to the east of the fault).
 - The **Swinton Pottery Coal** was encountered in only one trial pit (TP20) suggesting the outcrop lies a little further south than that shown on BGS plans. However, further trial pitting and drilling to the north did not encounter the Swinton Pottery Coal.
- 7.8.7 No evidence of voids or significant broken ground was recorded to the east of the fault with competent cover typically greater than 14 times seam thickness. Therefore, the surface stability of the east of the site is considered unlikely to be affected by shallow underground coal workings.
- 7.8.8 However, soft and broken ground with less than 10x competent cover was identified in 5 of the probeholes (PHs 3, 4, 108, 109 & 114). Further soft and broken ground with >10 times competent cover was also recorded in PHs 112 & 113. Probeholes with identified shallow workings (Soft Ground/Broken Ground) are shown on Drawing 2409/9 in Appendix B.
- 7.8.9 The soft/broken ground was typically accompanied by an absence of solid coal seam within the probehole, and triangulation shows the depth of soft/broken ground at the expected depth of the Newhill coal.
- 7.8.10 Consequently, given the above, mitigation of risks to surface stability are considered necessary in the north-west of the site; see Section 12.2.

Summary of Ground Conditions (Probeholes)

Hole ID	Final Depth (m)	Depth to Rockhead (mbgl)	Newhill Rider Coal				Newhill Coal				Remarks
			Depth to base of Coal (m)	Seam Thickness (m)	Worked?	Cover ratio	Depth to base of Coal (m)	Seam Thickness (m)	Worked?	Cover ratio	
PH01	30.0	3.0	6.5	0.5	No	7	13.0	1.0	No	10	-
PH02	15.0	2.0	-	-	-	-	3.5	1.0	No	2	-
PH03	12.0	2.0	7.0	0.5	Broken Ground	10	10.0	1.0	No	8	Full returns below 7.0m
PH04	15.0	4.0	-	-	-	-	13.0	1.0	Broken Ground	9	Full returns
PH05	30.0	2.5	-	-	-	-	4.5	1.0	No	2	-
PH06	12.0	2.5	-	-	-	-	7.0	1.0	No	5	-
PH07	18.5	3.0	-	-	-	-	16.5	1.0	No	14	-
PH08	15.0	3.0	-	-	-	-	13.0	1.0	No	10	-
PH09	30.0	3.0	-	-	-	-	-	-	-	-	No coal encountered
PH10	24.0	2.0	21.5	1.0	No	20	-	-	-	-	-
PH11	33.0	2.0	16.0	1.0	No	14	29.5	2.0	No	14	-
PH14	30.0	2.0	-	-	-	-	-	-	-	-	No coal encountered
PH15	15.0	3.0	-	-	-	-	11.5	1.0	No	9	-
PH16	13.0	2.5	-	-	-	-	10.0	1.0	No	8	-
PH17	13.0	3.0	-	-	-	-	10.0	1.0	No	7	-
PH18	12.0	1.5	-	-	-	-	9.5	1.0	No	8	-
PH101	30.0	2.5	6.5	0.5	No	8	-	-	-	-	-
PH102	15.0	2.5	6.5	0.5	No	8	-	-	-	-	-
PH103	15.0	3.0	4.2	0.2	No	6	11.0	1.0	-	8	-
PH104	15.0	3.0	6.2	0.2	No	16	14.0	1.0	-	11	-
PH105	30.0	4.0	14.0	0.5	No	20	18.0	1.0	-	14	-
PH106	21.0	4.0	11.25	0.75	No	10	18.5	1.0	-	15	-
PH107	18.0	3.0	8.0	0.50	No	10	15.5	1.0	-	13	-
PH108	18.0	3.0	7.25	0.25	No	17	11.5	1.5	Soft Ground	6	Flush returns lost below 10m
							14.5	1.0	Soft Ground	15	
PH109	12.0	3.0	6.25	0.25	No	13	11.0	1.0	Broken Ground	8	Flush returns lost below 10m

Hole ID	Final Depth (m)	Depth to Rockhead (mbgl)	Newhill Rider Coal				Newhill Coal				Remarks
			Depth to base of Coal (m)	Seam Thickness (m)	Worked?	Cover ratio	Depth to base of Coal (m)	Seam Thickness (m)	Worked?	Cover ratio	
PH110	12.0	3.0	6.25	0.25	No	13	11.0	1.0	-	8	-
PH111	12.0	2.5	8.25	0.25	No	23	16.25	1.25	-	11	-
PH112	12.0	3.0	8.75	0.25	No	23	13.75	1.0	Soft Ground	11	Flush returns lost below 12.7m
PH113	15.0	3.0	9.25	0.25	No	25	13.75	1.0	Broken Ground	11	Flush returns lost below 12.7m
PH114	14.0	3.0	6.0	0.25	No	12	12.0	1.0	Soft Ground	9	Flush returns lost below 11.0m

NOTES: Values in **red** indicate a cover ration of <10x seam thickness
Swinton Pottery Coal not encountered in any of the probeholes, seam outcrops on far north-east boundary and dips away from site

8 CONTAMINATION (ANALYSIS)

8.1 General

- 8.1.1 No significant previous development is recorded, and no potentially contaminative raw materials are known to have been stored or used at the site.
- 8.1.2 The site's former usage is therefore considered unlikely to have given rise to any significant ground contamination. Furthermore, no significant made ground was encountered during the ground investigation.
- 8.1.3 However, samples of topsoil have been recovered in order to confirm its suitability for re-use.
- 8.1.4 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.
- 8.1.5 Where available, Category 4 Screening Levels (C4SL) have also been referenced.
- 8.1.6 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

8.2 Testing scheduled

- 8.2.1 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	11	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Total Organic Carbon (TOC) Speciated Polycyclic Aromatic Hydrocarbons (PAH)
	3	Organochlorine & Organophosphorous Pesticides
Coal	4	Calorific Value (CV)

8.3 Soil contamination results

- 8.3.1 The soil contamination test results are summarised in the table on page 19.
- 8.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix H to this report.

Inorganic determinands

- 8.3.3 Of the 11 samples of Topsoil analysed for inorganic parameters, all can be classified as uncontaminated.
- 8.3.4 These 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).

Calorific value

- 8.3.5 The Calorific Value (CV) of four samples of weathered coal, have yielded an average CV of 7.6 MJ/kg. Materials whose CVs exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn.

8.3.6 Results of the CV testing are summarised in the table below:

Hole ID	Depth	Material Description	CV (MJ/kg)
TP01	0.80	Thinly interlaminated mudstone and coal	<1.0
TP05	1.50	Very gravelly CLAY, gravel is fine to medium of coal	5.4
TP08	1.25	Slightly gravelly CLAY, gravel is fine of coal	11.5
TP20	0.85	Thinly interlaminated mudstone and coal	12.6

8.3.7 Consequently, despite being highly weathered, the shallow coal should be regarded as potentially combustible with appropriate measures adopted where these materials lie within the upper 1,000mm in garden and landscaped areas or where they are encountered in foundation and drainage excavations (see Sections 12.4 & 13.7).

Asbestos

8.3.8 No asbestos fibres were identified in any of the 11 samples screened.

Organic determinands

8.3.9 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).

8.3.10 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.

8.3.11 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.

8.3.12 In order to check the validity of Lithos' Tier 1 Soil Screening Values, the average TOC for the Topsoil has been determined:

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Topsoil	2.8%	Yes, but no significant organic contamination was recorded in this soil type. All determinands well below "6%" screening value; most below limit of detection.

Polycyclic Aromatic Hydrocarbons (PAH)

8.3.13 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.

8.3.14 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).

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

Insecticides

Each of the 3 samples of topsoil scheduled for pesticide analysis yielded results for the various determinands below the laboratory limit of detection (0.01 mg/kg).

Summary of degree of soils contamination

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 gardens end-use.														
			pH	As ∞	B ~	Cd ∞	Cr x	Cu ♣\$	Pb ∞	Hg *	Ni	Se	Zn \$	TOC (%)	PAH		Asbestos I.D.
				B(a)P ∞	Naphthalene												
				37	5	26	3000	200	200	169	127	350	200		5	8	
TP02	0.10	Topsoil	6.6	16	2.0	0.4	22	37	52	0.1	24	0.7	100	3.0	<0.1	<0.1	ND
TP05	0.10	Topsoil	6.8	18	1.3	0.4	24	38	56	0.1	29	1.4	100	2.7	<0.1	<0.1	ND
TP07	0.10	Topsoil	6.4	13	2.1	0.3	23	30	42	0.1	26	0.8	89	2.8	<0.1	<0.1	ND
TP09	0.10	Topsoil	6.9	16	2.0	0.3	21	32	51	0.1	22	1.0	90	2.7	<0.1	<0.1	ND
TP12	0.10	Topsoil	6.0	16	1.7	0.3	19	27	42	<0.1	25	0.9	88	2.2	<0.1	<0.1	ND
TP14	0.10	Topsoil	6.9	16	1.8	0.2	19	26	44	<0.1	22	0.8	80	2.1	<0.1	<0.1	ND
TP16	0.10	Topsoil	5.9	15	2.0	0.3	19	39	42	<0.1	22	1.1	75	2.2	<0.1	<0.1	ND
TP17	0.10	Topsoil	6.9	16	1.8	0.3	19	39	44	<0.1	21	<0.5	85	2.5	<0.1	<0.1	ND
TP18	0.10	Topsoil	6.5	26	1.8	0.3	21	44	51	0.2	25	1.2	94	2.1	<0.1	<0.1	ND
TP22	0.10	Topsoil	7.1	36	2.1	0.4	25	68	73	0.2	28	1.0	110	4.1	<0.1	<0.1	ND
TP25	0.10	Topsoil	6.5	36	2.4	0.5	22	45	54	0.1	29	1.3	99	4.1	<0.1	<0.1	ND

Key		Source of guidance trigger level	
36	Parameter tested for and found to be in excess of Tier 1 concentration.	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.	
12	Parameter tested for but not found to be in excess of Tier 1 concentration.		
ND	No fibres detected (asbestos screen)	∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
♣	Tier 1 Value is pH dependent.	\$	MAFF. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.	~	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.		

9 CONTAMINATION (QUALITATIVE RISK ASSESSMENT & REMEDIATION)

9.1 Topsoil

- 9.1 Topsoil, typically 300mm thick, underlies the entire site. Testing suggests this material is chemically suitable for re-use.
- 9.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth. However, no testing in accordance with BS3882:2015 Specification for Topsoil (N-P-K, clay content etc) has been undertaken to date.

9.2 Waste classification

- 9.2.1 Some excess arisings may be generated by excavations for foundations, sewers etc.
- 9.2.2 Classification of soils as inert, non-hazardous or hazardous should be undertaken in accordance with the Environment Agency's Technical Guidance WM3¹, and is quite a complex process. However, all soil arisings generated by excavations at this site are likely to be classified inert.
- 9.2.3 Off-site disposal to landfill is not recommended. In accordance with the CL:AIRE Code of Practice² 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.

10 HAZARDOUS GAS

10.1 General

- 10.1.1 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 landfills (nearest 20m south)	Human health	Asphyxiation & explosion	Lateral migration, ingress & accumulation	Low: natural strata to at least 5m depth are generally of low permeability
	Buildings	Explosion		
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	Very Low: no shallow workings identified beneath the site, although there are deeper workings at c. 50m bgl
	Buildings	Explosion		

- 10.1.2 Given the above gas monitoring wells have been installed in 10 boreholes across the site. Details of the installations are given on the probehole logs presented in Appendix G to this the report.
- 10.1.3 The probeholes with monitoring well installations are suffixed 'A' (e.g. PH02A) and were drilled adjacent to the correspondingly numbered deep mining investigation probeholes (e.g. PH02). However, no deep mining probehole was drilled adjacent to PH12A.
- 10.1.4 The generation potential of the gas source was initially considered to be Low, and this has been confirmed by the initial monitoring results obtained. Consequently, in accordance with CIRIA Report C665, given the proposed residential end use, 9 visits have been scheduled over a 6 month period.

¹ Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015

² The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

10.2 Scope of works

- 10.2.1 To date, the wells have been monitored on 5 occasions between 6th October and 14th December 2017) for groundwater levels and soils-gases, and the results are presented in Appendix J.
- 10.2.2 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)

10.3 Monitoring results

- 10.3.1 The results of the monitoring completed to date are summarised below.

Hole ID	Response zone	Range of methane concentrations (% v/v)	Range of carbon dioxide concentrations (% v/v)	Range of steady flow rates (litre/hour)
PH2A	3.0m to 6.0m (Mudstone & Coal)	None detected	1.5 to 4.2	None detected
PH4A	3.0m to 6.0m (Mudstone & Coal)	None detected	2.2 to 3.2	0.1
PH5A	3.0m to 6.0m (Mudstone with sandstone bands & Coal)	0.4 to 2.0	0.3 to 3.8	0.1
PH6A	3.0m to 6.0m (Mudstone with sandstone bands)	None detected	0.2 to 0.6	0.6 to 2.1
PH7A	3.0m to 6.0m (Mudstone)	None detected	1.6 to 2.6	0.1
PH8A	3.0m to 6.0m (Mudstone with sandstone bands)	None detected	0.1 to 0.2	7.0 to 16.0
PH9A	3.0m to 6.0m (Mudstone)	None detected	1.8 to 2.7	0.4
PH11A	3.0m to 6.0m (Mudstone with sandstone bands)	None detected	0.9 to 9.8	None detected
PH12A	3.0m to 6.0m (Mudstone with sandstone bands)	None detected	2.8 to 4.4	None detected
PH14A	3.0m to 6.0m (Mudstone with sandstone bands)	None detected	0.3 to 1.3	0.1 to 9.0

10.4 Discussion

- 10.4.1 No significant concentrations of methane or carbon dioxide have been recorded to date with the exception of carbon dioxide between 7.4% on Visit 2 increasing to 9.8% by Visit 5 in PH11A. The initial visit recorded a concentration of carbon dioxide of 0.9% in PH11A. Methane at 0.4% and 2.0% was recorded in PH05A on visits 4 and 5 respectively, no methane has been recorded on any other visits or in any other exploratory holes.
- 10.4.2 No significant positive flow rates were recorded with the exception of PH8A where a flow of 16l/hr was recorded on the first visit, falling to 7l/hr on the second visit.
- 10.4.3 However, the groundwater level in PH8A at the time of monitoring was recorded at 1.2mbgl, on visit 1 and 0.6mbgl on visit 2 i.e. above the response zone. It is likely that the flow rate recorded was due to air being squeezed out of the monitoring well when the gas bung was opened for monitoring.

- 10.4.4 Groundwater levels were above the response zone in 4 of the monitoring wells on the first visit, these were bailed out for monitoring on the next visit, however, groundwater levels returned above the response zone.
- 10.4.5 Generic Note 05 in Appendix A outlines how monitoring results are interpreted.
- 10.4.6 A hazardous gas risk assessment incorporating all of the results will be issued on completion of monitoring in April 2018. At this stage it would be prudent to allow for basic (Amber 1) gas protection measures in all new dwellings.

10.5 Radon

- 10.5.1 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. At present Approved Document C advocates basic measures for the probability banding 3% to 10% (full measures if >10%).
- 10.5.2 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. Consequently, basic radon protection measures may not be required in new dwellings.
- 10.5.3 However, Public Health England would like to see all new build include basic measures. Given that the site lies in an area where >1% of homes are estimated to be above the action level, the Developer might consider providing all new dwellings with basic radon protection measures.

11 GEOTECHNICAL TESTING

11.1 General

- 11.1.1 A total of 13 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.
- 11.1.2 The geotechnical laboratory test results are presented in Appendix I to this report.

11.2 Atterberg limits

- 11.2.1 The plasticity indices of 12 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
Residual Soils	8	17 to 24 (21)	18 to 41 (28)	Low to high
Weathered Sandstone	2	17 to 26 (22)	16 to 32 (24)	Low to medium
Weathered Coal Measures	2	17 to 21 (19)	14 to 30 (22)	Low to 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.

- 11.2.2 Only one sample had a PI of >40% (at 41%), therefore, for the purposes of foundation design, it is recommended that all cohesive soils be regarded as being of medium shrinkability.

11.3 Soluble sulphate and pH

- 11.3.1 In accordance with BRE Special Digest 1:2005, this site has been classified as greenfield with a mobile groundwater regime.
- 11.3.2 It is envisaged foundations will extend to depths of about 1m into natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).
- 11.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 11 samples were determined. In addition, 4 samples of Coal Measures strata (Sandstone, Siltstone & Mudstone) were tested as part of the contamination suite. The pH value of each sample has also been determined.
- 11.3.4 The highest water-soluble sulphate concentration and the lowest pH value for each soil type analysed are shown in the table below.

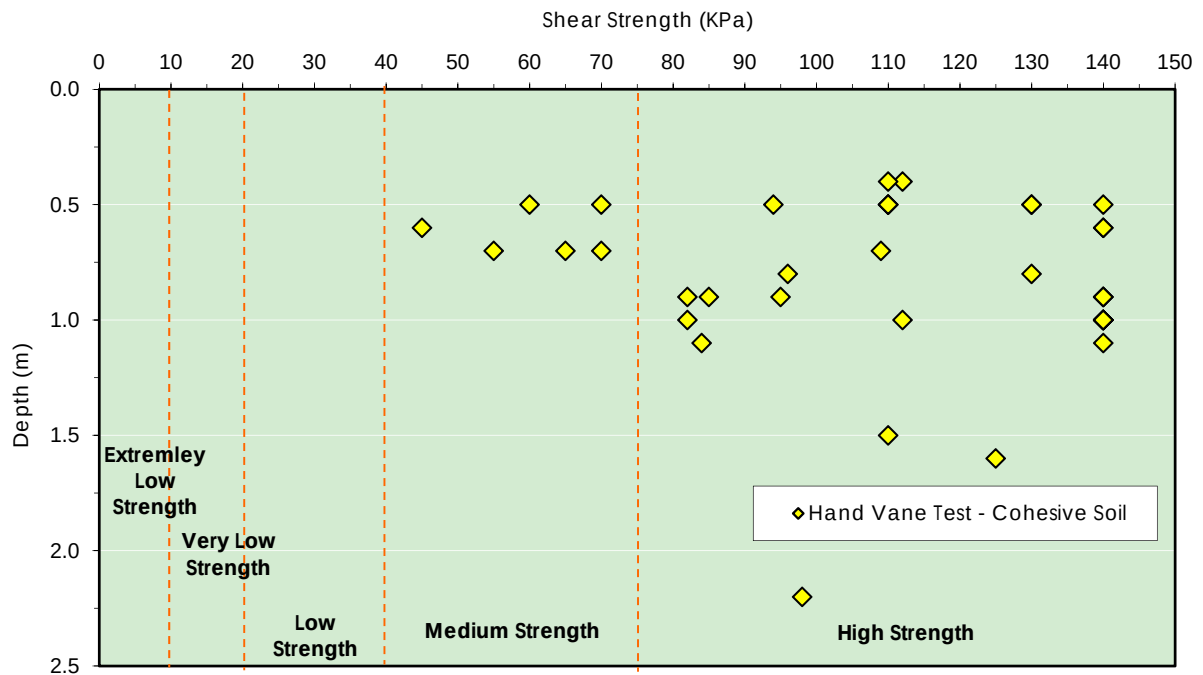
Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Residual Soils (gravelly Clay)	11	5.5, typically >7.0	240, typically <50
Weathered Coal Measures (Clay with lithorelicts)	2	7.3	25
Coal Measures (Sandstone, Siltstone & Mudstone)	4	6.0	20

- 11.3.5 pH values were all above 5.5, therefore concentrations of chloride and nitrate are considered insignificant.
- 11.3.6 In accordance with Table C1 of SD1, sub-surface concrete should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.

Hand shear vane testing

- 11.3.7 Hand shear vane testing was undertaken within trial pits in-situ to around 1.2m depth and from larger blocks of excavated clay below that depth.
- 11.3.8 The results are summarised within the plot below and illustrate a linear increase in undrained shear strength (S_u) with depth within the cohesive deposits. Below approximately 0.5m depth S_u is typically greater than 80kPa.
- 11.3.9 The plot on page 25 provides a summary of undrained shear strengths.

Hand Vane Test - Cohesive Soil



12 GEOTECHNICAL ISSUES

12.1 Conceptual site model

- 12.1.1 A revised Conceptual Site Model is presented as Drawing 2409/8 in Appendix B.
- 12.1.2 Ground conditions at the site typically comprise an increasingly weathered sequence of Residual soils (gravelly clay), over weathered Coal Measures (Clay with structured lithorelicts), with Coal Measures bedrock (Sandstone, Siltstone and Mudstone) from around 2m to 3m depth.
- 12.1.3 Coal was encountered in 4 of the 26 trial pits (recovered as clayey interlaminated mudstone and coal or gravelly clay) and in 14 of the 16 deep probeholes.

12.2 Mining & quarrying

- 12.2.1 Those areas of the site close to outcrop of both the Newhill and Swinton Pottery coal seams are shown to lie within High Risk Areas, typically the western fault block and north-west corner of the eastern fault block.
- 12.2.2 The remainder of the site, predominantly the eastern fault block and far north of the western fault block, lies within a Low Risk Area.
- 12.2.3 Therefore, a mining investigation comprising the drilling of 30 deep rotary openhole probeholes to between 12m and 33m depth was undertaken.
- 12.2.4 The majority of the holes encountered solid coal. However, soft and broken ground with less than 10x competent cover was identified in 5 of the probeholes (PHs 3, 4, 108, 109 & 114). Further soft and broken ground with >10 times competent cover was also recorded in PHs 112 & 113.

- 12.2.5 Probeholes with identified shallow workings (Soft Ground/Broken Ground) are shown on Drawing 2409/9 in Appendix B.
- 12.2.6 Consequently, given the above, mitigation of risks to surface stability are considered necessary in the north-west of the site
- 12.2.7 Consolidation (grouting) required would likely comprise 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.
- 12.2.8 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).
- 12.2.9 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.
- 12.2.10 There are no known quarries at, or adjacent to, the site.

12.3 Site regrade and/or ground improvement

- 12.3.1 Given existing topography (much of the west of the site is sloping, with gradients of up to 1 in 7 on the south western boundary, some site regrade is anticipated, with the need for underbuild and possibly retaining walls.
- 12.3.2 Careful consideration will need to be given to earthworks design, and implications for slope stability, retaining walls, foundations, highway gradients and drainage.
- 12.3.3 Any digital terrain modelling undertaken or commissioned by Persimmon should consider implications for the foundation recommendations outlined below.
- 12.3.4 Natural ground underlying this site is often clayey, therefore consideration should be given to the implication of undertaking earthworks in poor/wet weather when the ground surface is likely to become difficult to cross with heavy machinery.
- 12.3.5 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 9.2 should apply.

12.4 Foundation recommendations

General

- 12.4.1 It is understood that consideration is being given to redevelopment of the site with 165 traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A site layout has been provided by Persimmon (Drawing reference Lundhill Road Illustrative Layout, dated June 16) which is reproduced as Drawing 2409/2 in Appendix B to this report.
- 12.4.2 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.
- 12.4.3 We have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation across the majority of the site, however, some re-grade may be necessary near the south-western boundary of the western field.
- 12.4.4 Any digital terrain modelling undertaken, or commissioned by, Persimmon should consider implications for the foundation recommendations outlined below.

- 12.4.5 Sub-surface concrete should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.
- 12.4.6 Conventional strip footings are considered the most suitable foundation solution for two or three storey residential properties constructed on this site and these are discussed below.
- 12.4.7 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses constructed at the site.
- 12.4.8 Footings will be founded in firm clay or competent rock.
- 12.4.9 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.
- 12.4.10 Where plots are founded over former mineworkings, even after consolidation, foundations should be “beefed-up” to accommodate any potential time dependant differential settlement.
- 12.4.11 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 ³	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

- 12.4.12 Where workings have been identified (north-west) rock cover is typically >5x seam thickness therefore strip footings should be suitable, however, this should be confirmed on completion of consolidation works.
- 12.4.13 Foundations will be required to be placed below a line drawn up at 45° from the base of any service or similar excavation.
- 12.4.14 Overdeepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.
- 12.4.15 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).
- 12.4.16 In addition to the above, Persimmon should review proposed plot designs and layouts, since deeper excavations for trench fill are likely to be unstable where the centre-lines of parallel trenches are closer than about 2m (assuming 600mm widths). Persimmon should supervise their groundworker to ensure footings are excavated in a controlled and safe manner.

³ See s5.6 of *Structural Foundations Manual* (M F Atkinson) 2nd Ed.

- 12.4.17 Persimmon 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 (Residual Soils and Weathered Coal Measures)

- 12.4.18 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.
- 12.4.19 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.
- 12.4.20 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.
- 12.4.21 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.
- 12.4.22 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.
- 12.4.23 It would therefore be prudent to prepare a detailed foundation schedule and seek approval from NHBC in order to determine likely foundation abnormalities.
- 12.4.24 A safe bearing capacity of at least 200kPa can be assumed if the following are true
- A maximum foundation line load of 90kN/m run
 - A foundation length of 8m
 - A foundation breadth of 0.6m
 - A foundation thickness of 225mm
 - A foundation depth of 0.9m depth
 - An undrained shear strength of 80kPa for the firm clay (typical minimum recorded on site)
- 12.4.25 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.

Coal Measures Bedrock (Sandstone, Siltstone & Mudstone)

- 12.4.26 The Coal Measures bedrock is generally considered to have a safe bearing capacity of at least 300kPa and minimal settlements would be anticipated.
- 12.4.27 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.

- 12.4.28 Locally, the bedrock at the site comprises mudstone which can be easily excavated using a backhoe excavator, and will be recovered as a tabular gravel. Where in-situ mudstone 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; Mudstone is not.

Coal

- 12.4.29 Some excavations for foundations (most notably in the west of the site, may come into contact with coal. Care should be taken not to unnecessarily overdeepen foundations, in order to minimise the chance of encountering coal.
- 12.4.30 Where foundation excavations do come into contact with coal, the foundation should be taken through the coal seam, into underlying natural in-situ strata of adequate bearing. The full thickness of coal should then be sealed with concrete to create a trench fill foundation. To prevent the ingress of air, the mass concrete fill should be placed as soon as possible after exposing the seam.
- 12.4.31 By virtue of the provisions of the Coal Industry Act 1994 interests in unworked coal and coal mines previously vested in the British Coal Corporation are now vested in the Coal Authority. The developer will need to contact the Coal Authority to dig or carry away such coal as they encounter in connection with redevelopment of the site (this is often referred to as incidental coal).

Geological fault

- 12.4.32 Drawing 2409/2 shows the approximate line of the fault superimposed on the proposed housing layout; the fault crosses the centre of the site, roughly north-south.
- 12.4.33 It should be noted that the line of a fault on a geological map is often very approximate, and it may be inaccurate by 10m or more. Furthermore, the presence of a fault is usually 'masked' by overlying drift or residual soils; they can only be seen where long trenches are excavated into bedrock.
- 12.4.34 At this site, no movement associated with past (none identified within c. 100m of the anticipated line of the fault), present or future mining is anticipated, therefore building can take place over the fault, without the need to search for the fault, and without the need to adopt special precautions in the footings of those plots suspected to lie in the vicinity of the fault.
- 12.4.35 However, NHBC like to see reinforcement of footings with one layer of B385 mesh placed 75mm above the base of the footing. Given the uncertainty regarding the precise line of the fault, it would be prudent to reinforce the footings of all plots within 25m of its assumed line.
- 12.4.36 Further advice should be sought if a significant weak zone is encountered (e.g. ground comprising loose, broken or soft 'gouge' material) during the excavation of footings. If associated with a fault, the weak zone is likely to form a fairly continuous "linear belt", rather than a localised "pocket", and be anything from a few centimetres to a few metres in width.
- 12.4.37 Lithos could prepare a detailed Foundation Schedule if provided with: an External Works Drawing (with proposed FFLs & infrastructure details) and a tree survey.
- 12.4.38 The foundation solutions outlined above assume that ground levels will not change significantly from those existing at present, however, it is anticipated that some site re-grade will be undertaken in the south-west of the site. This may increase footing depths.

12.5 Floor slabs

- 12.5.1 Suspended floor slabs should be utilised where the depth of made ground or engineered stone exceeds 600mm in accordance with NHBC Standards Chapter 5.1 (to negate potential settlement problems). Suspended floor slabs will be required for plots in areas of raised levels resulting from localised site re-grade.
- 12.5.2 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. Cast in-situ slabs are not acceptable where foundations are within the influence of trees.
- 12.5.3 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.
- 12.5.4 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.
- 12.5.5 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.
- 12.5.6 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.
- 12.5.7 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 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.
- 12.5.8 Should coal be exposed beneath the floor void, it would be prudent to prevent air ingress and the potential for spontaneous combustion by blinding with concrete, or removing the coal.

12.6 Designated concrete mixes

- 12.6.1 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.
- 12.6.2 Consequently, Persimmon should seek advice from their appointed Structural Engineer.

12.7 Excavations

- 12.7.1 Groundwater should be controlled in accordance with CIRIA report 113 “Control of Groundwater for Temporary Works”.
- 12.7.2 Initial groundwater monitoring suggests groundwater lies between 2m and 4m bgl.
- 12.7.3 Excavations should remain stable in the short term but if left open for any significant period of time may require shoring most notably in granular soils and made ground.
- 12.7.4 Bedrock was encountered in the majority of exploratory holes, typically between 2m and 3m depth. Based on the exploratory hole logs, excavation greater than 2m is likely to prove difficult across about 50% of the site, with excavation beyond 3m unlikely across the remainder. 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.

12.8 Drainage

- 12.8.1 Based on observations made during the investigation, soakaways are very unlikely to 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.
- 12.8.2 Alternative SUDS options (see CIRIA C753:2015 for further details) include:
 - Swales – linear grassed features in which surface water can be stored or conveyed.
 - 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.
- 12.8.3 Yorkshire Water have published a guide⁴ for developers and designers outlining their design requirements for surface water attenuation assets.
- 12.8.4 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.
- 12.8.5 The guide also discusses required access to flow control chambers, large diameter (i.e. >900mm) surface water storage pipes, and surface water storage tanks.
- 12.8.6 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.

⁴ Design Requirements for Surface Water Attenuation Assets, February 2017.

12.9 Highways

- 12.9.1 The natural soils present at shallow depth (anticipated formation) are predominantly cohesive. Based on visual inspection of the natural materials and the recorded plasticity indices at the site, published tables⁵ indicate that the natural cohesive deposits would be expected to provide a CBR value of at least 3%. This value should be verified prior to or during construction.
- 12.9.2 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.
- 12.9.3 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.

12.10 External works

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

13 REDEVELOPMENT ISSUES

13.1 General

- 13.1.1 This report has presented options with respect to foundation solutions, treatment of contamination 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.
- 13.1.2 If unanticipated ground is encountered during the site preparatory works, the Contractor should immediately seek further advice from the Engineer.

13.2 Control of excavation arisings

- 13.2.1 No significantly elevated concentrations of contaminants have been identified at the site. However, it should be ensured that the groundworker understands the need for good materials management. Most notably the importance of not mixing different materials within a given stockpile; i.e. there should be separate stockpiles of: topsoil; excess clean, natural soil arisings; potentially combustible soils; general construction waste etc.
- 13.2.2 Further characterisation of stockpiled materials is likely to be required if off-site disposal is proposed.

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

13.3 Good practice guidance

13.3.1 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 Guidelines⁶:
 - o PPG6 - Working at construction and demolition sites
 - o PPG2 - Above ground oil storage tank
 - o PPG7 – The safe operation of refuelling facilities.
 - o PPG21 – Incident Response Planning

13.4 New utilities

13.4.1 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.

13.4.2 Drainage and other utilities should not be placed within any coal seam; the seam should either be removed to below the base of the lowest service, or services should be placed in oversize trenches cut into the seam & backfilled with inert material.

13.4.3 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.

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

13.5 Health & safety issues - construction workers

13.5.1 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.

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

13.5.3 No significant made ground or contaminants at concentrations above the guidance threshold values for an end use that includes domestic gardens have been identified.

13.5.4 However, simple precautionary measures are recommended, i.e. good personal hygiene and basic personnel protective equipment.

13.5.5 Consequently, during the construction phases of the site development it will be necessary to protect the health and safety of site personnel. General guidance on these matters is given in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land".

⁶ Whilst this has formally been withdrawn it can still be accessed via the EA archives and provides useful information on managing risks.

13.6 Coal extraction

- 13.6.1 The Newhill Coal (c. 1.0m thick) does underlie the site; from depths of 0.5m in the south-west (TP01), to around 27.5m in the south-east (PH11).
- 13.6.2 Prior extraction of coal is encouraged by both the Coal Authority and Planning Authorities, largely because a potential mineral resource will not be sterilised by the development. However, it is worth noting that the UK market for coal is changing (driven by government carbon emission targets) – most notably very few power stations are still burning coal. Consequently, prior extraction of coal has become less attractive in recent times.
- 13.6.3 For the developer/landowner, extraction can be attractive from a financial perspective, especially where mineworkings in the seam of interest require grouting, and/or the desired build programme can accommodate the time necessary to ensure settlement of the replaced overburden has reduced to tolerable levels.
- 13.6.4 However, extraction usually increases developer abnormal foundation costs. This would be the case here due to the need for rafts instead of strip footings, and issues associated with the peripheral 'high walls' created.
- 13.6.5 It is understood from preliminary enquiries, that extraction is viable where the overburden above a seam is less than 10 times the seam's thickness; at this site the overburden thickness increases from the south-west from less than 10 times to greater than 10 times seam thickness. The thickness of competent cover to the east of the fault is typically greater than 10 times seam thickness.
- 13.6.6 The coal recorded in the trial pits at shallow depth was typically of poor quality (interbedded with mudstones or recovered as gravelly clay). Consequently, it is considered unlikely that prior extraction of coal from this site would be economically viable.

13.7 Shallow coal in garden areas

- 13.7.1 The shallow weathered coal is considered combustible, and whilst there is no explicit guidance in NHBC Standards, liaison with NHBC suggests their stance is essentially the same as that they would apply to potentially combustible fills (such as Ash & Clinker). So, where significant coal is present at very shallow depth in garden areas (uppermost 1m), the following mitigation measures should be adopted:
- Garden areas: isolate beneath a minimum 1,000mm thickness of inert soil, comprising 850mm of "clean" subsoil plus 150mm topsoil. The thickness of cover will be determined by the actual depth of the coal, in practice only a total 1,000mm cover will be required which may also include existing overlying non-combustible natural soils, i.e. coal at 600mm depth would only require a further 400mm cover.
 - Services: utility trenches (especially those carrying potential heat sources e.g. electric cables) should be cut oversize and backfilled with clean, inert material. This applies to any utility trenches that run beneath estate roads or extend under houses. It is strongly recommended that further advice be sought from all statutory service bodies with respect to the ground conditions within which they will lay services.
 - Estate roads: no action required (although generally less than 1,000mm thick, the road construction is considered to provide adequate isolation as there will be no heat source). Local Authority Highways approval should be sought.
 - Houses: no action required (the floor slab will include insulation and therefore heat transfer into the ground will be negligible). Local Authority Building Control and Warranty Provider approval should be sought. See also comments on foundation excavations in Section 12.4.

- 13.7.2 In theory this could be an issue for about 15% of the total site area (far south-west). However, given seam dip and topography it seems likely that coal will lie at sufficient depth across the remainder of the site.
- 13.7.3 The most pragmatic way of dealing with shallow coal in gardens will be to inspect foundation excavations, and where coal is recorded within the uppermost 1m or so then excavate an inspection pit in the rear garden. Further advice should be sought from Lithos during the construction phase.
- 13.7.4 As with foundation arisings, the developer will need to contact the Coal Authority to dig or carry away excavated (incidental) coal.

13.8 Potential development constraints

- 13.8.1 Deterioration of the surface is likely to be caused by trafficking, especially after topsoil has been stripped and during/after periods of significant rainfall. Consequently, it would be prudent to consider placement of a minimum 200mm thickness of suitable granular fill (i.e. a “blanket” of 6F2) along the line of proposed highways and any temporary haul roads to protect formation during the construction phase.
- 13.8.2 The existing overhead power lines 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.
- 13.8.3 A drainage pipe crosses the centre of the site (with flows to the south) which is not marked on statutory plans. The ownership of the pipe should be established prior to diversion or decommissioning. This aspect requires further clarification.
- 13.8.4 The far south of the site lies within Flood Zone 2, consequently the EA are likely to object to any construction in this area without appropriate flood mitigation measures.

14 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

14.1 General

- 14.1.1 The site is located off Lundhill Road to the west, approximately 1km south-east of Wombwell town, and currently comprises two adjoining, overgrown fields (west and east), with areas of dense vegetation (bushes, brambles etc) predominantly in the western field.
- 14.1.2 It is understood that consideration is being given to redevelopment of the site with 165 traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers.
- 14.1.3 Ground conditions at the site typically comprise an increasingly weathered sequence of Residual soils (gravelly clay), over weathered Coal Measures (Clay with structured lithorelicts), over Coal Measures bedrock (Sandstone, Siltstone and Mudstone) from around 2m to 3m depth.
- 14.1.4 Coal was encountered in 4 of the 26 trial pits (recovered as clayey interlaminated mudstone and coal or gravelly clay), and in 14 of the 16 deep probeholes.

14.2 Mining

- 14.2.1 Those areas of the site close to outcrop of both the Newhill and Swinton Pottery coal seams are shown to lie within High Risk Areas, typically the western fault block and north-west corner of the eastern fault block.
- 14.2.2 The remainder of the site, predominantly the eastern fault block and far north of the western fault block, lies within a Low Risk Area.
- 14.2.3 An intrusive mining investigation has been undertaken, with the majority of probeholes encountering solid coal.
- 14.2.4 However, soft and broken ground with less than 10x competent cover was identified in 5 of the probeholes.
- 14.2.5 The soft/broken ground was typically accompanied by an absence of solid coal within the probehole, and triangulation shows the depth of soft/broken ground at the expected depth of the coal seam.
- 14.2.6 Consequently, mitigation of risks to surface stability are considered necessary; likely via drilling and grouting.

14.3 Hazardous gas

- 14.3.1 The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level.
- 14.3.2 There are three known areas of landfilling within 250m, and the site is underlain by known mineworkings (recorded from around 50m depth).
- 14.3.3 As such, monitoring for hazardous gas in wells installed across the site is underway and a hazardous gas risk assessment should be produced for April 2018. At this stage it would be prudent to allow for basic hazardous gas protection measures in all new dwellings.

14.4 Contamination & remediation

- 14.4.1 No made ground was identified in any of the exploratory holes across the site.
- 14.4.2 Existing Topsoil is considered chemically suitable for re-use.

14.5 Foundations

- 14.5.1 Reinforced strip/trenchfill footings are considered the most suitable foundation solution for the proposed 2 to 3 storey dwellings.
- 14.5.2 Footings will be founded in firm clay (from 900mm depth), or competent rock (from 600mm depth).

14.6 Flooding

- 14.6.1 The EA indicate that the far south-east of the site, adjacent to the canal, lies within Flood Zone 2.

14.7 Drainage

- 14.7.1 Based on observations made during the investigation, soakaways are unlikely to provide a suitable drainage solution for surface water run-off at this site.
- 14.7.2 Furthermore, the sloping nature of the site could result in springs being created down-gradient.

14.8 Highways

- 14.8.1 Based on visual inspection of the shallow natural materials and published guidance, the Residual Soils and weathered Coal Measures strata should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

Appendix A

General Notes

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 through 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 BR211¹, 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 2010². 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 2007³. 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.

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 stones¹ – 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 4°C, 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.

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:

$$I_p = I_p * (\% < 425\mu\text{m} / 100)$$

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 SO₄ 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:

- For stiff soils the effective overburden pressure*
- For firm soils "somewhat less" than the effective overburden pressure
- For soft soils "appreciably less" than the effective overburden pressure, usually 25 kPa or less
- 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 ϕ') 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 ϕ') 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 (SO₄), 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 C₆ to C₁₀). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C₁₀ to C₂₈)
- LRO – Lubricating Oil Range Organics (typically C₂₈ to C₄₀)
- MRO – Mineral Oil Range Organics (typically C₁₈ to C₄₄)

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 C₅-C₄₀, whereas others define TPH as C₁₀-C₃₀.

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 C₄ to C₅ 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 C₁₀ to C₄₀ (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 C₆ to C₈, aromatic C₁₀ to C₁₂ 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).

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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.

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Lithos have assumed the source of contamination is directly below the building foundations; i.e. a depth of 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	
Cu			80-200		80-200	80-200	80-200	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
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 study¹

¹ SP1010 Appendix E, Provisional C4SLs for benzo(a)pyrene as a surrogate marker for PAHs, CL:AIRE 2013

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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

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

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 ICRCCL 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

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, 1999ⁱⁱⁱ

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:

- 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.
- 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.
- 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 5.63m³ has been considered.
- 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.
- 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.
- 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.

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.

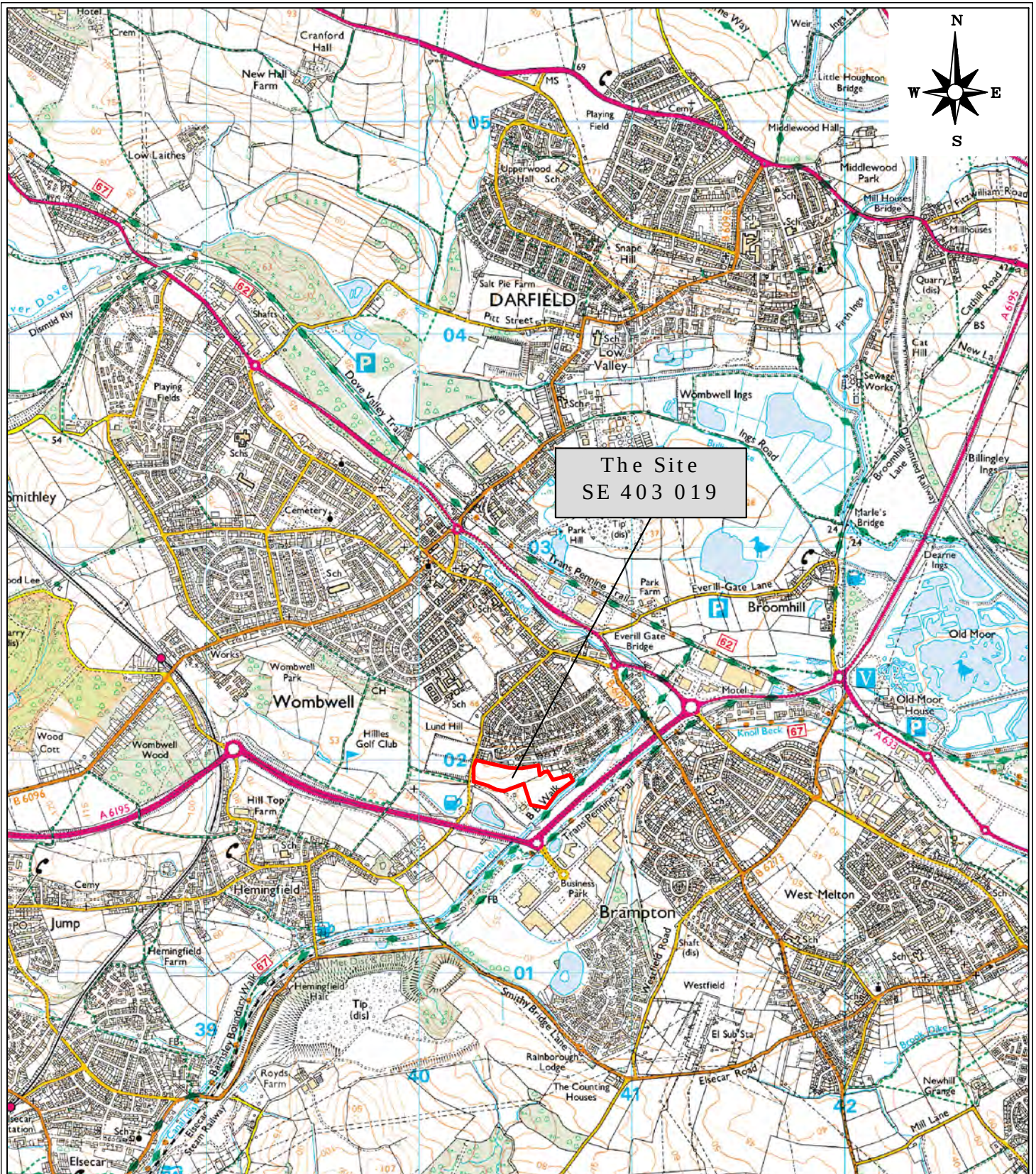
Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

- 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.



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CLIENT

PERSIMMON
HOMES

JOB TITLE

LUNDHILL ROAD,
WOMBWELL

DRAWING TITLE

SITE LOCATION
PLAN

DRAWN

ASw

DATE

25 08 16

CHECKED

REG

DATE

25 08 16

STATUS

FOR COMMENT ☐

DRAFT ☐

FOR APPROVAL ☐

FINAL ☒

SCALE

1:25,000

SHEET

A4

DRAWING NO.

2409/1

REVISION



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PERSIMMON
HOMES

LUNDHILL ROAD,
WOMBWELL

PROPOSED LAYOUT

- NOTES
- APPROXIMATE LINE OF FAULT
 - APPROXIMATE SITE BOUNDARY

REPRODUCED FROM PERSIMMON HOMES
ILLUSTRATIVE LAYOUT REFERENCE LUNDHILL
ROAD, WOMBWELL, DATED JUNE 16

REV.	DESCRIPTION	DATE

STATUS	
FOR COMMENT ☐	FOR APPROVAL ☐
DRAFT ☐	FINAL ☒
DRAWN ASw	DATE 25 08 16
APPROVED REG	DATE 25 08 16
SCALE 1:1,250 (approx.)	SHEET A3
DRAWING NO. 2409/2	REVISION



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PERSIMMON
HOMES

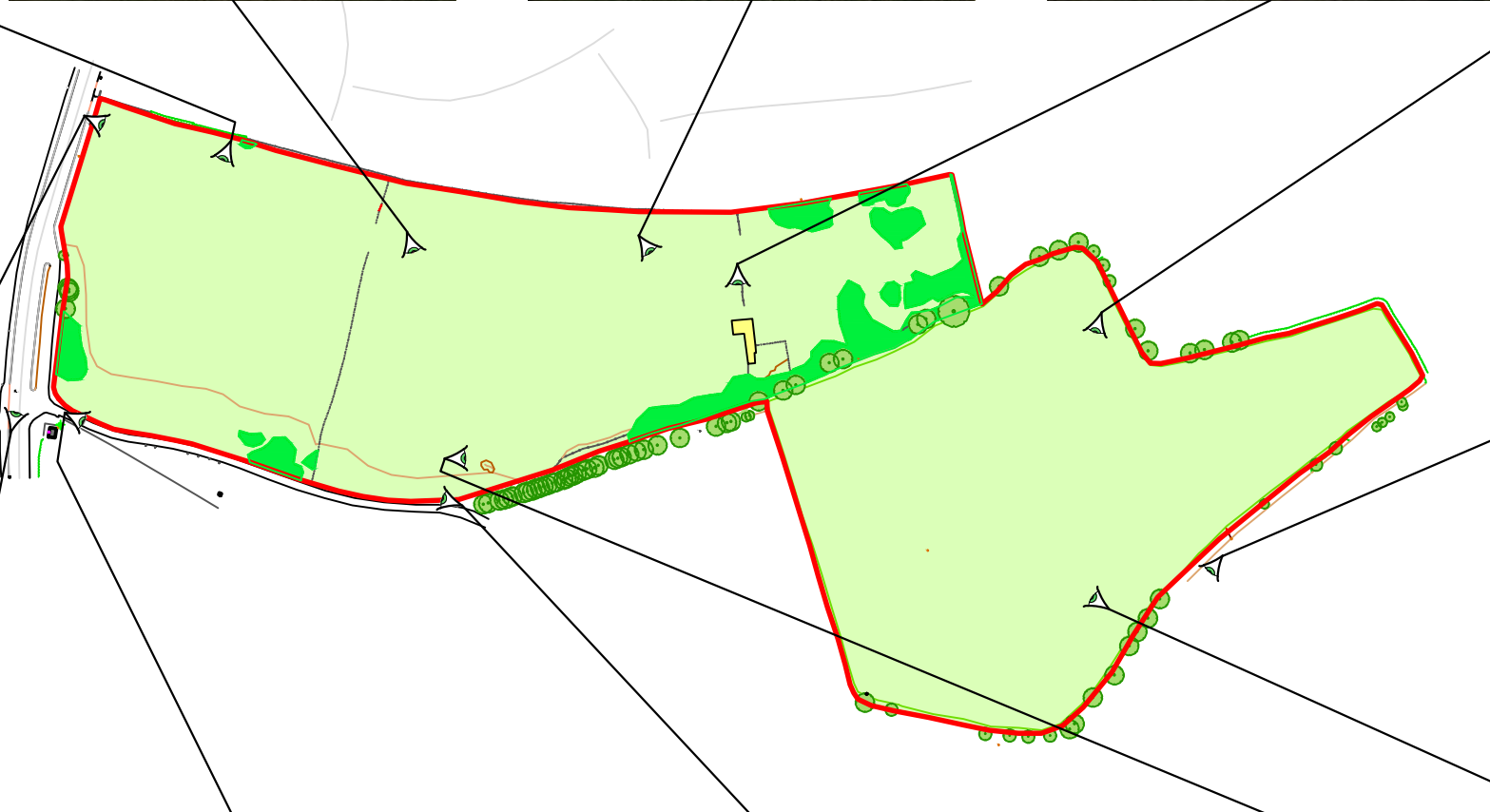
LUNDHILL ROAD,
WOMBWELL

SITE FEATURES

- NOTES
- GRASS & OVERGROWN AREAS
 - BUILDING (HORSE SHELTERS)
 - TREES
 - HEAVILY OVERGROWN (BUSHES, BRAMBLES ETC)
 - OVERHEAD BT
 - OVERHEAD ELECTRIC
 - APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

STATUS	
FOR COMMENT ☐	FOR APPROVAL ☐
DRAFT ☐	FINAL ☒
DRAWN ASw	DATE 25 08 16
APPROVED REG	DATE 25 08 16
SCALE 1:1,250	SHEET A3
DRAWING NO. 2409/3	REVISION



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CLIENT

PERSIMMON
HOMES

JOB TITLE

LUNDHILL ROAD,
WOMBWELL

DRAWING TITLE

SITE PHOTOGRAPHS

NOTES

- GRASS & OVERGROWN AREAS
- BUILDING (HORSE SHELTERS)
- TREES
- HEAVILY OVERGROWN (BUSHES, BRAMBLES ETC)
- LOCATION & ORIENTATION OF PHOTOGRAPH

REV.

DESCRIPTION

DATE

STATUS

FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☒

DRAWN

ASw

DATE

25 08 16

APPROVED

REG

DATE

25 08 16

SCALE

1:2,500

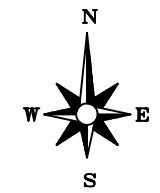
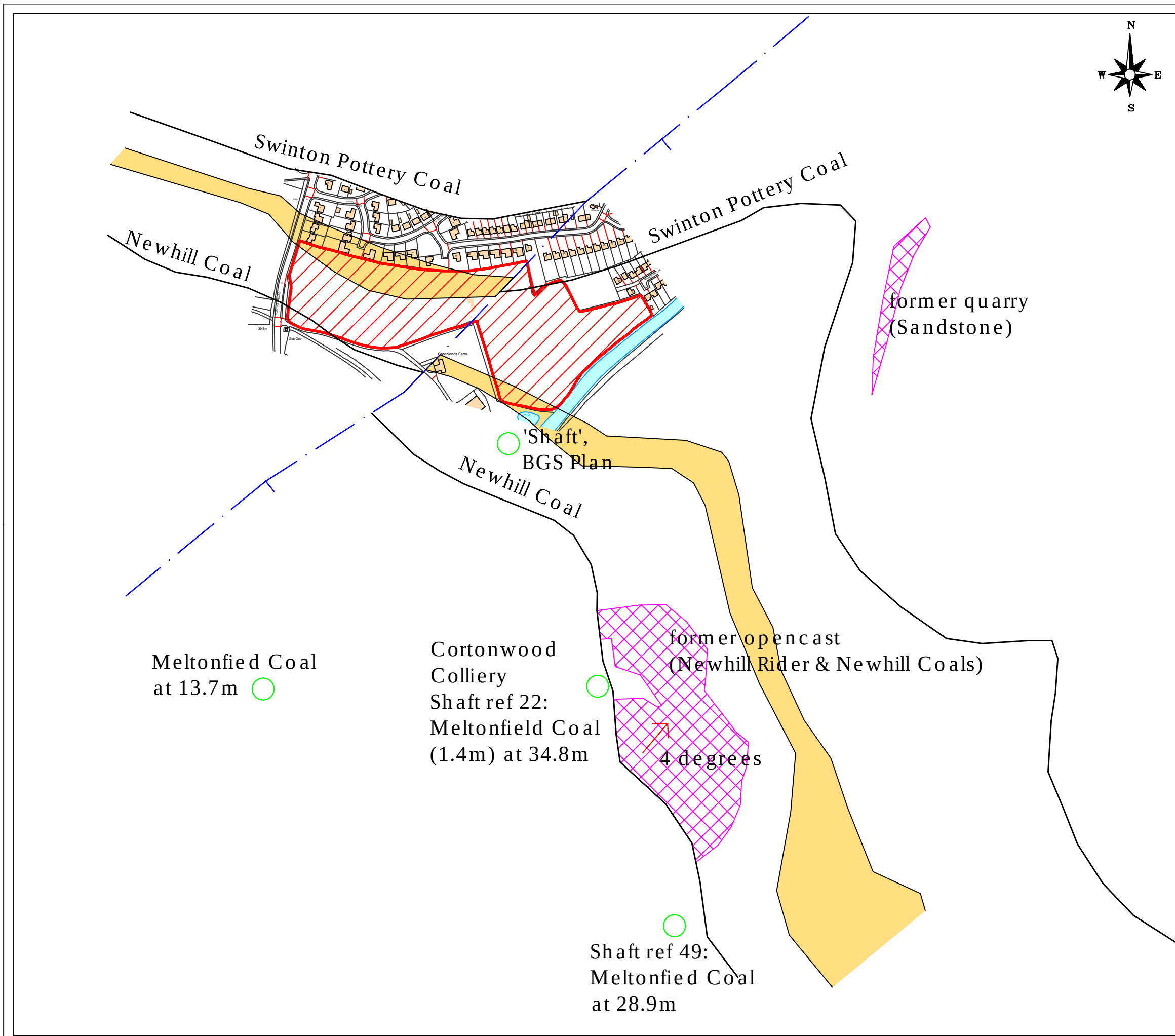
SHEET

A3

DRAWING NO.

2409/4

REVISION



NOTES

- APPROXIMATE LOCATION OF SITE
- UN-NAMED SANDSTONE UNIT
- FORMER OPENCAST OR QUARRY
- LOCATION OF SHAFT
- APPROXIMATE LINE OF FAULT
- APROXIMATE COAL OUTCROP

REPRODUCED FROM 1:10,000 SCALE BGS
PLAN SE 40 SW (WATH UPON DEARNE)

REV.	DESCRIPTION	DATE
------	-------------	------



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CLIENT

PERSIMMON
HOMES

JOB TITLE

LUNDHILL ROAD,
WOMBWELL

DRAWING TITLE

PUBLISHED GEOLOGY

DRAWN	ASw	DATE	09 09 16	STATUS	FOR COMMENT	☐
CHECKED	REG	DATE	09 09 16	FOR APPROVAL	DRAFT	☐
				FINAL		☒
SCALE	1:5,000	SHEET	A3	DRAWING NO.	2409/5	REVISION



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Tel 01937 545330

CLIENT

PERSIMMON
HOMES

JOB TITLE

LUNDHILL ROAD,
WOMBWELL

DRAWING TITLE

EXPLORATORY
HOLE LOCATIONS

NOTES

- TRIAL PIT LOCATION (TP01 to TP26)
- PROBEHOLE LOCATION (PHs 01 to 11 & 14 to 18)
- PROBEHOLE WITH MONITORING WELL (PHs 2A, 4A to 9A, 11A, 12A & 14A)
- PROBEHOLE LOCATION (PHs 101 to 114)
- APPROXIMATE SITE BOUNDARY

A	DECEMBER 2017 PROBEHOLES ADDED (PHs 101 to 114)	20/12/17
REV.	DESCRIPTION	DATE

STATUS

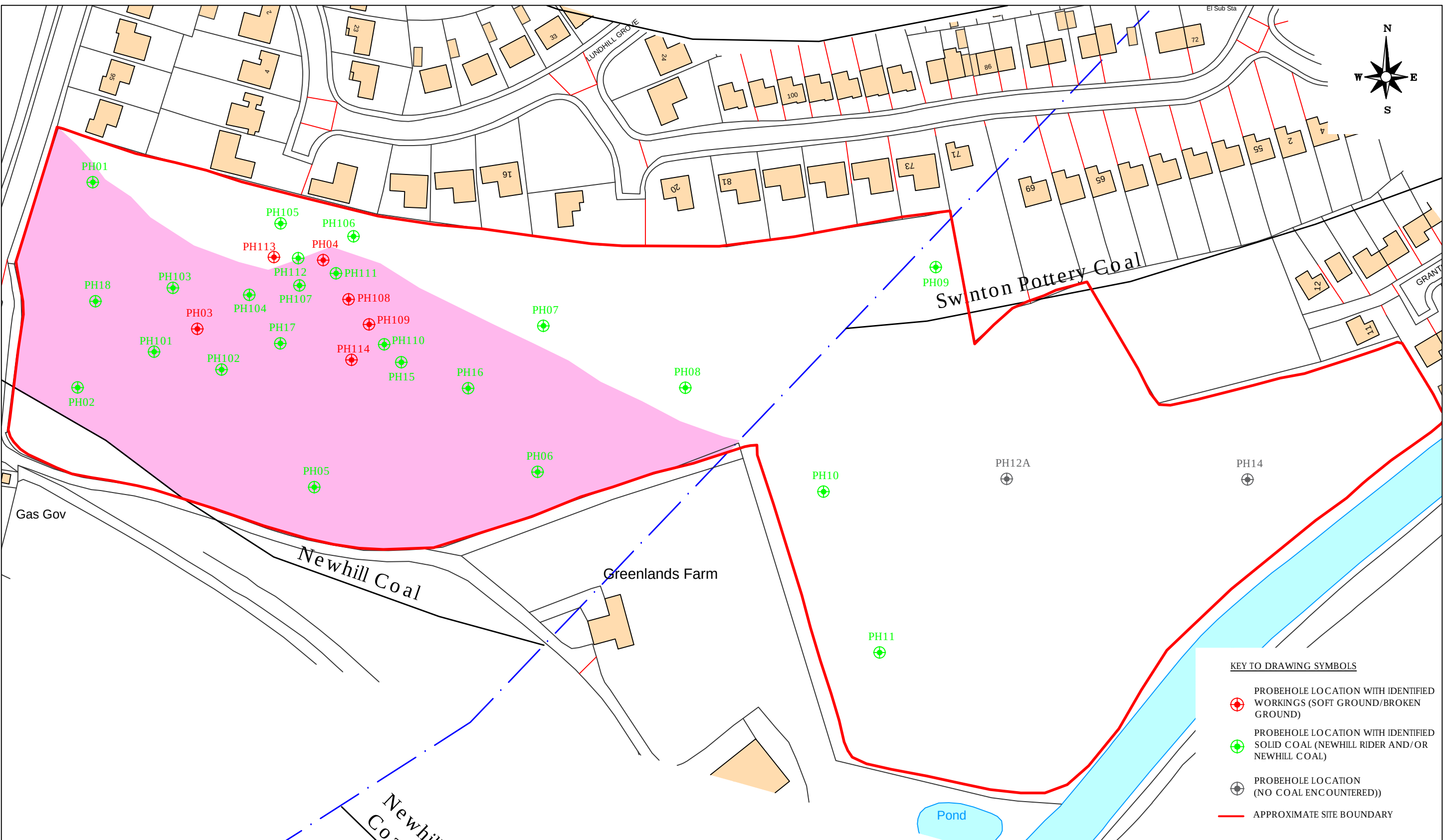
FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☒

DRAWN ASw DATE 29 09 17

APPROVED REG DATE 29 09 17

SCALE 1:1,250 SHEET A3

DRAWING NO. 2409/7 REVISION A



- KEY TO DRAWING SYMBOLS**
- PROBEHOLE LOCATION WITH IDENTIFIED WORKINGS (SOFT GROUND/BROKEN GROUND)
 - PROBEHOLE LOCATION WITH IDENTIFIED SOLID COAL (NEWHILL RIDER AND/OR NEWHILL COAL)
 - PROBEHOLE LOCATION (NO COAL ENCOUNTERED))
 - APPROXIMATE SITE BOUNDARY



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PERSIMMON
HOMES

LUNDHILL ROAD,
WOMBWELL

AREAS OF SHALLOW COAL &
IDENTIFIED WORKINGS

- NOTES**
- APPROXIMATE SITE BOUNDARY
 - AREA OF SHALLOW COAL (COMPETENT COVER OF <10X SEAM THICKNESS)
 - APPROXIMATE LINE OF FAULT
 - APROXIMATE COAL OUTCROP
- REPRODUCED FROM 1:10,000 SCALE BGS
PLAN SE 40 SW (WATH UPON DEARNE)

A	DECEMBER 2017 PROBEHOLES ADDED (PHs 101 to 114)	20/12/17
REV.	DESCRIPTION	DATE

STATUS	
FOR COMMENT ☐	FOR APPROVAL ☐
DRAFT ☐	FINAL ☒
DRAWN ASw	DATE 29 09 17
APPROVED REG	DATE 29 09 17
SCALE 1:1,250	SHEET A3
DRAWING NO. 2409/9	REVISION A

Appendix C

Commission

010a/2409/REG

11th April 2017

Mr K Atkinson
Persimmon Homes (West Yorkshire) Ltd
3 Hepton Court
York Road
Leed
LS9 6PW



Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330

www.lithos.co.uk

Dear Kevin

Lundhill Road, Wombwell

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 165 traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; an illustrative layout has been provided.

The site consists of a single parcel of land of approximately 5 hectares, east of Lundhill Road and south of Dove Road. As you know, we have already issued a Desk Study Report (Ref. 2409/1, dated September 2016), key findings of which were:

- The site comprises two adjoining overgrown fields (west and east), with areas of dense vegetation (bushes, brambles etc) predominantly in the western field.
- No former uses of the site are shown on historical OS plans other than open fields, with recent known grazing and stabling of horses.
- The site is shown to be underlain by Coal Measures strata dipping around 4° to the north-east, with a geological fault trending north-east to south-west roughly through the centre of the site.
- Much of this site is located within a Coal Mining Development High Risk Area.
- The Swinton Pottery Coal outcrops in far north of eastern field (within the eastern fault block), and dips to the north-east. The Newhill coal lies around 35m below the Swinton Pottery Coal. The Newhill coal outcrops on the southern boundary (within the western fault block) and dips towards the north-east.
- Weathered Coal Measures should provide sufficient bearing capacity to enable the adoption of strip footings.
- Recommendations for ground investigation were:
 - o About 25 trial pits, with associated chemical and geotechnical laboratory testing of selected samples to determine shallow ground conditions.
 - o About 10 rotary probeholes to check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings and to install monitoring wells to monitor for hazardous gas.

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, CLR11 etc). Our Report may not 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.



This proposal allows for the following works:

Fieldwork: We have allowed for the excavation of about 25 trial pits (a spacing of about 45m) and the drilling of 10 rotary probeholes. All trial pits and probeholes will be supervised and logged by an experienced geoenvironmental engineer.

Based on anticipated ground, soakaways are considered unlikely to provide a satisfactory solution for surface water drainage, but testing would remove any ambiguity with respect to Yorkshire Water queries. However, no allowance has been made for soakaway testing at this stage. If required, or considered feasible based on the ground actually encountered, soakaway tests could be undertaken for an additional fee of about £****.

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.

The site is underlain by the Newhill coal seam, and therefore we have allowed for the drilling of about 10 deep rotary probeholes to check for the presence of mineworkings. This drilling should be sufficient to determine whether old mineworkings are present and pose a significant risk to surface stability of the site. However, if a potential risk is perceived to exist, further probeholes may be required to delineate the extent of workings in order to obtain fixed price quotations for the necessary consolidation works.

It will be necessary to submit an application (with the associated fee) to the Coal Authority (CA) for 'Permission to enter CA mining interests'; and we have allowed for this. Given the proximity of surrounding housing (within 50m of about half the site), and in accordance with CA requirements we have had to assume that some of the probeholes will need to be advanced using water as the flushing medium (as reinforced by recent CA guidance on managing the risk of hazardous gas). Our drilling sub-contractor will need to locate the wash outs close to the site, and procure a standpipe and licence from Yorkshire Water.

With reference to the control, management and disposal of surplus water and flush arising from the works, (and in order to avoid additional costs associated with the provision of a telehandler to transfer a weir tank between boreholes, and the provision of a pump to transfer surplus water from the weir tank to an approved disposal point), we have made provision for a sand bag bund at the foot of the drilling mast, at each borehole to contain the majority of the drill cuttings. However, we have assumed that potentially discoloured surplus water will be allowed to flow and settle into the field.

We have also assumed that it will be possible to park plant overnight within the adjacent farmyard, where it will be more secure.

Given the possible presence of shallow mineworkings and areas of landfill within 250m of the site, we have allowed for the installation of wells in about 10 shallow probeholes and monitoring for hazardous gas (and any shallow groundwater).

The generation potential of this gas source is considered likely to be Low. Therefore, in accordance with CIRIA Report C665, we have initially allowed for 9 visits over a 6 month period. A hazardous gas risk assessment will be issued on completion of 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, and a track mounted drilling rig and associated tele-handler.

Soils 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.

At this stage, we have no reason to expect wide areas of the site to be underlain by significant thicknesses of made ground. Consequently, we have only allowed for contaminant testing of up to 4 made ground samples, plus a further 6 samples of topsoil 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 £38 per sample.

If more significant made ground is encountered, we will inform you immediately and provide costs for the recommended chemical testing.

Within in our proposal we have allowed for the screening (ID) of 10 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 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 at the milestones defined below:

- 1st milestone invoice (Items A to C) within 5 days of fieldwork completion, with exploratory hole logs and an interim letter report outlining our initial findings
- 2nd milestone invoice (Items D to F) on issue of the final SI report
- 3rd and final invoice (Item G) after completion of the gas monitoring

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 proposal includes for provision of a Welfare Unit, with the benefit of full canteen facilities, hot water with full size sink, toilet and drying room.

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

A handwritten signature in black ink, appearing to read "Mark Perrin".

Mark Perrin
Director

for and on behalf of
LITHOS CONSULTING LIMITED

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 asset 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**
- 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, 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's 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's 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's 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 determined 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 determination 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 determine 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 determination 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 determination 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.

Alan Swales

Subject: FW: Lundhill Road

From: Atkinson, Kevin [mailto:kevin.atkinson@persimmonhomes.com]

Sent: 11 April 2017 11:10

To: Reg <Reg@lithos.co.uk>; Thornton, Charlotte <Charlotte.Thornton@persimmonhomes.com>

Cc: Follows, Karen <karen.follows@persimmonhomes.com>

Subject: FW: Lundhill Road

Mark

I can confirm your quote attached is acceptable please can you programme in and let me know dates?
Could you also send over your RAMS?

Should you require any additional information please do not hesitate to contact me.

Charlotte, can you please raise a PO for the sum of £****

Regards,

Kevin Atkinson
Technical Manager

Tel: 0113 2409726 - 07429223291

**Persimmon Homes West Yorkshire
& Charles Church West Yorkshire**

3 Hepton Court, York Road, Leeds, LS9 6PW

Persimmon Homes West Yorkshire is a trading division of Persimmon Homes Limited registered in England number 4108747 a subsidiary company of Persimmon plc

Please consider the environment before printing this e-mail.

Alan Swales

Subject: FW: Lundhill Road, Wombwell - Phase 2 SI

From: Parkin, James [mailto:james-parkin@persimmonhomes.com]

Sent: 11 September 2017 10:48

To: Alan Swales <Alan.Swales@lithos.co.uk>

Subject: FW: Lundhill Road, Wombwell - Phase 2 SI

Morning Alan,

I have finally been given confirmation that we can now access all areas of the Lundhill Road site for the phase two investigation.

Thank you for your patience on this I know there has been a lot of messing about on this job.

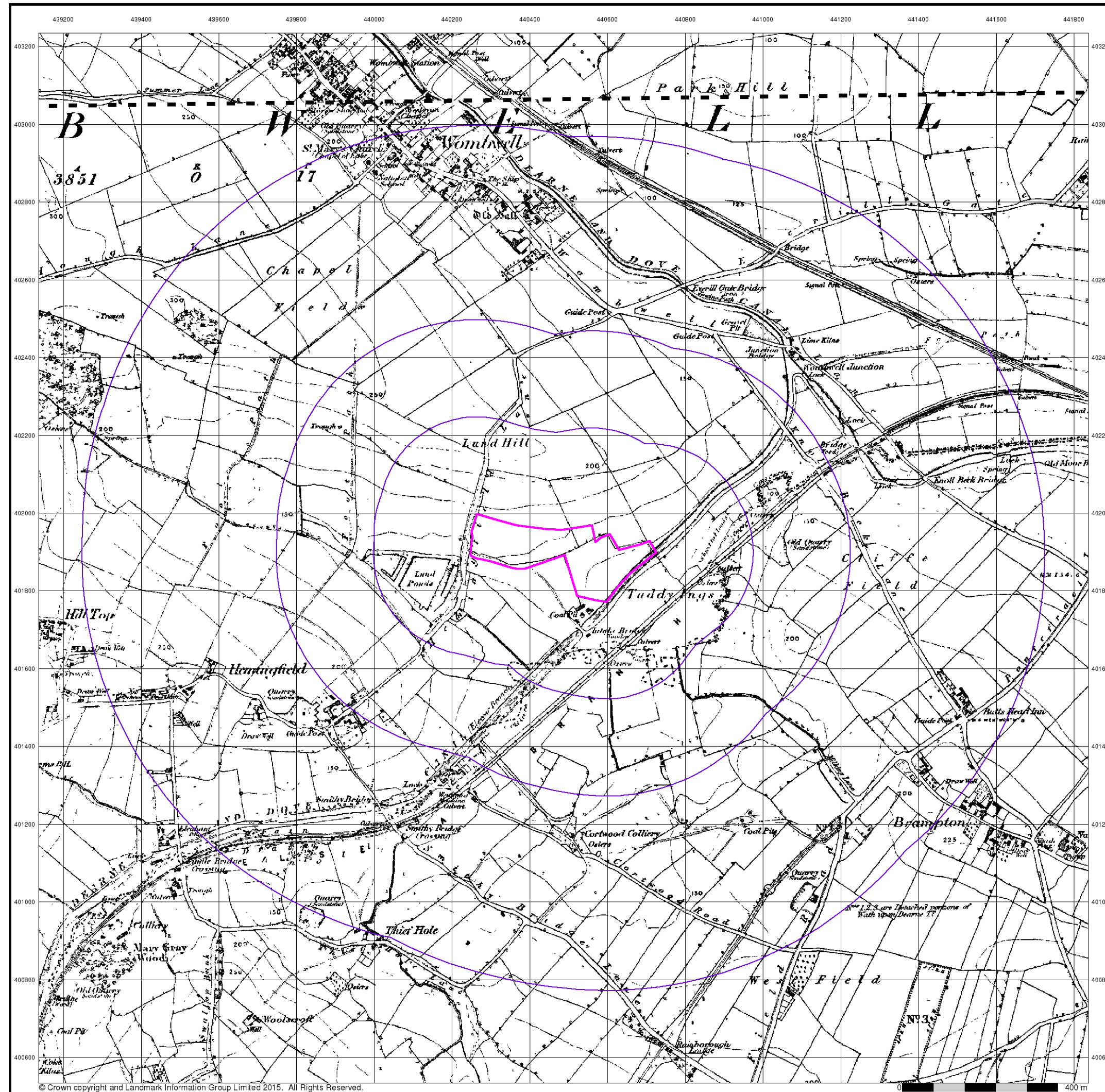
Please could you let me know when you are able to programme this work for and I will organise access arrangements with the landowners.

Also if you could provide me with the H&S info requested in the attached I will raise the PO.

Regards
James

Appendix D

Historical OS Plans



Yorkshire

Published 1854 - 1855

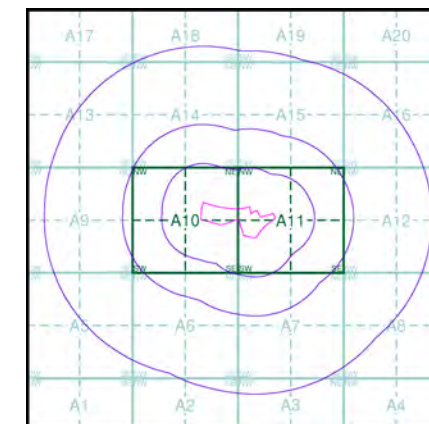
Source map scale - 1:10,560

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; these maps were used to update the 1:10,560 maps. The published date given therefore 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. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

27500
1854
1:10,560
28300
1855
1:10,560

Historical Map - Slice A



Order Details

Order Number: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
Slice: A
Site Area (Ha): 5.07
Search Buffer (m): 1000

Site Details

Lundhill Road, Wombwell, BARNSLEY, South Yorkshire, S73 0QZ



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



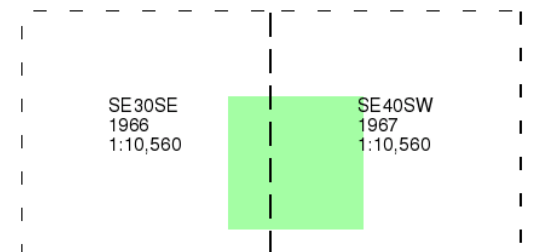
Ordnance Survey Plan

Published 1966 - 1967

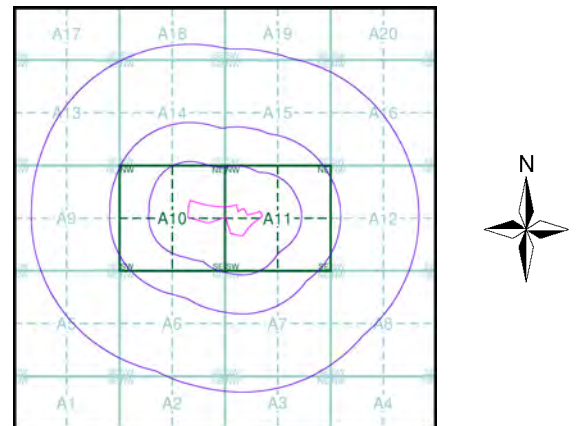
Source map scale - 1:10,000

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; these maps were used to update the 1:10,560 maps. The published date given therefore 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. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

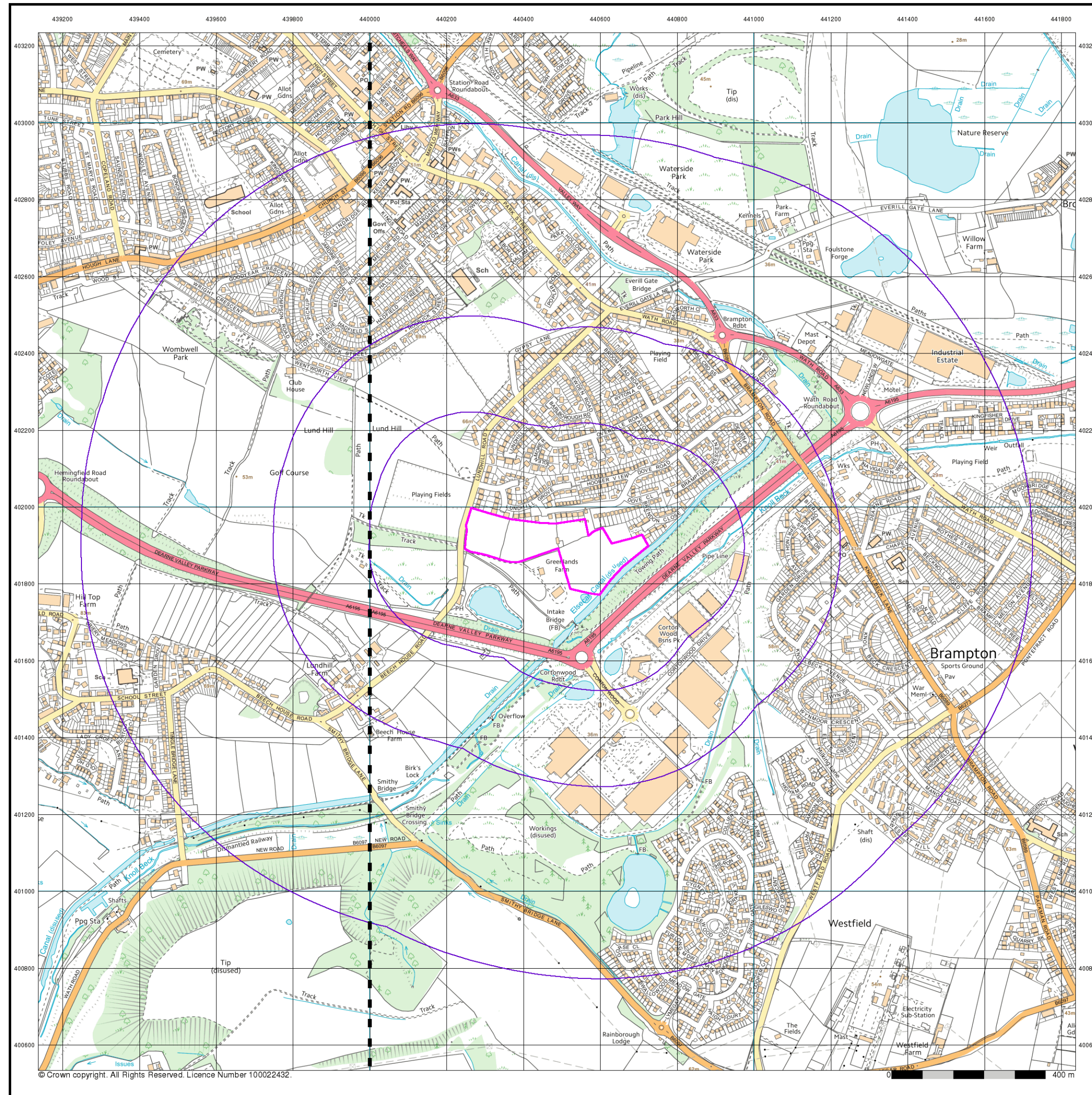
Order Number: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
Slice: A
Site Area (Ha): 5.07
Search Buffer (m): 1000

Site Details

Lundhill Road, Wombwell, BARNSELY, South Yorkshire, S73 0QZ



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



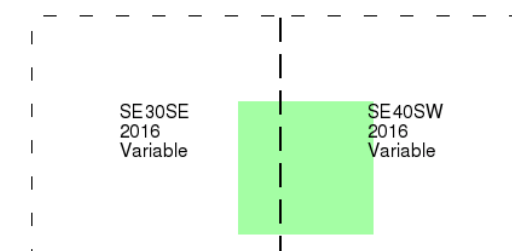
VectorMap Local

Published 2016

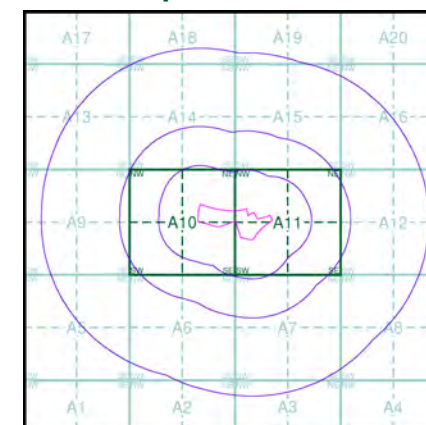
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities), 1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
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Site Area (Ha): 5.07
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Appendix E

Search Responses & other Correspondence

Envirocheck[®] Report:

Datasheet

Order Details:

Order Number:

94942589_1_1

Customer Reference:

2409

National Grid Reference:

440480, 401900

Slice:

A

Site Area (Ha):

5.07

Search Buffer (m):

1000

Site Details:

Lundhill Road
Wombwell
BARNSELY
South Yorkshire
S73 0QZ

Client Details:

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

Report Section	Page Number
Summary	-
Agency & Hydrological	1
Waste	21
Hazardous Substances	-
Geological	31
Industrial Land Use	42
Sensitive Land Use	51
Data Currency	52
Data Suppliers	57
Useful Contacts	58

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 the attached 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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Radon Potential dataset Copyright Notice

Information supplied from a joint dataset compiled by The British Geological Survey and Public Health England.

Report Version v50.0

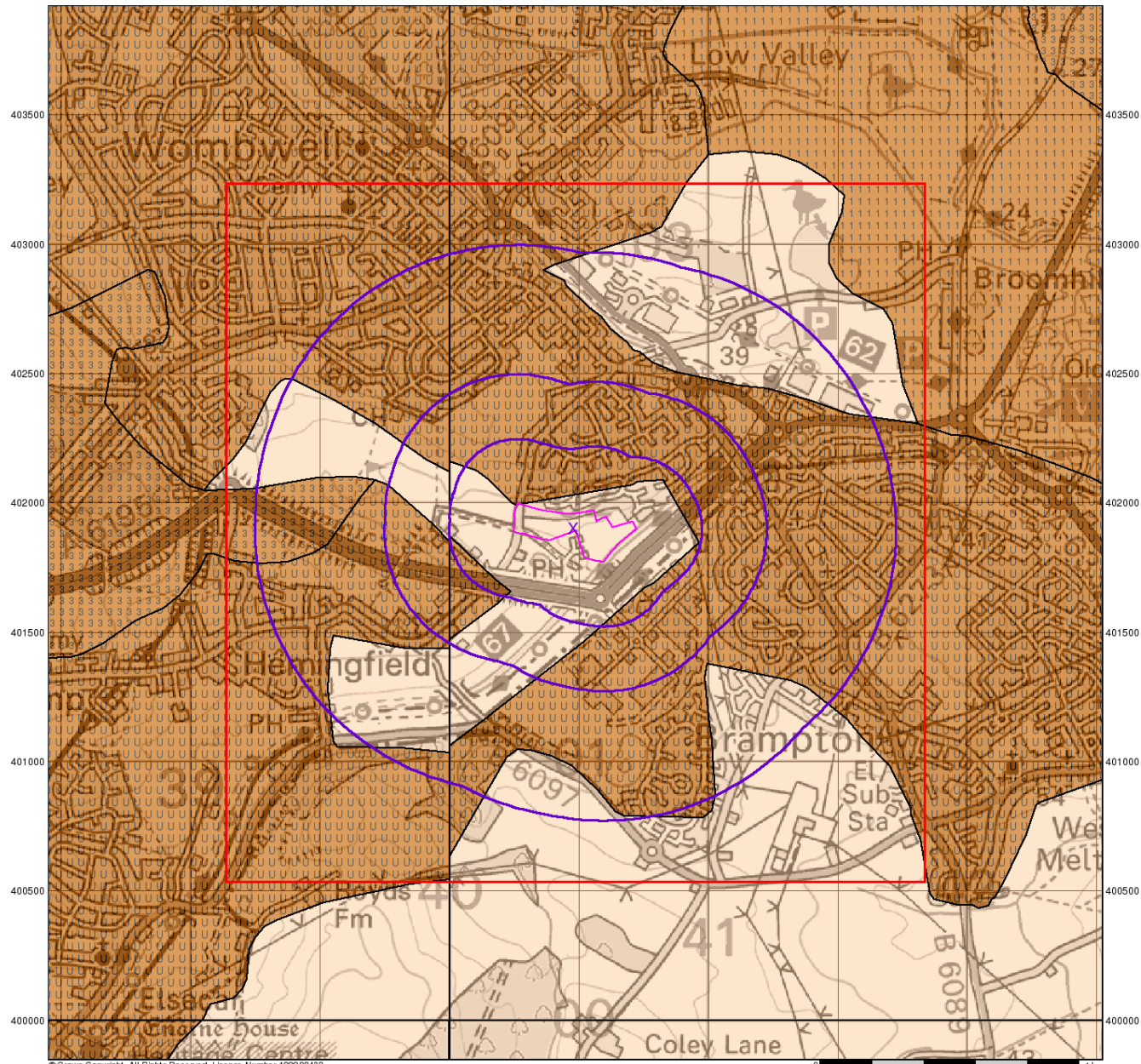
Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes	Yes	Yes	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 3		7	2	3
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control	pg 6				2
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 7			1	6
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature		Yes			
Pollution Incidents to Controlled Waters	pg 8		8	4	3
Prosecutions Relating to Authorised Processes	pg 10				1
Registered Radioactive Substances					
River Quality	pg 10	1	1		1
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register	pg 11				3
Water Abstractions	pg 11		2		(*1)
Water Industry Act Referrals	pg 12				1
Groundwater Vulnerability	pg 12	Yes	n/a	n/a	n/a
Drift Deposits			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 12	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	pg 12	Yes	Yes	n/a	n/a
Flooding from Rivers or Sea without Defences	pg 14	Yes		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
Detailed River Network Lines	pg 14		Yes	Yes	n/a
Detailed River Network Offline Drainage					n/a

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites	pg 21				1
Historical Landfill Sites	pg 21		3	1	8
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)	pg 23		1		1
Licensed Waste Management Facilities (Locations)	pg 24			1	1
Local Authority Landfill Coverage	pg 24	1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites	pg 24	1	1	1	9
Potentially Infilled Land (Non-Water)	pg 26		2	3	5
Potentially Infilled Land (Water)	pg 26		1	3	4
Registered Landfill Sites	pg 27		1	1	5
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					

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 31	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 31	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 36		1	3	8
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
Brine Compensation Area			n/a	n/a	n/a
Coal Mining Affected Areas	pg 38	Yes	n/a	n/a	n/a
Mining Instability	pg 38	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain	pg 38	Yes	Yes	n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 39	Yes	Yes	n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 39		Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 39	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 40		Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 40	Yes	Yes	n/a	n/a
Radon Potential - Radon Affected Areas	pg 41	Yes	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 42		5	7	36
Fuel Station Entries	pg 46			2	3
Points of Interest - Commercial Services	pg 46		1	4	9
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 48				13
Points of Interest - Public Infrastructure	pg 49			6	4
Points of Interest - Recreational and Environmental	pg 49				2
Gas Pipelines					
Underground Electrical Cables					

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 51	1			1
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 51	1			
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					

438500 439000 439500 440000 440500 441000 441500 442000 442500



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0 1 km



Groundwater Vulnerability

General

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

Agency and Hydrological

Geological Classes

Major Aquifer (Highly Permeable)

Minor Aquifer (Variably Permeable)

Non Aquifer (Negligibly Permeable)

Water or Sea

Drift Deposit

Soil Classes

High (H) 1, 2, 3, U

Intermediate (I) 1, 2

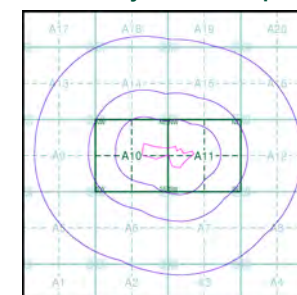
Low

High (H) 1, 2, 3, U

Intermediate (I) 1, 2

Low

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 94942589_1_1
 Customer Ref: 2409
 National Grid Reference: 440480, 401900
 Slice: A
 Site Area (Ha): 5.07
 Search Buffer (m): 1000

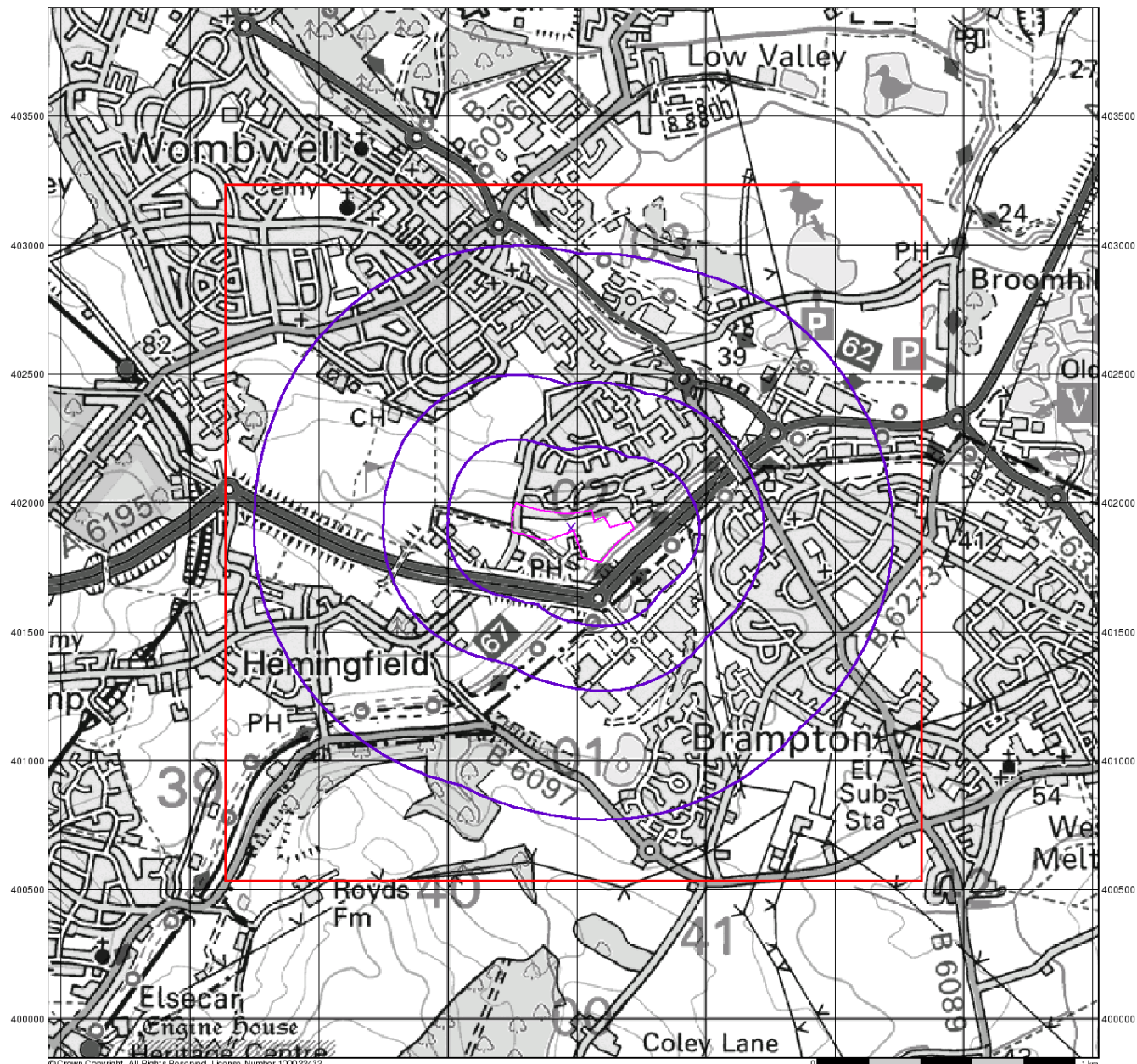
Site Details

Lundhill Road, Wombwell, BARNSELY, South Yorkshire, S73 0QZ



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

438500 439000 439500 440000 440500 441000 441500 442000 442500



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Source Protection Zones

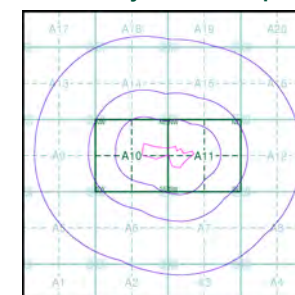
General

- 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)
- Source Protection Zone Borehole

Site Sensitivity Context Map - Slice A



Order Details

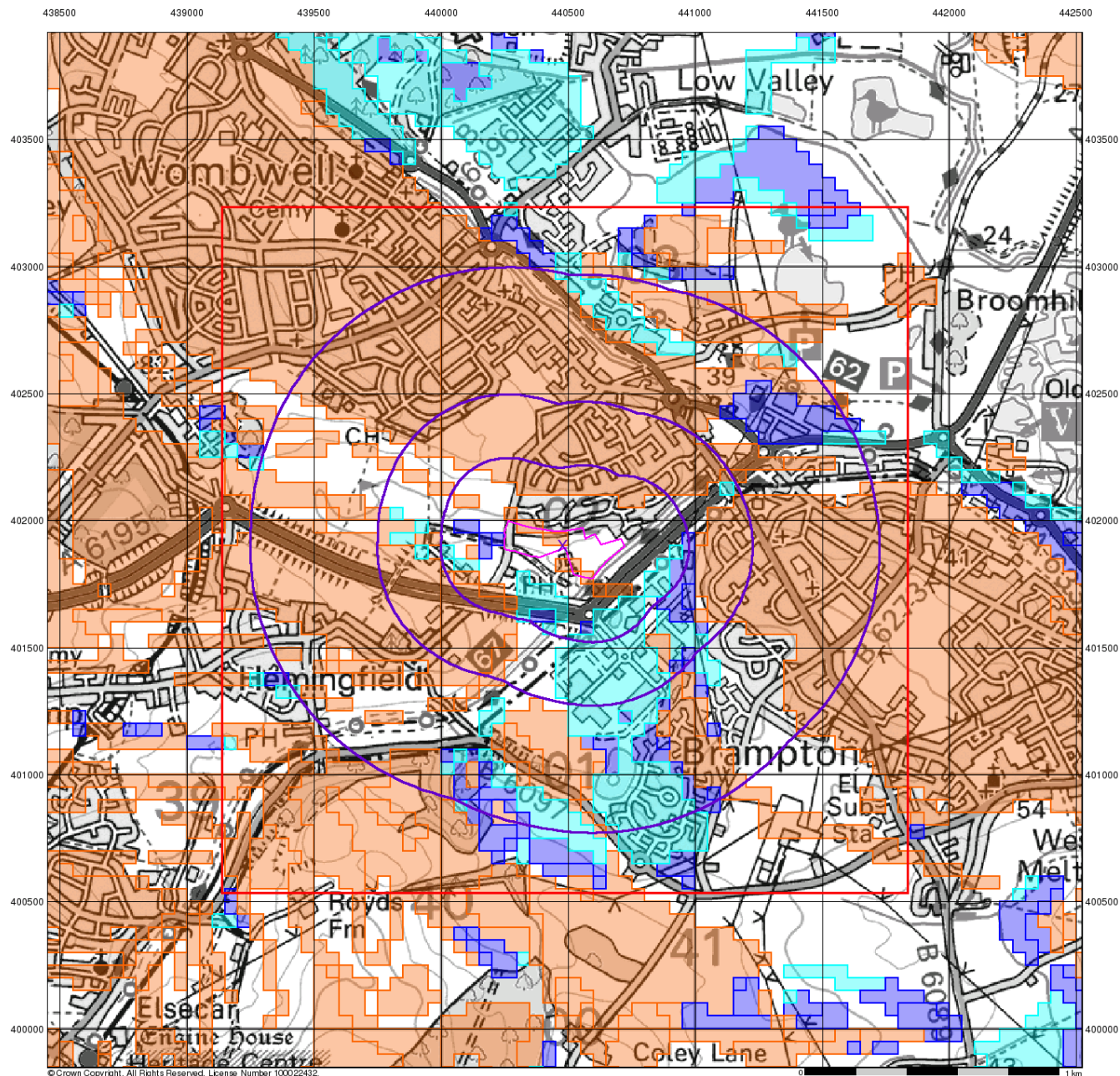
Order Number: 94942589_1_1
 Customer Ref: 2409
 National Grid Reference: 440480, 401900
 Slice: A
 Site Area (Ha): 5.07
 Search Buffer (m): 1000

Site Details

Lundhill Road, Wombwell, BARNLEY, South Yorkshire, S73 0QZ



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



BGS Flood GFS Data

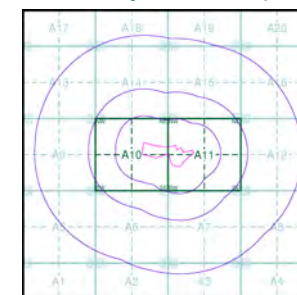
General

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

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 94942589_1_1
 Customer Ref: 2409
 National Grid Reference: 440480, 401900
 Slice: A
 Site Area (Ha): 5.07
 Search Buffer (m): 1000

Site Details

Lundhill Road, Wombwell, BARNSEY, South Yorkshire, S73 0QZ

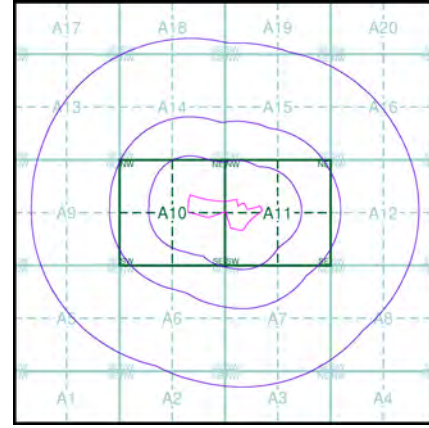


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- General**
- Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point
 - Map ID
- Agency and Hydrological**
- Contaminated Land Register Entry or Notice (Location)
 - Contaminated Land Register Entry or Notice
 - Discharge Consent
 - Enforcement or Prohibition Notice
 - Integrated Pollution Control
 - Integrated Pollution Prevention and Control
 - Local Authority Integrated 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
- 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 (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
- Hazardous Substances**
- COMAH Site
 - Explosive Site
 - NIHHS Site
 - Planning Hazardous Substance Consent
 - Planning Hazardous Substance Enforcement
 - BGS Recorded Mineral Site

Site Sensitivity Map - Slice A



Order Details

Order Number: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
Slice: A
Site Area (Ha): 5.07
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Site Details

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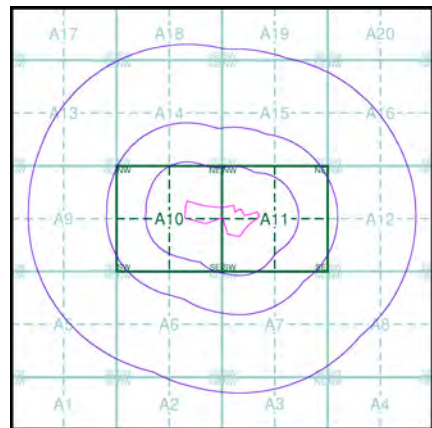
General

- 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: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
Slice: A
Site Area (Ha): 5.07
Search Buffer (m): 1000

Site Details

Lundhill Road, Wombwell, BARNSELY, South Yorkshire, S73 0QZ



Tel: 0844 844 9952
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General

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

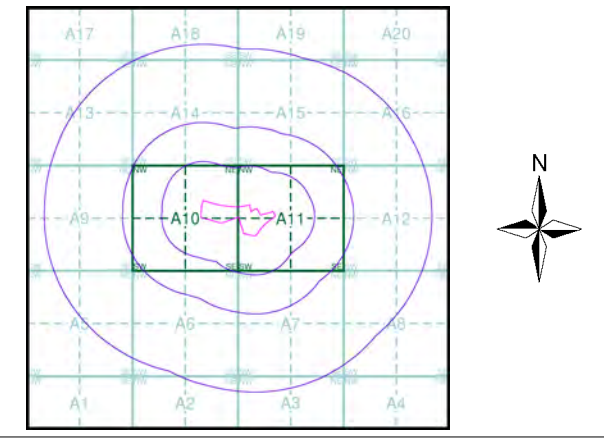
Detailed River Network Data

- Primary River
- Secondary River
- Tertiary River
- Canal
- Canal Tunnel
- Undefined River
- Lake/Reservoir
- Offline Drainage Feature
- Extended Culvert (greater than 50m)
- Underground River (inferred)
- Underground River (local knowledge)
- Downstream of High Water Mark
- Downstream of Seaward Extension
- Not assigned River feature

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- MLW - Mean Low Water
- MHW - Mean High Water

E/NRW Detailed River Network Map - Slice A



Order Details

Order Number: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
Slice: A
Site Area (Ha): 5.07
Search Buffer (m): 1000

Site Details

Lundhill Road, Wombwell, BARNSELY, South Yorkshire, S73 0QZ



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



General

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

Risk of Flooding from Surface Water

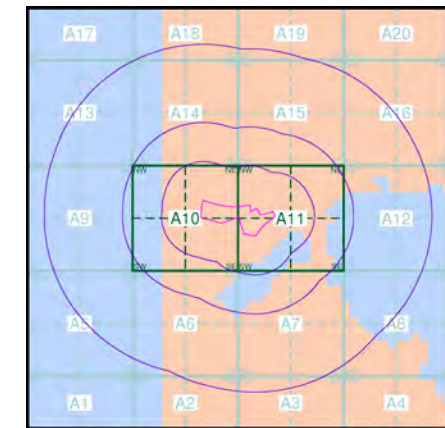
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

E/NRW Suitability Map - Slice A



Order Details

Order Number: 94942589_1_1
Customer Ref: 2409
National Grid Reference: 440480, 401900
Slice: A
Site Area (Ha): 5.07
Search Buffer (m): 1000

Site Details

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



The Coal
Authority

Resolving the **impacts** of mining

CON29M Non-Residential Mining Report

LUNDHILL ROAD
WOMBWELL
BARNESLEY
SOUTH YORKSHIRE

Date of enquiry: 23 August 2016
Date enquiry received: 23 August 2016
Issue date: 23 August 2016

Our reference: 51001241070001
Your reference: 94942589_2 |



CON29M Non-Residential Mining Report

This report is based on, and limited to, the records held by the Coal Authority and the Cheshire Brine Subsidence Compensation Board's records, at the time we answer the search.

Client name

LANDMARK INFORMATION GROUP LIMITED

Enquiry address

LUNDHILL ROAD, WOMBWELL, BARNSELY, SOUTH
YORKSHIRE

How to contact us

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

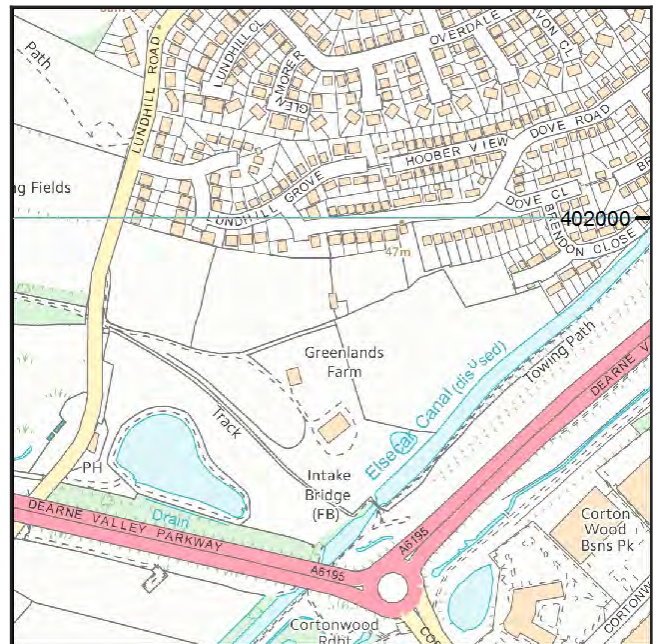
200 Lichfield Lane
Mansfield
Nottinghamshire
NG18 4RG

www.gov.uk/coalauthority

[in](#) /company/the-coal-authority

 /thecoalauthority

 /coalauthority



Approximate position of property



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Summary

Has the search report highlighted evidence or potential of		
1	Past underground coal mining	Yes
2	Present underground coal mining	No
3	Future underground coal mining	Yes
4	Mine entries	Yes
5	Coal mining geology	No
6	Past opencast coal mining	No
7	Present opencast coal mining	No
8	Future opencast coal mining	No
9	Coal mining subsidence	Yes
10	Mine gas	No
11	Hazards related to coal mining	No
12	Withdrawal of support	Yes
13	Working facilities order	No
14	Payments to owners of former copyhold land	No
15	Information from the Cheshire Brine Subsidence Compensation Board	No

Further recommended reports	
Coal mining subsidence claims history	

For detailed findings, please go to page 4.

Detailed findings

1. Past underground coal mining

The property is in a surface area that could be affected by underground mining in 5 seams of coal at 50m to 570m depth, and last worked in 1962.

Any movement in the ground due to coal mining activity should have stopped.

In addition the property is in an area where the Coal Authority believe there is coal at or close to the surface. This coal may have been worked at some time in the past. The potential presence of coal workings at or close to the surface should be considered prior to any site works or future development activity. Your attention is drawn to the Comments on the Coal Authority information section of the report.

2. Present underground coal mining

The property is not within a surface area that could be affected by present underground mining.

3. Future underground coal mining

The property is not in an area where the Coal Authority has plans to grant a licence to remove coal using underground methods.

The property is not in an area where a licence has been granted to remove or otherwise work coal using underground methods.

The property is not in an area likely to be affected from any planned future underground coal mining.

However, reserves of coal exist in the local area which could be worked at some time in the future.

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

4. Mine entries

There are no known coal mine entries within, or within 20 metres of, the boundary of the property.

There may however be mine entries/additional mine entries in the local area which the Coal Authority has no knowledge of.

5. Coal mining geology

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

6. Past opencast coal mining

The property is not within the boundary of an opencast site from which coal has been removed by opencast methods.

7. Present opencast coal mining

The property does not lie within 200 metres of the boundary of an opencast site from which coal is being removed by opencast methods.

8. Future opencast coal mining

There are no licence requests outstanding to remove coal by opencast methods within 800 metres of the boundary.

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

9. Coal mining subsidence

A damage notice or claim for alleged subsidence damage was made in August 2002 for 8 LUNDHILL GROVE, WOMBWELL, BARNSLEY, SOUTH YORKSHIRE, S73 0QZ. However, the claim was rejected.

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.

If further subsidence damage claims information is required, please visit www.groundstability.com.

10. Mine gas

The Coal Authority has no record of a mine gas emission requiring action.

11. Hazards related to coal mining

The property has not been subject to remedial works, by or on behalf of the Authority, under its Emergency Surface Hazard Call Out procedures.

12. Withdrawal of support

The property is in an area where notices to withdraw support were given in 1943, 1962, 1983.

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.

13. Working facilities order

The property is not in an area where an order has been made, under the provisions of the Mines (Working Facilities and Support) Acts 1923 and 1966 or any statutory modification or amendment thereof.

14. 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.

15. Information from the Cheshire Brine Subsidence Compensation Board

The property lies outside the Cheshire Brine Compensation District.

Comments on the Coal Authority information

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In view of the mining circumstances a prudent developer would seek appropriate technical advice before any works are undertaken.

Therefore if development proposals are being considered, technical advice relating to both the investigation of coal and former coal mines and their treatment should be obtained before beginning work on site. All proposals should apply good engineering practice developed for mining areas. No development should be undertaken that intersects, disturbs or interferes with any coal or mines of coal without the permission of the Coal Authority. Developers should be aware that the investigation of coal seams/former mines of coal may have the potential to generate and/or displace underground gases and these risks both under and adjacent to the development should be fully considered in developing any proposals. The need for effective measures to prevent gases entering into public properties either during investigation or after development also needs to be assessed and properly addressed. This is necessary due to the public safety implications of any development in these circumstances.

Additional remarks

Information provided by the Coal Authority in this report is compiled in response to the Law Society's Con29M Coal Mining and Brine Subsidence Claim enquiries. The said enquiries are protected by copyright owned by the Law Society of 113 Chancery Lane, London WC2A 1PL. Please note that Brine Subsidence Claim enquiries are only relevant for England and Wales. This report is prepared in accordance with the Law Society's Guidance Notes 2006, the User Guide 2006 and the Coal Authority and Cheshire Brine Board's Terms and Conditions applicable at the time the report was produced.

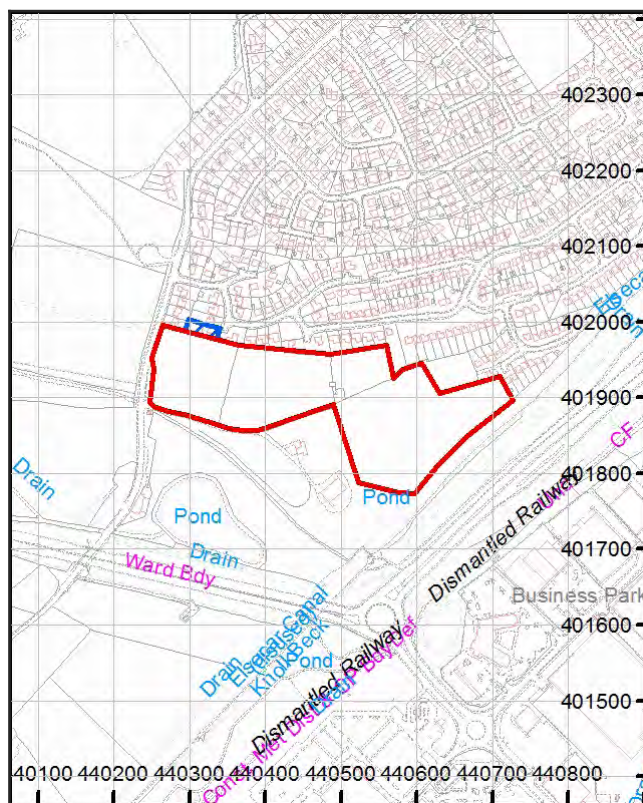
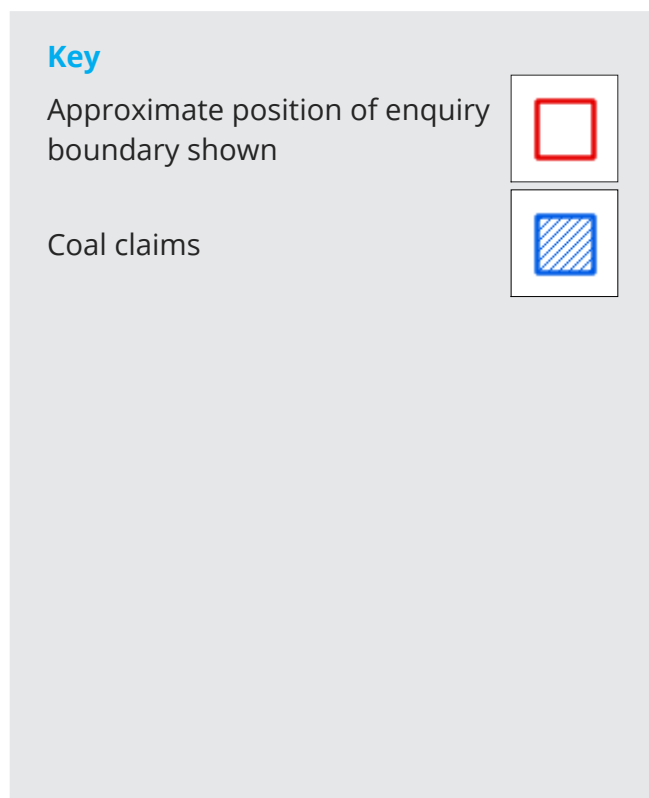
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Enquiry boundary



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The Coal
Authority

Permit to Enter or Disturb Coal Authority Mining Interests

Permit Reference Number 14198

Name and Address of Permit Holder:

*Persimmon Homes (West Yorks) Ltd
3 Hepton Court
York Road
Leeds
LS9 6PW*

Site Location:

*Lundhill Road
Wombwell*

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

Investigation by 13 boreholes to 30m to determine presence of shallow mine workings

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

Signed: *Helen Day* Granted Date: *20th June 2017*

For and on behalf of The Coal Authority

Nominated Representative: Helen Day, Permitting Technical Officer;

The Coal Authority, Permitting Office, 200 Lichfield Lane, Mansfield, Notts, NG18 4RG

Tel: 01623 637339; E-Mail: permissions@coal.gov.uk



The Coal Authority

Site Location

Permit Ref: 14198

Overview map



Permit Boundary

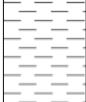
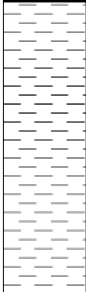
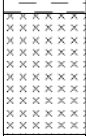


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Appendix F

Trial Pit Logs

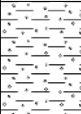
				Trial Pit Log			Trialpit No TP01 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440284.60 - 401889.55 Level: 41.45		Date 25/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 2.40					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.10	41.35		Friable brown very fine sandy CLAY with some rootlets. (TOPSOIL)	
							Stiff orangish brown and grey mottled fissured CLAY. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)	
	0.80	T		0.50	40.95		Dark grey and black thinly inter laminated MUDSTONE and COAL. Remoulds to clay under heavy hand pressure. (NEWHILL COAL)	
				1.00	40.45		Stiff grey occasionally orangish brown fissured CLAY. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (SEATEARTH)	1
	1.40	D	HVP=110					
				2.00	39.45		Weak brown SILTSTONE. Recovered as angular tabular fine to coarse gravel with black iron staining on surfaces. Remoulds to clay under heavy hand pressure. (COAL MEASURES)	2
				2.40	39.05	End of pit at 2.40 m		
								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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

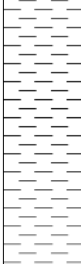
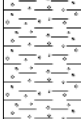
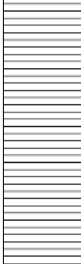
Stability:
 

				Trial Pit Log			Trialpit No TP02 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440278.38 - 401919.07 Level: 43.60		Date 25/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 1.30					

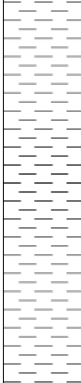
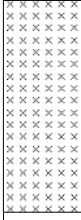
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T	HVP=110				Grey very fine sandy CLAY with occasional rootlets. (TOPSOIL)	
	0.60	D		0.40	43.20		Stiff orangish brown and grey mottled fissured CLAY. Fissures are randomly orientated, closely spaced, planar with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)	
				0.80	42.80		Stiff orangish brown and grey CLAY with many angular tabular fine to coarse gravel size lithorelicts of mudstone with black iron staining on surfaces. (WEATHERED COAL MEASURES)	1
				1.30	42.30		<i>Unable to excavate below 1.3m depth due to competent bedrock.</i> End of pit at 1.30 m	
								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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:
 

				Trial Pit Log				Trialpit No TP03 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440283.24 - 401960.70 Level: 46.45		Date 25/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.60		Logged ASw	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HVP=130 HVP=140	0.40	46.05		Friable grey very fine sandy slightly gravelly CLAY with some rootlets. Gravel is subangular to rounded fine to coarse of mixed lithologies. (TOPSOIL)		
	0.70	D		1.30	45.15		Stiff orangish brown mottled grey fissured CLAY. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES) <i>Vane test at 1m depth in excess of limit of hand vane (>140kPa)</i>		
				1.70	44.75		Stiff orangish brown gleyed grey fissured CLAY with some subangular fine to coarse gravel size lithologies of mudstone. Fissures are randomly orientated, closely spaced, planar smooth and clean. (RESIDUAL SOIL - COAL MEASURES)		
				2.60	43.85		Very weak grey MUDSTONE. Recovered as grey mottled orangish brown, occasionally black, clayey angular tabular fine to coarse structured gravel size lithorelicts. (COAL MEASURES)		
							End of pit at 2.60 m		
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level). Stability: 									

				Trial Pit Log			Trialpit No TP04 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440320.65 - 401947.65 Level: 47.05		Date 25/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 2.30					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.30	46.75		Brown very fine sandy CLAY with some rootlets. (TOPSOIL)	
	0.90	D	HVP=140				Stiff/friable grey mottled orangish brown CLAY with occasional fine rootlets. Fissures randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES) <i>Vane tests at 0.6m and 1.0m depth in excess of limit of hand vane (>140kPa)</i>	1
	1.70	T	HVP=140	1.60	45.45		Weak brown SILTSTONE. Recovered as angular tabular fine to coarse gravel with some black iron staining on surfaces and occasional clayey matrix. (COAL MEASURES)	2
				2.30	44.75		End of pit at 2.30 m	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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:
 

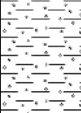
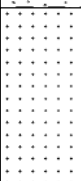
				Trial Pit Log				Trialpit No TP05 Sheet 1 of 1				
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440341.02 - 401912.31 Level: 44.15		Date 25/09/2017				
Location: Barnsley						Dimensions (m):		Scale 1:25				
Client: Persimmon Homes (West Yorkshire)						Depth 2.60		Logged ASw				
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description					
	Depth	Type	Results									
	0.10	J&T	HVP=140	0.20	43.95		Friable brown very sandy CLAY with some rootlets. (TOPSOIL)			1		
								Stiff orangish brown and grey mottled fissured CLAY. Fissures randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)				
												Vane tests at 0.5m and 1.0m depth in excess of limit of hand vane (>140kPa)
	0.90	D	HVP=140	0.60	43.55		Stiff grey occasionally mottled orangish brown CLAY with occasional subangular fine to medium gravel size lithorelicts of siltstone. Occasional reddish brown and orangish brown fine to coarse gravel of ironstone. (RESIDUAL SOIL - COAL MEASURES)				2	
								Stiff grey occasionally mottled orangish brown CLAY with occasional subangular fine to medium gravel size lithorelicts of siltstone. Occasional reddish brown and orangish brown fine to coarse gravel of ironstone. (RESIDUAL SOIL - COAL MEASURES)				
												
1.50	T		1.40	42.75					3			
										Stiff grey and orangish brown mottled fissured CLAY with occasional angular tabular fine to coarse gravel size lithorelicts of mudstone. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (WEATHERED COAL MEASURES)		
			1.70	42.45					4			
			2.60	41.55		End of pit at 2.60 m				5		

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:



				Trial Pit Log			Trialpit No TP06 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440367.66 - 401963.04 Level: 47.25		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 1.20		Logged ASw	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.20	47.05		Friable brown sandy CLAY with some rootlets. (TOPSOIL)	
				0.60	46.65		Friable orangish brown sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of sandstone. (RESIDUAL SOIL - SANDSTONE)	
				1.20	46.05		Strong grey and brown fine to medium grained SANDSTONE. Recovered as sandy angular to subangular generally tabular fine to coarse gravel and occasional cobbles. (COAL MEASURES)	1
							Unable to excavate below 1.2m depth due to competent bedrock. ----- End of pit at 1.20 m	
								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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).
Stability:	



				Trial Pit Log				Trialpit No TP07 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440360.01 - 401873.57 Level: 41.55		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 1.10		Logged ASw	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HVP=109	0.30	41.25		Greyish brown slightly sandy CLAY with many rootlets. (TOPSOIL)		
							Stiff brown and orangish brown slightly sandy CLAY with occasional fine rootlets. (RESIDUAL SOIL - SANDSTONE)		
	1.00	T		0.90	40.65		Strong brown fine to medium grained SANDSTONE. Recovered as slightly clayey angular tabular fine to coarse gravel and cobbles with grey staining on surfaces. (COAL MEASURES)		
				1.10	40.45		Unable to excavate below 1.1m depth due to competent bedrock. End of pit at 1.10 m		
1 2 3 4 5 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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).									
Stability:									

				Trial Pit Log				Trialpit No TP08 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440392.19 - 401895.49 Level: 42.55		Date 26/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 2.80					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.30	42.25		Grey sandy slightly gravelly CLAY with many rootlets. Gravel is angular to subangular fine to medium of mixed lithologies. (TOPSOIL)	
				0.70	41.85		Stiff orangish brown and brown mottled slightly sandy CLAY. (RESIDUAL SOIL - COAL MEASURES)	
	1.00	D	HVP=96				Stiff orangish brown and grey mottled fissured CLAY with occasional grey gleyed root tracks. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)	1
	1.25	T	HVP=82	1.20	41.35		Firm black slightly sandy slightly gravelly CLAY. Gravel is angular fine of coal. (NEWHILL COAL)	
				1.30	41.25		Very stiff light grey CLAY. (SEATEARTH)	
				1.60	40.95		Stiff orangish brown and grey mottled CLAY with many angular fine to medium gravel size lithorelicts of mudstone. (WEATHERED COAL MEASURES)	2
				2.20	40.35		Stiff orangish brown and grey mottled CLAY with many angular fine to medium gravel size lithorelicts of mudstone and some angular to subangular fine to coarse gravel and cobbles of reddish brown ironstone. (WEATHERED COAL MEASURES)	
				2.50	40.05		Moderately weak grey with orangish brown staining SILTSTONE. Recovered as slightly clayey angular tabular fine to coarse gravel and occasional cobbles. (COAL MEASURES)	
				2.80	39.75		End of pit at 2.80 m	3
								4
								5

Remarks: Stability:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).	
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				Trial Pit Log				Trialpit No TP09 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440396.16 - 401933.72 Level: 44.95		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.50		Logged ASw	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.20	44.75		Friable grey sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)	
	0.80	D		1.00	43.95		Orangish brown very sandy angular to subangular fine to coarse GRAVEL of fine to medium grained sandstone with occasional angular tabular cobbles. (RESIDUAL SOIL - SANDSTONE)	
			HVP=140	1.40	43.55		Stiff orangish brown mottled grey sandy slightly gravel fissured CLAY. Gravel is angular to subangular fine to coarse of sandstone. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)	1
				2.10	42.85		Weak grey and brown SILTSTONE. Recovered as slightly clayey angular tabular fine to coarse gravel with black iron staining on surfaces. (COAL MEASURES)	2
				2.50	42.45	End of pit at 2.50 m		3
								4
								5

Remarks: Stability:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).	
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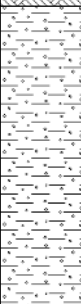
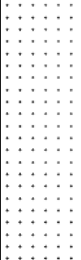
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Project Name: Lundhill Road				Project No. 2409		Co-ords: 440436.70 - 401907.33 Level: 41.95		Date 26/09/2017	
Location: Barnsley				Dimensions (m): Depth 2.60				Scale 1:25 Logged ASw	
Client: Persimmon Homes (West Yorkshire)									

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.20	41.75		Brown slightly sandy slightly gravelly CLAY with some rootlets. Gravel is angular to subrounded fine to medium of mixed lithologies. (TOPSOIL)	
			HVP=70				Firm brown, orangish brown and grey mottled slightly sandy CLAY. (RESIDUAL SOIL - COAL MEASURES)	
	0.90	D		0.60	41.35		Stiff brown gleyed grey fissured CLAY with many angular fine gravel size lithorelicts of mudstone. (WEATHERED COAL MEASURES)	
			HVP=140				Vane test at 1m depth in excess of limit of hand vane (>140kPa)	1
				1.60	40.35		Stiff brown gleyed grey CLAY with many angular tabular fine to coarse gravel size lithorelicts of siltstone. (WEATHERED COAL MEASURES)	2
				2.40	39.55		Weak brown SILTSTONE. Recovered as slightly clayey and tabular fine to coarse gravel with grey staining on surfaces. (COAL MEASURES)	
				2.60	39.35		End of pit at 2.60 m	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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:
 

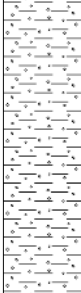
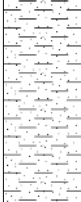
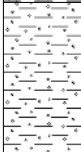
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Project Name: Lundhill Road				Project No. 2409		Co-ords: 440447.73 - 401951.43 Level: 44.05		Date 26/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 2.20					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
▼	1.50	T		0.30	43.75		Friable brown sandy slightly gravelly CLAY with occasional rootlets. (TOPSOIL)	1
				1.30	42.75		Stiff orangish brown and brown mottled sandy slightly gravelly CLAY. Gravel is subangular fine to coarse of sandstone. (RESIDUAL SOIL - SANDSTONE)	
				2.20	41.85		Strong brown fine to medium grained SANDSTONE. Recovered as slightly clayey angular tabular fine to coarse gravel and cobbles with orangish brown penetrative (<10mm) staining and grey staining on surfaces. (COAL MEASURES)	2
						At 2.2m depth, groundwater seepage in base of trial pit. Unable to excavate below 2.2m depth due to competent bedrock. End of pit at 2.20 m		3
								4
								5

Remarks:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at base of pit on completion of excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).
Stability:	



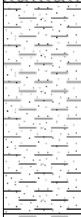
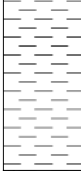
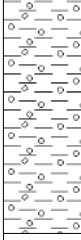
				Trial Pit Log				Trialpit No TP12 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440478.09 - 401926.96 Level: 41.75		Date 25/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.50		Logged ASw	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T					Friable brown and grey slightly sandy CLAY with occasional rootlets. (TOPSOIL)	
			HVP=70	0.30	41.45		Firm becoming stiff orangish brown and brown sandy slightly gravelly CLAY with occasional angular to subangular cobbles of sandstone. Gravel is angular to subangular fine to coarse of sandstone. (RESIDUAL SOIL - SANDSTONE)	1
			HVP=82	1.30	40.45		Stiff orangish brown and grey sandy slightly gravelly CLAY with occasional angular tabular cobbles of fine to medium grained sandstone. Gravel is angular to subangular fine to coarse of sandstone. (RESIDUAL SOIL - SANDSTONE)	
			HVP=98	2.00	39.75		Stiff orangish brown with much grey gleying (90%) slightly gravelly CLAY with rare decomposed rootlets and root tracks. Gravel is orangish brown and reddish brown subrounded fine to coarse ironstone exhibiting onion weathering. (WEATHERED COAL MEASURES)	2
				2.50	39.25		End of pit at 2.50 m	3
								4
								5

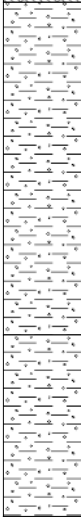
Remarks: Stability:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).	
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				Trial Pit Log			Trialpit No TP14 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440495.31 - 401953.25 Level: 42.85		Date 25/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.40		Logged ASw	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T					Friable grey sandy CLAY with occasional roots and rootlets. (TOPSOIL)	
				0.30	42.55		Stiff orangish brown and brown sandy slightly gravelly CLAY with occasional angular tabular cobbles of sandstone. (RESIDUAL SOIL - SANDSTONE)	
	1.20	D		1.00	41.85		Stiff grey and dark grey fissured CLAY. Fissures are randomly orientated, curved, polished. (RESIDUAL SOIL - COAL MEASURES)	1
				1.60	41.25		Stiff grey and brown fissured CLAY with rare orangish brown and reddish brown subrounded tabular cobbles of ironstone exhibiting onion weathering. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)	2
				2.40	40.45	----- End of pit at 2.40 m -----		
								3
								4
								5

Remarks: Stability:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).	
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				Trial Pit Log				Trialpit No TP15 Sheet 1 of 1				
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440555.44 - 401959.34 Level: 42.00		Date 25/09/2017				
Location: Barnsley						Dimensions (m):		Scale 1:25				
Client: Persimmon Homes (West Yorkshire)						Depth 2.50		Logged ASw				
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description					
	Depth	Type	Results									
	0.10	J&T	HVP=85	0.30	41.70		Grey slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)					
	1.00	D		1.40	40.60					Stiff grey occasionally mottled brown slightly gravelly fissured CLAY. Gravel is subangular to subrounded fine to coarse of mudstone. Fissures are randomly orientated, curved, polished with grey gleying on surfaces. (RESIDUAL SOIL - COAL MEASURES)		
							2.00	40.00				
										2.50	39.50	
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).												
Stability:												



				Trial Pit Log				Trialpit No TP16 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440538.54 - 401931.20 Level: 41.05		Date 25/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.60		Logged ASw	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HVP=65	0.20	40.85		Friable grey slightly sandy slightly gravelly CLAY with some roots and rootlets. Gravel is angular to subangular fine to medium of mixed lithologies. (TOPSOIL) Firm brown and orangish brown slightly sandy CLAY with occasional roots and rootlets. (RESIDUAL SOIL - COAL MEASURES)		
	1.50	D	HVP=125	1.10	39.95		Stiff orangish brown and grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to medium of siltstone. (RESIDUAL SOIL - COAL MEASURES)		
	2.20	T		2.10	38.95		Weak grey MUDSTONE. Recovered as clayey angular tabular fine to coarse gravel (structured), becoming angular fine to coarse gravel with depth. (COAL MEASURES)		
			2.60	38.45		End of pit at 2.60 m			
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).									
Stability:									



				Trial Pit Log			Trialpit No TP17 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440513.76 - 401865.51 Level: 39.15		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.50		Logged ASw	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.25	38.90		Dark grey slightly sandy slightly gravelly CLAY with some rootlets. (TOPSOIL)	
			HVP=130				Stiff orangish brown sandy slightly gravelly CLAY. Gravel is angular fine to medium of sandstone. (RESIDUAL SOIL - COAL MEASURES)	
	1.10	D	HVP=140	0.80	38.35		Stiff grey mottled orangish brown CLAY with some grey gleyed root tracks. (RESIDUAL SOIL - COAL MEASURES) <i>Vane test at 1m depth in excess of limit of hand vane (>140kPa)</i>	1
	1.80	D		1.70	37.45		Stiff brown and grey mottled CLAY with many angular fine to medium gravel size lithorelicts of mudstone. Remoulds to clay under heavy hand pressure. (WEATHERED COAL MEASURES)	2
				2.30	36.85		Weak brown SILTSTONE. Recovered as slightly clayey angular tabular fine to coarse gravel with grey and black iron staining on surfaces (wet). (COAL MEASURES)	
				2.50	36.65	End of pit at 2.50 m		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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level). Stability:	
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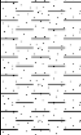
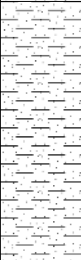
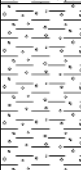
				Trial Pit Log			Trialpit No TP18 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440556.67 - 401885.46 Level: 39.00		Date 26/09/2017	
Location: Barnsley				Dimensions (m): Depth 2.30				Scale 1:25 Logged ASw	
Client: Persimmon Homes (West Yorkshire)									

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.20	38.80		Grey slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)	1
			HVP=112	0.50	38.50		Stiff orangish brown and brown sandy CLAY. (RESIDUAL SOIL - COAL MEASURES)	
			HVP=140				Stiff grey occasionally mottled orangish brown CLAY with some grey gleyed root tracks and rare orangish brown and reddish brown subrounded fine to coarse gravel and cobbles of ironstone exhibiting onion weathering. (RESIDUAL SOIL - COAL MEASURES)	
							Vane test at 0.9m depth in excess of limit of hand vane (>140kPa)	
	1.20	D		1.60	37.40		Very weak grey with occasional brown mottling MUDSTONE. Recovered as clayey angular tabular fine to medium gravel (structured). Rare orangish brown and reddish brown subrounded to rounded medium to coarse gravel and cobbles of ironstone exhibiting onion weathering. Remoulds to clay under heavy hand pressure. (COAL MEASURES)	
			2.30	36.70		End of pit at 2.30 m		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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:
 

				Trial Pit Log				Trialpit No TP19 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440572.57 - 401825.86 Level: 36.00		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.50		Logged ASw	

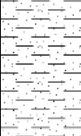
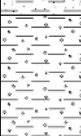
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.60	D	HVP=94	0.30	35.70		Dark grey slightly sandy slightly gravelly CLAY with some rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)	
			HVP=112	0.80	35.20		Stiff brown and orangish brown mottled slightly sandy slightly gravelly CLAY. Gravel is and to subangular fine to medium of sandstone. (RESIDUAL SOIL - SANDSTONE)	
				1.70	34.30		Stiff orangish brown and grey mottled slightly sandy CLAY. (RESIDUAL SOIL - COAL MEASURES)	1
				2.30	33.70		Stiff orangish brown and grey mottled CLAY with some angular fine to medium gravel size lithorelicts of mudstone. Remoulds to clay under heavy hand pressure. (WEATHERED COAL MEASURES)	2
				2.50	33.50		Moderately weak grey MUDSTONE. Recovered as slightly clayey and tabular fine to coarse gravel. (wet). (COAL MEASURES)	
End of pit at 2.50 m								
								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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level). Stability:	
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				Trial Pit Log				Trialpit No TP20 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440582.34 - 401924.12 Level: 40.00		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.20		Logged ASw	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HVP=110	0.25	39.75		Brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to rounded fine to coarse of mixed lithologies. (TOPSOIL) Stiff orangish brown and brown mottled sandy CLAY. (RESIDUAL SOIL - COAL MEASURES) Stiff light grey occasionally mottled orangish brown and brown CLAY. (RESIDUAL SOIL - COAL MEASURES) Dark grey and black interlaminated COAL and MUDSTONE. Recovered as angular fine to coarse structured gravel. Remoulds to clay under heavy hand pressure. (SWINTON POTTERY COAL) Weak grey and orangish brown fine to medium grained SANDSTONE with occasional reddish brown and black fossilised plant remains. Recovered as slightly clayey angular to subangular fine to coarse gravel. (COAL MEASURES)		
	0.85	T		0.60	39.40				
				0.80	39.20				
				0.90	39.10				
				2.20	37.80				
	Unable to excavate below 2.2m depth due to competent bedrock.						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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).									
Stability:									



				Trial Pit Log			Trialpit No TP21 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440587.41 - 401863.23 Level: 37.40		Date 26/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 1.90					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.20	37.20		Dark grey slightly sandy CLAY with some rootlets. (TOPSOIL)	
			HVP=130				Stiff orangish brown and grey mottled sandy CLAY with occasional subangular fine to coarse gravel of sandstone. (RESIDUAL SOIL - SANDSTONE)	
				0.70	36.70		Stiff grey occasionally mottled orangish brown gravelly CLAY with occasional grey gleyed root tracks. Gravel is subangular fine to coarse of sandstone. (RESIDUAL SOIL - SANDSTONE)	
			HVP=140				Vane test at 1m depth in excess of limit of hand vane (>140kPa)	1
				1.60	35.80		Stiff grey occasionally mottled orangish brown gravelly CLAY. Gravel is angular to subangular tabular fine to coarse of sandstone with rare ironstone. (RESIDUAL SOIL - SANDSTONE)	
				1.90	35.50		End of pit at 1.90 m	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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:
 

				Trial Pit Log				Trialpit No TP23 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440619.58 - 401905.86 Level: 37.75		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.50		Logged ASw	

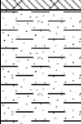
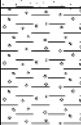
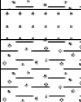
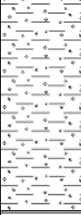
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.30	37.45		Grey sandy slightly gravelly CLAY with occasional rootlets. (TOPSOIL)	1
			HVP=110				Stiff orangish brown and brown mottled sandy CLAY. (RESIDUAL SOIL - COAL MEASURES)	
			HVP=140	0.70	37.05		Very stiff grey occasionally mottled orangish brown CLAY. (RESIDUAL SOIL - COAL MEASURES) <i>Vane test at 0.9m depth in excess of limit of hand vane (>140kPa)</i>	
	1.50	D						2
				1.80	35.95		Firm orangish brown and grey mottled sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of sandstone. (RESIDUAL SOIL - SANDSTONE)	
	2.00	D		2.20	35.55		Strong brown fine to medium grained SANDSTONE with occasional reddish brown and black fossilised plant remains. Recovered as slightly clayey angular to subangular tabular fine to coarse gravel with some cobbles with some grey staining on surfaces. (COAL MEASURES)	
			2.50	35.25		End of pit at 2.50 m	3	
								4
								5

Remarks: Stability:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).	
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				Trial Pit Log				Trialpit No TP24 Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440628.74 - 401862.13 Level: 35.65		Date 26/09/2017	
Location: Barnsley						Dimensions (m):		Scale 1:25	
Client: Persimmon Homes (West Yorkshire)						Depth 2.30		Logged ASw	

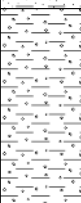
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.20	35.45		Dark grey slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is angular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)	
			HVP=140				Stiff brown and orangish brown sandy slightly gravelly CLAY. (RESIDUAL SOIL - COAL MEASURES)	
			HVP=140	0.80	34.85		Stiff brown and grey mottled CLAY with occasional grey gleyed root tracks. (RESIDUAL SOIL - COAL MEASURES)	1
	1.20	D					Vane tests at 0.6m and 1m depth in excess of limit of hand vane (>140kPa)	
							Weak brown MUDSTONE. Recovered as slightly clayey angular tabular fine to coarse gravel. (COAL MEASURES)	2
	2.00	T		1.90	33.75		End of pit at 2.30 m	
				2.30	33.35		End of pit at 2.30 m	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. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).	
Stability:	

				Trial Pit Log				Trialpit No TP25 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440673.90 - 401888.77 Level: 35.10		Date 26/09/2017		
Location: Barnsley						Dimensions (m):		Scale 1:25		
Client: Persimmon Homes (West Yorkshire)						Depth 2.60		Logged ASw		
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
	Depth	Type	Results							
	0.10	J&T		0.20	34.90		Grey slightly sandy CLAY with many rootlets. (TOPSOIL)			
			HVP=110	0.60	34.50		Stiff orangish brown and brown mottled sandy CLAY with occasional fine rootlets. (RESIDUAL SOIL - COAL MEASURES)			
	1.00	D	HVP=140	1.20	33.90		Stiff orangish brown and grey mottled slightly gravelly CLAY with occasional grey gleyed root tracks. Gravel is angular tabular medium to coarse of siltstone. (RESIDUAL SOIL - COAL MEASURES)			
				1.30	33.80		Vane test at 0.9m depth in excess of limit of hand vane (>140kPa)			
				2.20	32.90		Strong brown and orangish brown fine to medium grained SANDSTONE. Recovered as slightly clayey angular to subangular fine to coarse gravel. (COAL MEASURES)			
				2.60	32.50		Stiff grey mottled brown CLAY with some angular fine to medium gravel size lithorelicts of mudstone. Rare reddish brown and orangish brown subrounded fine to medium gravel of ironstone exhibiting onion weathering. (WEATHERED COAL MEASURES - SANDSTONE)			
							Weak grey MUDSTONE with penetrative orangish brown and reddish brown iron staining (90%). Recovered as slightly clayey angular tabular fine to coarse gravel. (COAL MEASURES)			
						End of pit at 2.60 m				
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).										
Stability:										



				Trial Pit Log			Trialpit No TP26 Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440707.86 - 401900.53 Level: 34.85		Date 26/09/2017	
Location: Barnsley				Dimensions (m):		Scale 1:25		Logged ASw	
Client: Persimmon Homes (West Yorkshire)				Depth 2.60					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.20	34.65		Dark greyish brown sandy slightly gravelly CLAY with occasional rootlets. (TOPSOIL)	
			HVP=45				Firm orangish brown and brown mottled sandy slightly gravelly CLAY. Gravel is angular to subangular fine to medium of sandstone. (RESIDUAL SOIL - COAL MEASURES)	
			HVP=84	0.90	33.95		Stiff brown gleyed grey slightly gravelly CLAY. Gravel is subangular fine of siltstone. (RESIDUAL SOIL - COAL MEASURES)	1
				1.60	33.25		Stiff grey CLAY with many angular tabular fine to medium gravel size lithorelicts of mudstone. (WEATHERED COAL MEASURES - SANDSTONE)	
				1.90	32.95		Weak grey and brown SILTSTONE with occasional angular tabular medium to coarse gravel and cobbles of ironstone. Recovered as slightly sly angular tabular fine to coarse gravel. (COAL MEASURES)	2
				2.60	32.25	End of pit at 2.60 m		3
								4
								5

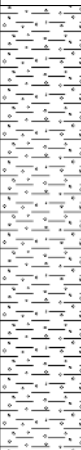
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion. 5. Hole surveyed in prior to excavation (co-ordinates and ground level).

Stability:
 

Appendix G

Borehole Logs

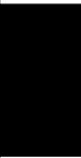
					Borehole Log			Borehole No. PH01 Sheet 1 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440276.03 - 401978.42		Hole Type PH
Location: Barnsley					Level: 46.95		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					3.00	43.95		Overburden (OVERBURDEN)	1	
									2	
									Light grey MUDSTONE (COAL MEASURES)	3
									4	
					6.00	40.95		COAL (NEWHILL RIDER COAL)	6	
					6.50	40.45		Light and medium grey MUDSTONE (COAL MEASURES)	7	
									8	
									9	
									10	

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.

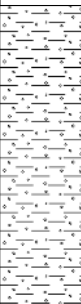
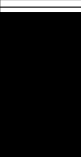


					Borehole Log			Borehole No. PH01 Sheet 2 of 3										
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440276.03 - 401978.42		Hole Type PH									
Location: Barnsley					Level: 46.95		Scale 1:50		Logged By FQ									
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017													
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description										
		Depth (m)	Type	Results														
					12.00	34.95		COAL (NEWHILL COAL)	11									
									12									
														13.00	33.95		Light grey MUDSTONE (COAL MEASURES)	13
																		14
																		15
																		16
																		17
																		18
																		19
																		20
																		Continued on next sheet

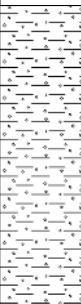
Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



					Borehole Log			Borehole No. PH01 Sheet 3 of 3			
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440276.03 - 401978.42		Hole Type PH		
Location: Barnsley					Level: 46.95		Scale 1:50		Logged By FQ		
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
									21 22 23 24 25 26 27 28 29 30		
					30.00	16.95	End of borehole at 30.00 m				
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.											

					Borehole Log			Borehole No. PH02 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440271.02 - 401910.33		Hole Type PH
Location: Barnsley					Level: 43.20		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/07/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Overburden (OVERBURDEN)	1
					2.00	41.20		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
					2.50	40.70		COAL (NEWHILL COAL)	3
					3.50	39.70		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	4
									5
									6
									7
									8
									9
									10
Continued on next sheet									
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 12.0m.									

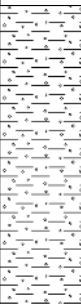
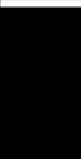


				Borehole Log			Borehole No. PH02A Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440271.02 - 401910.33		Hole Type PH	
Location: Barnsley				Level: 43.20		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 26/09/2017 - 26/07/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Overburden (OVERBURDEN)	1
					2.00	41.20		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
					2.50	40.70		COAL (NEWHILL COAL)	3
					3.50	39.70		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	4
					6.00	37.20	End of borehole at 6.00 m		
									7
									8
									9
									10

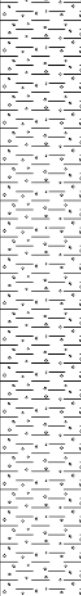
Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



					Borehole Log			Borehole No. PH03 Sheet 1 of 2		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440310.69 - 401929.76		Hole Type PH	
Location: Barnsley					Level: 45.25		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					2.00	43.25		Overburden (OVERBURDEN)	1	
									Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
										3
										4
										5
					6.50	38.75		Broken ground (BROKEN GROUND - POSSIBLE NEWHILL RIDER COAL)		
					7.00	38.25		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	7	
									8	
					9.00	36.25		COAL (NEWHILL COAL)	9	
					10.00	35.25			10	
Continued on next sheet										
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 6.5m.										

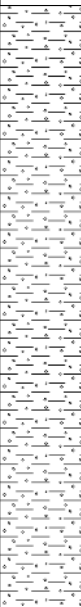
					Borehole Log			Borehole No. PH03 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440310.69 - 401929.76		Hole Type PH
Location: Barnsley					Level: 45.25		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					12.00	33.25		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	11
								End of borehole at 12.00 m	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 encountered at 6.5m.									

					Borehole Log			Borehole No. PH04 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440352.42 - 401952.56		Hole Type PH
Location: Barnsley					Level: 47.20		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					4.00	43.20		Overburden (OVERBURDEN)	1
								Light grey MUDSTONE (COAL MEASURES)	4
									5
									6
									7
									8
									9
									10
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. 3. Flush returns were lost from 12.0m to 13.0m.									

					Borehole Log			Borehole No. PH04 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440352.42 - 401952.56		Hole Type PH
Location: Barnsley					Level: 47.20		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					12.00	35.20		Broken ground (BROKEN GROUND - POSSIBLE NEWHILL COAL)	11
					13.00	34.20		Solid ground (Full Returns) (COAL MEASURES)	12
					15.00	32.20	End of borehole at 15.00 m		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 from 12.0m to 13.0m.								
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				Borehole Log				Borehole No. PH04A Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440352.42 - 401952.56		Hole Type PH	
Location: Barnsley				Level: 47.20		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 25/09/2017 - 25/07/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					4.00	43.20		Overburden (OVERBURDEN)	1
									2
								Light grey MUDSTONE (COAL MEASURES)	3
									4
									5
					6.00	41.20		End of borehole at 6.00 m	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.									

				Borehole Log			Borehole No. PH05 Sheet 1 of 3	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440349.45 - 401877.27		Hole Type PH
Location: Barnsley				Level: 41.70		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)				Dates: 26/09/2017 - 26/09/2017		Logged By FQ		

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							Overburden (OVERBURDEN)	1	
					2.50	39.20		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
					3.50	38.20		COAL (NEWHILL COAL)	3
					4.50	37.20		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	4
									5
								6	
								7	
								8	
								9	
								10	

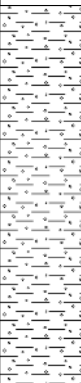
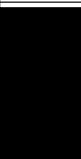
Continued on next sheet

Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 3.0m.



					Borehole Log			Borehole No. PH05 Sheet 2 of 3									
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440349.45 - 401877.27		Hole Type PH								
Location: Barnsley					Level: 41.70		Scale 1:50		Logged By FQ								
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017												
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description									
		Depth (m)	Type	Results													
									11								
									12								
									13								
									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 3.0m.								
																	

					Borehole Log			Borehole No. PH05 Sheet 3 of 3										
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440349.45 - 401877.27		Hole Type PH									
Location: Barnsley					Level: 41.70		Scale 1:50		Logged By FQ									
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017													
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description										
		Depth (m)	Type	Results														
									21									
									22									
									23									
									24									
									25									
									26									
									27									
									28									
									29									
									30									
														30.00	11.70	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 3.0m.									
																		

				Borehole Log				Borehole No. PH05A Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440349.45 - 401877.27		Hole Type PH		
Location: Barnsley				Level: 41.70		Scale 1:50				
Client: Persimmon Homes (West Yorkshire)				Dates: 26/09/2017 - 26/09/2017		Logged By FQ				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					2.50	39.20		Overburden (OVERBURDEN)	1	
									Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
					3.50	38.20		COAL (NEWHILL COAL)	3	
					4.50	37.20		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	4	
					6.00	35.70	End of borehole at 6.00 m			5
										6
									7	
									8	
									9	
									10	

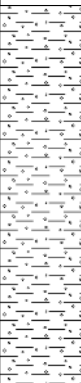
Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out.
 2. Groundwater was encountered at 3.0m.



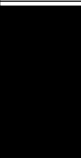
					Borehole Log			Borehole No. PH06 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440423.49 - 401882.32		Hole Type PH
Location: Barnsley					Level: 41.40		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							Overburden (OVERBURDEN)	1	
				2.50	38.90		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2	
								3	
								4	
								5	
				6.00	35.40		COAL (NEWHILL COAL)	6	
				7.00	34.40		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	7	
								8	
								9	
								10	
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.									
									

					Borehole Log			Borehole No. PH06 Sheet 2 of 2									
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440423.49 - 401882.32		Hole Type PH								
Location: Barnsley					Level: 41.40		Scale 1:50		Logged By FQ								
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017												
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description									
		Depth (m)	Type	Results													
					12.00	29.40			11								
									12								
									13								
									14								
									15								
									16								
									17								
									18								
									19								
									20								
									End of borehole at 12.00 m								
									Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.								
																	

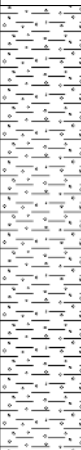
					Borehole Log			Borehole No. PH06A Sheet 1 of 1			
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440423.49 - 401882.32		Hole Type PH		
Location: Barnsley					Level: 41.40		Scale 1:50		Logged By FQ		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					2.50	38.90		Overburden (OVERBURDEN)		1	
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)		2	
										3	
										4	
										5	
					6.00	35.40		End of borehole at 6.00 m		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.											

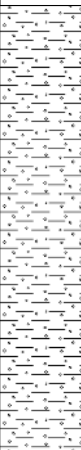


					Borehole Log			Borehole No. PH07 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440425.44 - 401930.78		Hole Type PH
Location: Barnsley					Level: 43.60		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					15.50	28.10		COAL (NEWHILL COAL)	
					16.50	27.10		Light grey MUDSTONE (COAL MEASURES)	
					18.50	25.10	End of borehole at 18.50 m		

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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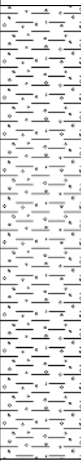
				Borehole Log				Borehole No. PH07A Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440425.44 - 401930.78		Hole Type PH	
Location: Barnsley				Level: 43.60		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 25/09/2017 - 25/07/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	40.60		Overburden (OVERBURDEN)	1
									2
								Light grey MUDSTONE (COAL MEASURES)	3
									4
									5
					6.00	37.60		End of borehole at 6.00 m	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.									

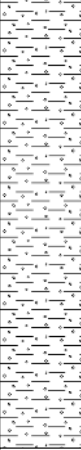
					Borehole Log			Borehole No. PH08 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440472.46 - 401910.24		Hole Type PH
Location: Barnsley					Level: 41.05		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	38.05		Overburden (OVERBURDEN)	1
								2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	
								10	
Continued on next sheet									
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 3.0m.									

					Borehole Log			Borehole No. PH08 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440472.46 - 401910.24		Hole Type PH
Location: Barnsley					Level: 41.05		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
									11	
					12.00	29.05				12
					13.00	28.05		COAL (NEWHILL COAL)		13
							Grey MUDSTONE with brown sandstone bands (COAL MEASURES)		14	
					15.00	26.05		End of borehole at 15.00 m	15	
									16	
									17	
									18	
									19	
									20	

Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 3.0m.		
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				Borehole Log			Borehole No. PH08A Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440472.46 - 401910.24		Hole Type PH	
Location: Barnsley				Level: 41.05		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 26/09/2017 - 26/09/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	38.05		Overburden (OVERBURDEN)	1
					6.00	35.05		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
End of borehole at 6.00 m									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 encountered at 3.0m.									

					Borehole Log			Borehole No. PH09 Sheet 1 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440554.63 - 401951.72		Hole Type PH
Location: Barnsley					Level: 41.55		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	38.55		Overburden (OVERBURDEN)	1
								Light grey MUDSTONE (COAL MEASURES)	2
									3
									4
									5
									6
									7
									8
									9
									10
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.									

					Borehole Log			Borehole No. PH09 Sheet 2 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440554.63 - 401951.72		Hole Type PH
Location: Barnsley					Level: 41.55		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
									11
									12
									13
									14
									15
									16
									17
									18
									19
									20

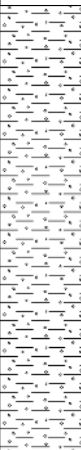
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Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

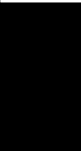


					Borehole Log			Borehole No. PH09 Sheet 3 of 3		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440554.63 - 401951.72		Hole Type PH	
Location: Barnsley					Level: 41.55		Scale 1:50		Logged By FQ	
Client: Persimmon Homes (West Yorkshire)					Dates: 25/09/2017 - 25/07/2017					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
									21	
									22	
									23	
									24	
									25	
									26	
									27	
									28	
									29	
									30	
					30.00	11.55	End of borehole at 30.00 m			
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.										

					Borehole Log			Borehole No. PH09A Sheet 1 of 1	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440554.63 - 401951.72		Hole Type PH
Location: Barnsley					Level: 41.55		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	38.55		Overburden (OVERBURDEN)	1
									2
								Light grey MUDSTONE (COAL MEASURES)	3
									4
									5
					6.00	35.55		End of borehole at 6.00 m	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.									

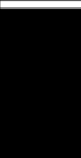


					Borehole Log			Borehole No. PH10 Sheet 2 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440518.30 - 401875.79		Hole Type PH
Location: Barnsley					Level: 39.45		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
									11
									12
									13
									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 9.0m.									

					Borehole Log			Borehole No. PH10 Sheet 3 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440518.30 - 401875.79		Hole Type PH
Location: Barnsley					Level: 39.45		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					20.50	18.95			
					21.50	17.95		COAL (NEWHILL RIDER COAL)	21
					24.00	15.45		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	22
								End of borehole at 24.00 m	24
									25
									26
									27
									28
									29
									30
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 9.0m.									

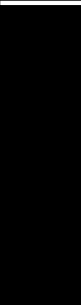


					Borehole Log			Borehole No. PH11 Sheet 2 of 4	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440536.87 - 401822.42		Hole Type PH
Location: Barnsley					Level: 37.85		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
									11	
										12
										13
										14
					15.00	22.85		COAL (NEWHILL RIDER COAL)	15	
					16.00	21.85		Light grey MUDSTONE (COAL MEASURES)	16	
					18.00	19.85		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	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 12.0m.		
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					Borehole Log			Borehole No. PH11 Sheet 3 of 4	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440536.87 - 401822.42		Hole Type PH
Location: Barnsley					Level: 37.85		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					27.50	10.35		COAL (NEWHILL COAL)	21
					29.50	8.35		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	22
									23
									24
									25
									26
									27
									28
									29
									30

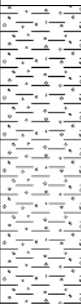
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Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 12.0m.

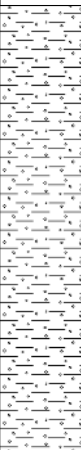


					Borehole Log			Borehole No. PH11 Sheet 4 of 4	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440536.87 - 401822.42		Hole Type PH
Location: Barnsley					Level: 37.85		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					33.00	4.85			31
									32
									33
								End of borehole at 33.00 m	34
									35
									36
									37
									38
									39
									40
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 12.0m.									

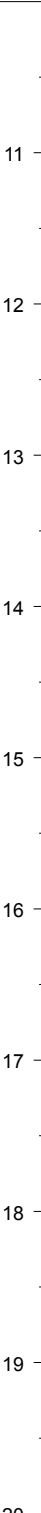
				Borehole Log			Borehole No. PH11A Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440536.87 - 401822.42		Hole Type PH	
Location: Barnsley				Level: 37.85		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 27/09/2017 - 27/09/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.00	35.85		Overburden (OVERBURDEN)	1
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
					6.00	31.85		End of borehole at 6.00 m	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.

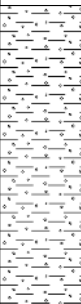


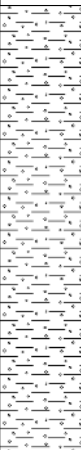
				Borehole Log				Borehole No. PH12A Sheet 1 of 1	
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440579.01 - 401879.99		Hole Type PH	
Location: Barnsley				Level: 38.10		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 27/09/2017 - 27/09/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	35.10		Overburden (OVERBURDEN)	1
									2
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	3
									4
									5
					6.00	32.10		End of borehole at 6.00 m	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.									

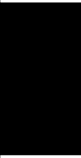


					Borehole Log			Borehole No. PH14 Sheet 2 of 3		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440658.84 - 401879.81		Hole Type PH	
Location: Barnsley					Level: 35.30		Scale 1:50		Logged By FQ	
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
										
Continued on next sheet								20		
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 12.0m.										

					Borehole Log			Borehole No. PH14 Sheet 3 of 3		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440658.84 - 401879.81		Hole Type PH	
Location: Barnsley					Level: 35.30		Scale 1:50		Logged By FQ	
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
									21	
									22	
									23	
									24	
									25	
									26	
									27	
									28	
									29	
									30	
					30.00	5.30	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 12.0m.										

				Borehole Log			Borehole No. PH14A Sheet 1 of 1		
Project Name: Lundhill Road				Project No. 2409		Co-ords: 440658.84 - 401879.81		Hole Type PH	
Location: Barnsley				Level: 35.30		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)				Dates: 27/09/2017 - 27/09/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.00	33.30		Overburden (OVERBURDEN)	1
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
									3
									4
									5
					6.00	29.30		End of borehole at 6.00 m	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.									

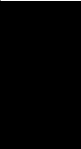
					Borehole Log			Borehole No. PH15 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440378.32 - 401918.69		Hole Type PH
Location: Barnsley					Level: 44.30		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	41.30		Overburden (OVERBURDEN)	1
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	2
									3
									4
									5
									6
									7
									8
									9
									10
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.									

					Borehole Log			Borehole No. PH15 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440378.32 - 401918.69		Hole Type PH
Location: Barnsley					Level: 44.30		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 26/09/2017 - 26/09/2017				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					10.50	33.80			11
					11.50	32.80		COAL (NEWHILL COAL)	
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	12
					15.00	29.30		End of borehole at 15.00 m	15
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.									16
									17
									18
									19
									20

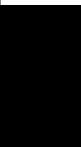


					Borehole Log			Borehole No. PH16 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440400.45 - 401910.06		Hole Type PH
Location: Barnsley					Level: 43.25		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.50	40.75		Overburden (OVERBURDEN)	1
								Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	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 encountered at 6.0m.									

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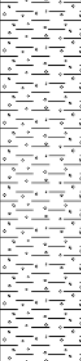
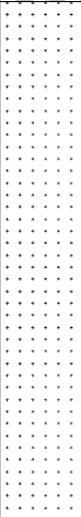
					Borehole Log			Borehole No. PH16 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440400.45 - 401910.06		Hole Type PH
Location: Barnsley					Level: 43.25		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.00	32.25		COAL (NEWHILL COAL)	
					13.00	30.25		Grey MUDSTONE with brown sandstone bands (COAL MEASURES)	11 12 13 14 15 16 17 18 19 20
End of borehole at 13.00 m									
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 6.0m.									
									

					Borehole Log			Borehole No. PH17 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440338.21 - 401924.96		Hole Type PH
Location: Barnsley					Level: 45.15		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Overburden (OVERBURDEN)	
					3.00	42.15		Light grey MUDSTONE (COAL MEASURES)	1
									2
									3
									4
									5
									6
									7
									8
									9
					10.00	35.15			10
Continued on next sheet									
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 12.0m.									

					Borehole Log			Borehole No. PH17 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440338.21 - 401924.96		Hole Type PH
Location: Barnsley					Level: 45.15		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.00	34.15		COAL (NEWHILL COAL)	
								Light grey MUDSTONE (COAL MEASURES)	11
					13.00	32.15	End of borehole at 13.00 m		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 encountered at 12.0m.									

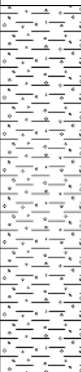
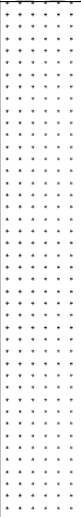


					Borehole Log			Borehole No. PH18 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440276.95 - 401938.92		Hole Type PH
Location: Barnsley					Level: 44.65		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 27/09/2017 - 27/09/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					10.50	34.15		Light grey MUDSTONE (COAL MEASURES)	11
					12.00	32.65			
							----- End of borehole at 12.00 m -----		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.									

					Borehole Log			Borehole No. PH101 Sheet 1 of 3				
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440295.10 - 401922.28		Hole Type PH			
Location: Barnsley					Level: 44.15		Scale 1:50					
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description				
		Depth (m)	Type	Results								
					2.50	41.65		Overburden (COHESIVE RESIDUAL SOIL)	1			
									SANDSTONE (COAL MEASURES)	3		
									6.00	38.15		COAL (NEWHILL RIDER COAL)
								6.50				37.65
										10		
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.												

					Borehole Log			Borehole No. PH101 Sheet 2 of 3		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440295.10 - 401922.28		Hole Type PH	
Location: Barnsley					Level: 44.15		Scale 1:50		Logged By FQ	
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
									11 12 13 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 not apparent during drilling.										
										

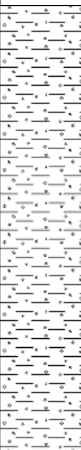
					Borehole Log			Borehole No. PH101 Sheet 3 of 3									
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440295.10 - 401922.28		Hole Type PH								
Location: Barnsley							Level: 44.15		Scale 1:50								
Client: Persimmon Homes (West Yorkshire)							Dates: 07/12/2017 - 07/12/2017		Logged By FQ								
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description									
		Depth (m)	Type	Results													
									21								
									22								
									23								
									24								
									25								
									26								
									27								
									28								
									29								
									30								
									End of borehole at 30.00 m								
									Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.								
																	

					Borehole Log			Borehole No. PH102 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440317.01 - 401908.42		Hole Type PH
Location: Barnsley					Level: 43.75		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.50	41.25		Overburden (COHESIVE RESIDUAL SOIL)	1
									2
									3
									4
									5
									6
									7
									8
									9
									10
					6.00	37.75		SANDSTONE (COAL MEASURES)	
					6.50	37.25		COAL (NEWHILL RIDER COAL)	
								MUDSTONE and SANDSTONE (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.									
									

					Borehole Log			Borehole No. PH102 Sheet 2 of 2									
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440317.01 - 401908.42		Hole Type PH								
Location: Barnsley					Level: 43.75		Scale 1:50										
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ										
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description									
		Depth (m)	Type	Results													
					15.00	28.75			11								
									12								
									13								
									14								
									15								
									16								
									17								
									18								
									19								
									20								
									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.		

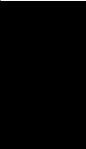
					Borehole Log			Borehole No. PH103 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440297.46 - 401944.33		Hole Type PH
Location: Barnsley					Level: 46.05		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					3.00	43.05		Overburden (COHESIVE RESIDUAL SOIL)	1	
									2	
									SANDSTONE (COAL MEASURES)	3
						4.00 4.20	42.05 41.85	 	COAL (NEWHILL RIDER COAL) MUDSTONE and SANDSTONE (COAL MEASURES)	4
					10.00	36.05			10	

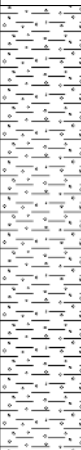
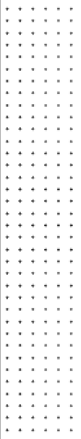
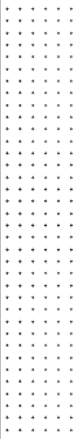
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Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



					Borehole Log			Borehole No. PH103 Sheet 2 of 2								
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440297.46 - 401944.33		Hole Type PH							
Location: Barnsley					Level: 46.05		Scale 1:50									
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ									
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description								
		Depth (m)	Type	Results												
					11.00	35.05		COAL (NEWHILL COAL)								
								MUDSTONE and SANDSTONE (COAL MEASURES)	11							
					15.00	31.05			12							
									13							
									14							
									15							
									16							
									17							
									18							
									19							
									20							
								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.								

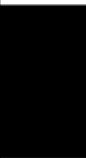
					Borehole Log			Borehole No. PH104 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440325.85 - 401940.50		Hole Type PH
Location: Barnsley					Level: 46.55		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017				

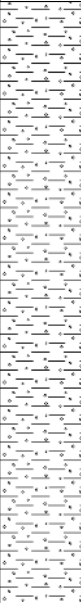
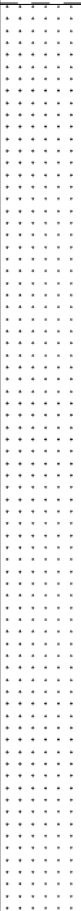
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	43.55		Overburden (COHESIVE RESIDUAL SOIL)	1
									2
									3
									4
									5
									6
									7
									8
									9
									10
					6.00	40.55		SANDSTONE (COAL MEASURES)	1
									2
									3
									4
									5
									6
									7
									8
									9
									10
				6.20	40.35		COAL (NEWHILL RIDER COAL)	1	
								2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	
								10	
								MUDSTONE and SANDSTONE (COAL MEASURES)	1
									2
									3
									4
									5
									6
									7
									8
									9
									10

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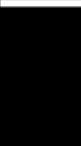
Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



					Borehole Log			Borehole No. PH104 Sheet 2 of 2		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440325.85 - 401940.50		Hole Type PH	
Location: Barnsley					Level: 46.55		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					13.00	33.55		COAL (NEWHILL COAL)	11	
									12	
									13	
									14	
									15	
					14.00	32.55		MUDSTONE and SANDSTONE (COAL MEASURES)	16	
									17	
									18	
									19	
									20	
									21	
End of borehole at 15.00 m									22	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.										

					Borehole Log			Borehole No. PH105 Sheet 1 of 3							
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440336.79 - 401964.10		Hole Type PH						
Location: Barnsley					Level: 48.10		Scale 1:50								
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ								
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description							
		Depth (m)	Type	Results											
					4.00	44.10		Overburden (COHESIVE RESIDUAL SOIL)	1						
									2						
									3						
									4						
														SANDSTONE (COAL MEASURES)	5
															6
															7
															8
															9
															10
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.															
															

					Borehole Log			Borehole No. PH105 Sheet 2 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440336.79 - 401964.10		Hole Type PH
Location: Barnsley					Level: 48.10		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017				

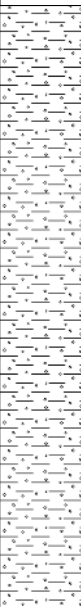
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
									11		
										12	
										13	
		13.50				34.60				COAL (NEWHILL RIDER COAL)	14
		14.00				34.10				MUDSTONE and SANDSTONE (COAL MEASURES)	15
										16	
										17	
		17.00				31.10				COAL (NEWHILL COAL)	18
		18.00				30.10				MUDSTONE and SANDSTONE (COAL MEASURES)	19
										20	

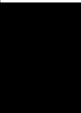
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Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

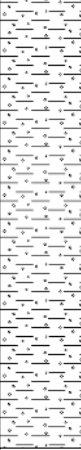


					Borehole Log			Borehole No. PH105 Sheet 3 of 3			
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440336.79 - 401964.10		Hole Type PH		
Location: Barnsley					Level: 48.10		Scale 1:50		Logged By FQ		
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
									21 22 23 24 25 26 27 28 29 30		
					30.00	18.10		End of borehole at 30.00 m			
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.											

					Borehole Log			Borehole No. PH106 Sheet 1 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440363.25 - 401961.31		Hole Type PH
Location: Barnsley					Level: 47.30		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					4.00	43.30		Overburden (COHESIVE RESIDUAL SOIL)	1
									2
									3
									4
									5
									6
									7
									8
									9
									10
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.									

					Borehole Log			Borehole No. PH106 Sheet 2 of 3		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440363.25 - 401961.31		Hole Type PH	
Location: Barnsley					Level: 47.30		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					10.50	36.80		COAL (NEWHILL RIDER COAL)	11	
					11.25	36.05		MUDSTONE and SANDSTONE (COAL MEASURES)	12	
										13
										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 not apparent during drilling.										

					Borehole Log			Borehole No. PH106 Sheet 3 of 3	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440363.25 - 401961.31		Hole Type PH
Location: Barnsley					Level: 47.30		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 07/12/2017 - 07/12/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					21.00	26.30		End of borehole at 21.00 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.									

					Borehole Log			Borehole No. PH107 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440343.67 - 401943.87		Hole Type PH
Location: Barnsley					Level: 46.80		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.00	43.80		Overburden (COHESIVE RESIDUAL SOIL)	1
									2
									3
5									
6									
					8.00	38.80		COAL (NEWHILL RIDER COAL)	7
									8
								MUDSTONE and SANDSTONE (COAL MEASURES)	9
									10
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.									

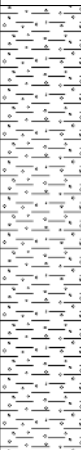
					Borehole Log			Borehole No. PH107 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440343.67 - 401943.87		Hole Type PH
Location: Barnsley					Level: 46.80		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
									11
									12
									13
					14.50	32.30	COAL (NEWHILL COAL)		14
				15.50	31.30	15			
							MUDSTONE and SANDSTONE (COAL MEASURES)		16
									17
					18.00	28.80			18
									19
									20

End of borehole at 18.00 m

Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



					Borehole Log			Borehole No. PH108 Sheet 1 of 2		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440359.92 - 401939.31		Hole Type PH	
Location: Barnsley					Level: 46.15		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					3.00	43.15		Overburden (COHESIVE RESIDUAL SOIL)	1	
									2	
									3	
									4	
									5	
									6	
									7	
									8	
									9	
									10	
					7.00	39.15		MUDSTONE and SANDSTONE (COAL MEASURES)		
				7.25	38.90				COAL (NEWHILL RIDER COAL)	
									MUDSTONE and SANDSTONE (COAL MEASURES)	
					10.00	36.15				

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.



					Borehole Log			Borehole No. PH108 Sheet 2 of 2				
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440359.92 - 401939.31		Hole Type PH			
Location: Barnsley					Level: 46.15		Scale 1:50					
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description				
		Depth (m)	Type	Results								
					11.50	34.65	 Soft Ground (SOFT GROUND - POSSIBLE NEWHILL COAL) <i>At 10.m, flush lost</i>	11				
							 Solid Ground (COAL MEASURES)		12			
							 Soft Ground (SOFT GROUND - POSSIBLE NEWHILL COAL)			14		
											 Solid Ground (COAL MEASURES)	15
					13.50	32.65		16				
					18.00	28.15		19				
End of borehole at 18.00 m												
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.												

					Borehole Log			Borehole No. PH109 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440367.34 - 401931.79		Hole Type PH
Location: Barnsley					Level: 45.55		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017				

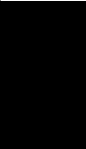
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					3.00	42.55		Overburden (COHESIVE RESIDUAL SOIL)	1	
										2
										3
						6.00	39.55		MUDSTONE and SANDSTONE (COAL MEASURES)	4
										5
										6
						6.25	39.30		COAL (NEWHILL RIDER COAL)	6
										7
									MUDSTONE and SANDSTONE (COAL MEASURES)	8
										9
								10		
				10.00	35.55		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.



					Borehole Log			Borehole No. PH109 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440367.34 - 401931.79		Hole Type PH
Location: Barnsley					Level: 45.55		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.00	34.55		Broken Ground (BROKEN GROUND - POSSIBLE NEWHILL COAL) <i>At 10.m, flush lost</i>	
					12.00	33.55		Solid Ground (COAL MEASURES)	11
							----- End of borehole at 12.00 m -----		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.									

					Borehole Log			Borehole No. PH110 Sheet 1 of 2		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440371.38 - 401924.31		Hole Type PH	
Location: Barnsley					Level: 44.90		Scale 1:50			
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					3.00	41.90		Overburden (COHESIVE RESIDUAL SOIL)	1	
									2	
									3	
									MUDSTONE and SANDSTONE (COAL MEASURES)	4
									5	
						6.00	38.90		COAL (NEWHILL RIDER COAL)	6
					6.25	38.65	MUDSTONE and SANDSTONE (COAL MEASURES)		7	
									8	
									9	
						10.00	34.90		10	
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.										
										

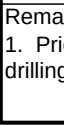
					Borehole Log			Borehole No. PH110 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440371.38 - 401924.31		Hole Type PH
Location: Barnsley					Level: 44.90		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.00	33.90		COAL (NEWHILL COAL)	
					12.00	32.90		MUDSTONE and SANDSTONE (COAL MEASURES)	11
								End of borehole at 12.00 m	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.									

					Borehole Log			Borehole No. PH111 Sheet 1 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440354.43 - 401949.21		Hole Type PH
Location: Barnsley					Level: 46.95		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017				

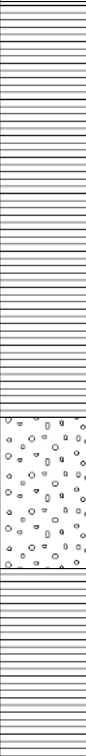
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.50	44.45		Overburden (COHESIVE RESIDUAL SOIL)	1
								MUDSTONE and SANDSTONE (COAL MEASURES)	2
									3
									4
									5
									6
									7
									8
									9
									10

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.							



					Borehole Log			Borehole No. PH111 Sheet 2 of 2			
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440354.43 - 401949.21		Hole Type PH		
Location: Barnsley					Level: 46.95		Scale 1:50		Logged By FQ		
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					15.00	31.95		COAL (NEWHILL COAL)		11	
										12	
										13	
					16.25	30.70		MUDSTONE and SANDSTONE (COAL MEASURES) End of borehole at 12.00 m		14	
										15	
										16	
					18.00	28.95				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.											

					Borehole Log			Borehole No. PH112 Sheet 1 of 2							
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440345.36 - 401954.49		Hole Type PH						
Location: Barnsley					Level: 47.55		Scale 1:50								
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ								
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description							
		Depth (m)	Type	Results											
					3.00	44.55		Overburden (COHESIVE RESIDUAL SOIL)	1						
															2
															3
															4
															5
															6
															7
															8
															9
															10
					8.50	39.05		COAL (NEWHILL RIDER COAL)							
					8.75	38.80		MUDSTONE and SANDSTONE (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.															

					Borehole Log			Borehole No. PH112 Sheet 2 of 2		
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440345.36 - 401954.49		Hole Type PH	
Location: Barnsley							Level: 47.55		Scale 1:50	
Client: Persimmon Homes (West Yorkshire)							Dates: 08/12/2017 - 08/12/2017		Logged By FQ	
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					12.75	34.80		Soft Ground (SOFT GROUND - POSSIBLE NEWHILL COAL) <i>At 12.7 m, flush lost</i> Solid Ground (COAL MEASURES) <i>End of borehole at 12.00 m</i>		11
					13.75	33.80				13
					15.00	32.55				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.										

					Borehole Log			Borehole No. PH113 Sheet 1 of 2			
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440337.19 - 401956.62		Hole Type PH		
Location: Barnsley					Level: 47.70		Scale 1:50				
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					3.00	44.70		Overburden (COHESIVE RESIDUAL SOIL)	1		
											2
											3
											4
											5
											6
											7
											8
											9
											10
					9.00	38.70		COAL (NEWHILL RIDER COAL)			
				9.25	38.45	MUDSTONE and SANDSTONE (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.											

					Borehole Log			Borehole No. PH113 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440337.19 - 401956.62		Hole Type PH
Location: Barnsley					Level: 47.70		Scale 1:50		Logged By FQ
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017				

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					12.75	34.95		Broken Ground (BROKEN GROUND - POSSIBLE NEWHILL COAL) <i>At 12.7 m, flush lost</i>	11
					13.75	33.95			13
					15.00	32.70			14
							End of borehole at 15.00 m		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.								
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					Borehole Log			Borehole No. PH114 Sheet 1 of 2							
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440354.66 - 401923.75		Hole Type PH						
Location: Barnsley					Level: 45.15		Scale 1:50								
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ								
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description							
		Depth (m)	Type	Results											
					3.00	42.15		Overburden (COHESIVE RESIDUAL SOIL)	1						
															2
															3
															4
															5
															6
															7
															8
															9
															10
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.															



					Borehole Log			Borehole No. PH114 Sheet 2 of 2	
Project Name: Lundhill Road					Project No. 2409		Co-ords: 440354.66 - 401923.75		Hole Type PH
Location: Barnsley					Level: 45.15		Scale 1:50		
Client: Persimmon Homes (West Yorkshire)					Dates: 08/12/2017 - 08/12/2017		Logged By FQ		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.00	34.15		Soft Ground (SOFT GROUND - POSSIBLE NEWHILL COAL) <i>At 12.7.m, flush lost</i>	11
					12.00	33.15		Solid Ground (COAL MEASURES)	12
									13
					14.00	31.15		End of borehole at 14.00 m	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.									

Appendix H
Chemical Results



Certificate of Analysis

Certificate Number 17-11781

06-Oct-17

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 17-11781

Client Reference 2409

Order No 12110/2409/ASW

Contract Title Lundhill Road, Wombwell

Description 23 Soil samples.

Date Received 02-Oct-17

Date Started 02-Oct-17

Date Completed 06-Oct-17

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



Summary of Chemical Analysis

Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237594	1237595	1237596	1237597	1237598	1237599
Sample ID	TP02	TP03	TP05	TP07	TP09	TP10
Depth	0.10	0.10	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units					
Metals								
Arsenic	DETS 2301#	0.2	mg/kg	16		18	13	16
Boron, Water Soluble	DETS 2123#	0.2	mg/kg	2		1.3	2.1	2
Cadmium	DETS 2301#	0.1	mg/kg	0.4		0.4	0.3	0.3
Chromium	DETS 2301#	0.15	mg/kg	22		24	23	21
Chromium III	DETS 2301*	0.15	mg/kg	22		24	23	21
Chromium, Hexavalent	DETS 2204*	1	mg/kg	< 1.0		< 1.0	< 1.0	< 1.0
Copper	DETS 2301#	0.2	mg/kg	37		38	30	32
Lead	DETS 2301#	0.3	mg/kg	52		56	42	51
Mercury	DETS 2325#	0.05	mg/kg	0.11		0.13	0.12	0.11
Nickel	DETS 2301#	1	mg/kg	24		29	26	22
Selenium	DETS 2301#	0.5	mg/kg	0.7		1.4	0.8	1
Zinc	DETS 2301#	1	mg/kg	100		100	89	90
Inorganics								
pH	DETS 2008#			6.6		6.8	6.4	6.9
Calorific Value	DETS 5008	1	MJ/kg					
Total Organic Carbon	DETS 2002	0.1	%	3		2.7	2.8	2.7
Sulphate Aqueous Extract as SO4	DETS 2076#	10	mg/l					
PAHs								
Naphthalene	DETS 3303#	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Acenaphthylene	DETS 3303#	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Acenaphthene	DETS 3303#	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Fluorene	DETS 3303	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Phenanthrene	DETS 3303#	0.03	mg/kg	0.12		0.06	0.05	0.08
Anthracene	DETS 3303	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Fluoranthene	DETS 3303#	0.03	mg/kg	0.23		0.09	0.08	0.13
Pyrene	DETS 3303#	0.03	mg/kg	0.19		0.08	0.07	0.1
Benzo(a)anthracene	DETS 3303#	0.03	mg/kg	0.08		< 0.03	< 0.03	0.05
Chrysene	DETS 3303	0.03	mg/kg	0.11		0.05	0.04	0.07
Benzo(b)fluoranthene	DETS 3303#	0.03	mg/kg	0.11		0.05	< 0.03	0.06
Benzo(k)fluoranthene	DETS 3303#	0.03	mg/kg	0.04		< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETS 3303#	0.03	mg/kg	0.05		< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETS 3303#	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETS 3303#	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETS 3303#	0.03	mg/kg	< 0.03		< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETS 3303	0.1	mg/kg	0.92		0.33	0.24	0.48
OCPs								
alpha-BHC	DETS 3441*	0.1	mg/kg		< 0.1			< 0.1
gamma-BHC (Lindane)	DETS 3441*	0.1	mg/kg		< 0.1			< 0.1
beta-BHC	DETS 3441*	0.1	mg/kg		< 0.1			< 0.1
delta-BHC	DETS 3441*	0.1	mg/kg		< 0.1			< 0.1
Heptachlor	DETS 3441*	0.1	mg/kg		< 0.1			< 0.1

Summary of Chemical Analysis

Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237594	1237595	1237596	1237597	1237598	1237599
Sample ID	TP02	TP03	TP05	TP07	TP09	TP10
Depth	0.10	0.10	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Aldrin	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Heptachlor epoxide	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
gamma-Chlordane	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Endosulphan I & Alpha-chlorodane	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
4,4-DDE	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Dieldrin	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Endrin	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Endosulphan II & 4,4-DDD	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Endrin aldehyde	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
4,4-DDT	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Endosulphan sulphate	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Methoxychlor	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
Endrin ketone	DETSC 3441*	0.1	mg/kg		< 0.1				< 0.1
OPPs									
Dichlorvos	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Mevinphos	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Demeton-O	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Ethoprop	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Naled	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Phorate	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Demeton-S	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Diazinon	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Disulfoton	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Methylparathion	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Ronnel	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Fenthion	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Chlopyrifos	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Trichlorinate	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Merphos	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Stirofos	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Tokuthion	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Fensulfothion	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Bolstar	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Azinphos methyl	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1
Coumaphos	DETSC 3443*	0.1	mg/kg		< 0.1				< 0.1

Summary of Chemical Analysis

Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237600	1237601	1237602	1237603	1237604	1237605
Sample ID	TP12	TP14	TP16	TP17	TP18	TP22
Depth	0.10	0.10	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Metals									
Arsenic	DETS 2301#	0.2	mg/kg	16	16	15	16	26	36
Boron, Water Soluble	DETS 2123#	0.2	mg/kg	1.7	1.8	2	1.8	1.8	2.1
Cadmium	DETS 2301#	0.1	mg/kg	0.3	0.2	0.3	0.3	0.3	0.4
Chromium	DETS 2301#	0.15	mg/kg	19	19	19	19	21	25
Chromium III	DETS 2301*	0.15	mg/kg	19	19	19	19	21	25
Chromium, Hexavalent	DETS 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETS 2301#	0.2	mg/kg	27	26	39	39	44	68
Lead	DETS 2301#	0.3	mg/kg	42	44	42	44	51	73
Mercury	DETS 2325#	0.05	mg/kg	0.09	0.07	0.05	0.09	0.19	0.16
Nickel	DETS 2301#	1	mg/kg	25	22	22	21	25	28
Selenium	DETS 2301#	0.5	mg/kg	0.9	0.8	1.1	< 0.5	1.2	1
Zinc	DETS 2301#	1	mg/kg	88	80	75	85	94	110
Inorganics									
pH	DETS 2008#			6	6.9	5.9	6.9	6.5	7.1
Calorific Value	DETS 5008	1	MJ/kg						
Total Organic Carbon	DETS 2002	0.1	%	2.2	2.1	2.2	2.5	2.1	4.1
Sulphate Aqueous Extract as SO4	DETS 2076#	10	mg/l						
PAHs									
Naphthalene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETS 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETS 3303#	0.03	mg/kg	< 0.03	0.04	< 0.03	< 0.03	< 0.03	0.06
Anthracene	DETS 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETS 3303#	0.03	mg/kg	< 0.03	0.06	0.05	0.05	0.05	0.09
Pyrene	DETS 3303#	0.03	mg/kg	< 0.03	0.05	0.04	0.04	< 0.03	0.07
Benzo(a)anthracene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chrysene	DETS 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(b)fluoranthene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(k)fluoranthene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETS 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETS 3303	0.1	mg/kg	< 0.10	0.14	< 0.10	< 0.10	< 0.10	0.22
OCPs									
alpha-BHC	DETS 3441*	0.1	mg/kg						
gamma-BHC (Lindane)	DETS 3441*	0.1	mg/kg						
beta-BHC	DETS 3441*	0.1	mg/kg						
delta-BHC	DETS 3441*	0.1	mg/kg						
Heptachlor	DETS 3441*	0.1	mg/kg						

Summary of Chemical Analysis

Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237600	1237601	1237602	1237603	1237604	1237605
Sample ID	TP12	TP14	TP16	TP17	TP18	TP22
Depth	0.10	0.10	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Aldrin	DETSC 3441*	0.1	mg/kg						
Heptachlor epoxide	DETSC 3441*	0.1	mg/kg						
gamma-Chlordane	DETSC 3441*	0.1	mg/kg						
Endosulphan I & Alpha-chlorodane	DETSC 3441*	0.1	mg/kg						
4,4-DDE	DETSC 3441*	0.1	mg/kg						
Dieldrin	DETSC 3441*	0.1	mg/kg						
Endrin	DETSC 3441*	0.1	mg/kg						
Endosulphan II & 4,4-DDD	DETSC 3441*	0.1	mg/kg						
Endrin aldehyde	DETSC 3441*	0.1	mg/kg						
4,4-DDT	DETSC 3441*	0.1	mg/kg						
Endosulphan sulphate	DETSC 3441*	0.1	mg/kg						
Methoxychlor	DETSC 3441*	0.1	mg/kg						
Endrin ketone	DETSC 3441*	0.1	mg/kg						
OPPs									
Dichlorvos	DETSC 3443*	0.1	mg/kg						
Mevinphos	DETSC 3443*	0.1	mg/kg						
Demeton-O	DETSC 3443*	0.1	mg/kg						
Ethoprop	DETSC 3443*	0.1	mg/kg						
Naled	DETSC 3443*	0.1	mg/kg						
Phorate	DETSC 3443*	0.1	mg/kg						
Demeton-S	DETSC 3443*	0.1	mg/kg						
Diazinon	DETSC 3443*	0.1	mg/kg						
Disulfoton	DETSC 3443*	0.1	mg/kg						
Methylparathion	DETSC 3443*	0.1	mg/kg						
Ronnel	DETSC 3443*	0.1	mg/kg						
Fenthion	DETSC 3443*	0.1	mg/kg						
Chlopyrifos	DETSC 3443*	0.1	mg/kg						
Trichlorinate	DETSC 3443*	0.1	mg/kg						
Merphos	DETSC 3443*	0.1	mg/kg						
Stirofos	DETSC 3443*	0.1	mg/kg						
Tokuthion	DETSC 3443*	0.1	mg/kg						
Fensulfothion	DETSC 3443*	0.1	mg/kg						
Bolstar	DETSC 3443*	0.1	mg/kg						
Azinphos methyl	DETSC 3443*	0.1	mg/kg						
Coumaphos	DETSC 3443*	0.1	mg/kg						

Summary of Chemical Analysis Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237606	1237607	1237608	1237609	1237610	1237611
Sample ID	TP24	TP25	TP04	TP07	TP11	TP16
Depth	0.10	0.10	1.70	1.00	1.50	2.20
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg		36				
Boron, Water Soluble	DETSC 2123#	0.2	mg/kg		2.4				
Cadmium	DETSC 2301#	0.1	mg/kg		0.5				
Chromium	DETSC 2301#	0.15	mg/kg		22				
Chromium III	DETSC 2301*	0.15	mg/kg		22				
Chromium, Hexavalent	DETSC 2204*	1	mg/kg		< 1.0				
Copper	DETSC 2301#	0.2	mg/kg		45				
Lead	DETSC 2301#	0.3	mg/kg		54				
Mercury	DETSC 2325#	0.05	mg/kg		0.13				
Nickel	DETSC 2301#	1	mg/kg		29				
Selenium	DETSC 2301#	0.5	mg/kg		1.3				
Zinc	DETSC 2301#	1	mg/kg		99				
Inorganics									
pH	DETSC 2008#				6.5	6.5	6.4	6.7	6
Calorific Value	DETSC 5008	1	MJ/kg						
Total Organic Carbon	DETSC 2002	0.1	%		4.1				
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l		< 10	< 10	20	12	
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg		< 0.03				
Acenaphthylene	DETSC 3303#	0.03	mg/kg		< 0.03				
Acenaphthene	DETSC 3303#	0.03	mg/kg		< 0.03				
Fluorene	DETSC 3303	0.03	mg/kg		< 0.03				
Phenanthrene	DETSC 3303#	0.03	mg/kg		0.04				
Anthracene	DETSC 3303	0.03	mg/kg		< 0.03				
Fluoranthene	DETSC 3303#	0.03	mg/kg		0.06				
Pyrene	DETSC 3303#	0.03	mg/kg		0.05				
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg		< 0.03				
Chrysene	DETSC 3303	0.03	mg/kg		< 0.03				
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg		< 0.03				
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg		< 0.03				
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg		< 0.03				
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg		< 0.03				
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg		< 0.03				
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg		< 0.03				
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg		0.15				
OCPs									
alpha-BHC	DETSC 3441*	0.1	mg/kg	< 0.1					
gamma-BHC (Lindane)	DETSC 3441*	0.1	mg/kg	< 0.1					
beta-BHC	DETSC 3441*	0.1	mg/kg	< 0.1					
delta-BHC	DETSC 3441*	0.1	mg/kg	< 0.1					
Heptachlor	DETSC 3441*	0.1	mg/kg	< 0.1					

Summary of Chemical Analysis

Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237606	1237607	1237608	1237609	1237610	1237611
Sample ID	TP24	TP25	TP04	TP07	TP11	TP16
Depth	0.10	0.10	1.70	1.00	1.50	2.20
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Aldrin	DETSC 3441*	0.1	mg/kg	< 0.1					
Heptachlor epoxide	DETSC 3441*	0.1	mg/kg	< 0.1					
gamma-Chlordane	DETSC 3441*	0.1	mg/kg	< 0.1					
Endosulphan I & Alpha-chlorodane	DETSC 3441*	0.1	mg/kg	< 0.1					
4,4-DDE	DETSC 3441*	0.1	mg/kg	< 0.1					
Dieldrin	DETSC 3441*	0.1	mg/kg	< 0.1					
Endrin	DETSC 3441*	0.1	mg/kg	< 0.1					
Endosulphan II & 4,4-DDD	DETSC 3441*	0.1	mg/kg	< 0.1					
Endrin aldehyde	DETSC 3441*	0.1	mg/kg	< 0.1					
4,4-DDT	DETSC 3441*	0.1	mg/kg	< 0.1					
Endosulphan sulphate	DETSC 3441*	0.1	mg/kg	< 0.1					
Methoxychlor	DETSC 3441*	0.1	mg/kg	< 0.1					
Endrin ketone	DETSC 3441*	0.1	mg/kg	< 0.1					
OPPs									
Dichlorvos	DETSC 3443*	0.1	mg/kg	< 0.1					
Mevinphos	DETSC 3443*	0.1	mg/kg	< 0.1					
Demeton-O	DETSC 3443*	0.1	mg/kg	< 0.1					
Ethoprop	DETSC 3443*	0.1	mg/kg	< 0.1					
Naled	DETSC 3443*	0.1	mg/kg	< 0.1					
Phorate	DETSC 3443*	0.1	mg/kg	< 0.1					
Demeton-S	DETSC 3443*	0.1	mg/kg	< 0.1					
Diazinon	DETSC 3443*	0.1	mg/kg	< 0.1					
Disulfoton	DETSC 3443*	0.1	mg/kg	< 0.1					
Methylparathion	DETSC 3443*	0.1	mg/kg	< 0.1					
Ronnel	DETSC 3443*	0.1	mg/kg	< 0.1					
Fenthion	DETSC 3443*	0.1	mg/kg	< 0.1					
Chlopyrifos	DETSC 3443*	0.1	mg/kg	< 0.1					
Trichlorinate	DETSC 3443*	0.1	mg/kg	< 0.1					
Merphos	DETSC 3443*	0.1	mg/kg	< 0.1					
Stirofos	DETSC 3443*	0.1	mg/kg	< 0.1					
Tokuthion	DETSC 3443*	0.1	mg/kg	< 0.1					
Fensulfothion	DETSC 3443*	0.1	mg/kg	< 0.1					
Bolstar	DETSC 3443*	0.1	mg/kg	< 0.1					
Azinphos methyl	DETSC 3443*	0.1	mg/kg	< 0.1					
Coumaphos	DETSC 3443*	0.1	mg/kg	< 0.1					

Summary of Chemical Analysis

Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237612	1237613	1237614	1237615	1237616
Sample ID	TP24	TP01	TP05	TP08	TP20
Depth	2.00	0.80	1.50	1.25	0.85
Other ID					
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units					
Metals								
Arsenic	DETS 2301#	0.2	mg/kg					
Boron, Water Soluble	DETS 2123#	0.2	mg/kg					
Cadmium	DETS 2301#	0.1	mg/kg					
Chromium	DETS 2301#	0.15	mg/kg					
Chromium III	DETS 2301*	0.15	mg/kg					
Chromium, Hexavalent	DETS 2204*	1	mg/kg					
Copper	DETS 2301#	0.2	mg/kg					
Lead	DETS 2301#	0.3	mg/kg					
Mercury	DETS 2325#	0.05	mg/kg					
Nickel	DETS 2301#	1	mg/kg					
Selenium	DETS 2301#	0.5	mg/kg					
Zinc	DETS 2301#	1	mg/kg					
Inorganics								
pH	DETS 2008#			7.3				
Calorific Value	DETS 5008	1	MJ/kg		< 1.0	5.4	11.5	12.6
Total Organic Carbon	DETS 2002	0.1	%					
Sulphate Aqueous Extract as SO4	DETS 2076#	10	mg/l	< 10				
PAHs								
Naphthalene	DETS 3303#	0.03	mg/kg					
Acenaphthylene	DETS 3303#	0.03	mg/kg					
Acenaphthene	DETS 3303#	0.03	mg/kg					
Fluorene	DETS 3303	0.03	mg/kg					
Phenanthrene	DETS 3303#	0.03	mg/kg					
Anthracene	DETS 3303	0.03	mg/kg					
Fluoranthene	DETS 3303#	0.03	mg/kg					
Pyrene	DETS 3303#	0.03	mg/kg					
Benzo(a)anthracene	DETS 3303#	0.03	mg/kg					
Chrysene	DETS 3303	0.03	mg/kg					
Benzo(b)fluoranthene	DETS 3303#	0.03	mg/kg					
Benzo(k)fluoranthene	DETS 3303#	0.03	mg/kg					
Benzo(a)pyrene	DETS 3303#	0.03	mg/kg					
Indeno(1,2,3-c,d)pyrene	DETS 3303#	0.03	mg/kg					
Dibenzo(a,h)anthracene	DETS 3303#	0.03	mg/kg					
Benzo(g,h,i)perylene	DETS 3303#	0.03	mg/kg					
PAH - USEPA 16, Total	DETS 3303	0.1	mg/kg					
OCPs								
alpha-BHC	DETS 3441*	0.1	mg/kg					
gamma-BHC (Lindane)	DETS 3441*	0.1	mg/kg					
beta-BHC	DETS 3441*	0.1	mg/kg					
delta-BHC	DETS 3441*	0.1	mg/kg					
Heptachlor	DETS 3441*	0.1	mg/kg					

Summary of Chemical Analysis Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	1237612	1237613	1237614	1237615	1237616
Sample ID	TP24	TP01	TP05	TP08	TP20
Depth	2.00	0.80	1.50	1.25	0.85
Other ID					
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	25/09/17	25/09/17	25/09/17	25/09/17	25/09/17
Sampling Time	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units					
Aldrin	DETSC 3441*	0.1	mg/kg					
Heptachlor epoxide	DETSC 3441*	0.1	mg/kg					
gamma-Chlordane	DETSC 3441*	0.1	mg/kg					
Endosulphan I & Alpha-chlorodane	DETSC 3441*	0.1	mg/kg					
4,4-DDE	DETSC 3441*	0.1	mg/kg					
Dieldrin	DETSC 3441*	0.1	mg/kg					
Endrin	DETSC 3441*	0.1	mg/kg					
Endosulphan II & 4,4-DDD	DETSC 3441*	0.1	mg/kg					
Endrin aldehyde	DETSC 3441*	0.1	mg/kg					
4,4-DDT	DETSC 3441*	0.1	mg/kg					
Endosulphan sulphate	DETSC 3441*	0.1	mg/kg					
Methoxychlor	DETSC 3441*	0.1	mg/kg					
Endrin ketone	DETSC 3441*	0.1	mg/kg					
OPPs								
Dichlorvos	DETSC 3443*	0.1	mg/kg					
Mevinphos	DETSC 3443*	0.1	mg/kg					
Demeton-O	DETSC 3443*	0.1	mg/kg					
Ethoprop	DETSC 3443*	0.1	mg/kg					
Naled	DETSC 3443*	0.1	mg/kg					
Phorate	DETSC 3443*	0.1	mg/kg					
Demeton-S	DETSC 3443*	0.1	mg/kg					
Diazinon	DETSC 3443*	0.1	mg/kg					
Disulfoton	DETSC 3443*	0.1	mg/kg					
Methylparathion	DETSC 3443*	0.1	mg/kg					
Ronnel	DETSC 3443*	0.1	mg/kg					
Fenthion	DETSC 3443*	0.1	mg/kg					
Chlopyrifos	DETSC 3443*	0.1	mg/kg					
Trichlorinate	DETSC 3443*	0.1	mg/kg					
Merphos	DETSC 3443*	0.1	mg/kg					
Stirofos	DETSC 3443*	0.1	mg/kg					
Tokuthion	DETSC 3443*	0.1	mg/kg					
Fensulfothion	DETSC 3443*	0.1	mg/kg					
Bolstar	DETSC 3443*	0.1	mg/kg					
Azinphos methyl	DETSC 3443*	0.1	mg/kg					
Coumaphos	DETSC 3443*	0.1	mg/kg					

Summary of Asbestos Analysis Soil Samples

Our Ref 17-11781

Client Ref 2409

Contract Title Lundhill Road, Wombwell

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1237594	TP02 0.10	SOIL	NAD	none	Paul Dunn
1237596	TP05 0.10	SOIL	NAD	none	Paul Dunn
1237597	TP07 0.10	SOIL	NAD	none	Paul Dunn
1237598	TP09 0.10	SOIL	NAD	none	Paul Dunn
1237600	TP12 0.10	SOIL	NAD	none	Paul Dunn
1237601	TP14 0.10	SOIL	NAD	none	Paul Dunn
1237602	TP16 0.10	SOIL	NAD	none	Paul Dunn
1237603	TP17 0.10	SOIL	NAD	none	Paul Dunn
1237604	TP18 0.10	SOIL	NAD	none	Paul Dunn
1237605	TP22 0.10	SOIL	NAD	none	Paul Dunn
1237607	TP25 0.10	SOIL	NAD	none	Paul Dunn

Analysis was carried out at our Lanarkshire laboratory. DETS Newhouse Laboratory (BioCity Scotland, Room 1217, Block 41, Bo'Ness Road, Newhouse, Lanarkshire, ML1 5UH.) Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * -not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 17-11781
 Client Ref 2409
 Contract Lundhill Road, Wombwell

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1237594	TP02 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237595	TP03 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237596	TP05 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237597	TP07 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237598	TP09 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237599	TP10 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237600	TP12 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237601	TP14 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237602	TP16 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237603	TP17 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237604	TP18 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237605	TP22 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237606	TP24 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237607	TP25 0.10 SOIL	25/09/17	GJ 500ml, PT 1L		
1237608	TP04 1.70 SOIL	25/09/17	PT 1L		
1237609	TP07 1.00 SOIL	25/09/17	PT 1L		
1237610	TP11 1.50 SOIL	25/09/17	PT 1L		
1237611	TP16 2.20 SOIL	25/09/17	PT 1L		
1237612	TP24 2.00 SOIL	25/09/17	PT 1L		
1237613	TP01 0.80 SOIL	25/09/17	PT 1L		
1237614	TP05 1.50 SOIL	25/09/17	PT 1L		
1237615	TP08 1.25 SOIL	25/09/17	PT 1L		
1237616	TP20 0.85 SOIL	25/09/17	PT 1L		

Key: G-Glass P-Plastic J-Jar 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 I
Geotechnical Test Results



LABORATORY REPORT REPORT



4043

Contract Number: PSL17/4756

Report Date: 05 October 2017
Client's Reference: 2409
Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire

For the attention of: Alan Swales

Contract Title: Lundhill Road, Wombwell
Date Received: 29/9/2017
Date Commenced: 29/9/2017
Date Completed: 5/10/2017

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)

C Marshall
(Laboratory Manager)

A Fry
(Senior Technician)

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Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP02	2	D	0.60		Brown slightly gravelly sandy very silty CLAY.
TP04	1	D	0.90		Brown mottled grey slightly sandy very silty CLAY.
TP05	2	D	0.90		Brown mottled grey sandy very silty CLAY.
TP13	2	D	1.00		Brown slightly gravelly sandy very silty CLAY.
TP15	2	D	1.00		Brown mottled grey slightly gravelly sandy very silty CLAY.
TP16	2	D	1.50		Grey mottled brown sandy very silty CLAY.
TP17	2	D	1.10		Brown mottled grey slightly sandy very silty CLAY.
TP24	2	D	1.20		Brown mottled grey slightly gravelly sandy very silty CLAY.
TP19	1	D	0.60		Brown mottled grey slightly gravelly sandy very silty CLAY.
TP23	2	D	2.00		Brown mottled grey very sandy very silty CLAY.
TP10	2	D	0.90		Brown mottled grey sandy very silty CLAY.
TP17	3	D	1.80		Brown very gravelly sandy very silty CLAY.



Lundhill Road, Wombwell

Contract No:

PSL17/4756

Client Ref:

2409

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
TP02	2	D	0.60		17			47	23	24	98	Intermediate plasticity CI.
TP04	1	D	0.90		17			65	27	38	100	High plasticity CH.
TP05	2	D	0.90		21			59	26	33	100	High plasticity CH.
TP13	2	D	1.00		23			44	22	22	98	Intermediate plasticity CI.
TP15	2	D	1.00		24			51	25	26	98	High plasticity CH.
TP16	2	D	1.50		24			39	21	18	100	Intermediate plasticity CI.
TP17	2	D	1.10		24			68	27	41	100	High plasticity CH.
TP24	2	D	1.20		17			49	24	25	98	Intermediate plasticity CI.
TP19	1	D	0.60		26			59	26	33	98	High plasticity CH.
TP23	2	D	2.00		19			37	21	16	100	Intermediate plasticity CI.
TP10	2	D	0.90		21			56	26	30	100	High plasticity CH.
TP17	3	D	1.80		17			41	22	19	73	Intermediate plasticity CI.

SYMBOLS : NP : Non Plastic

* : Liquid Limit and Plastic Limit Wet Sieved.



Lundhill Road, Wombwell

Contract No:

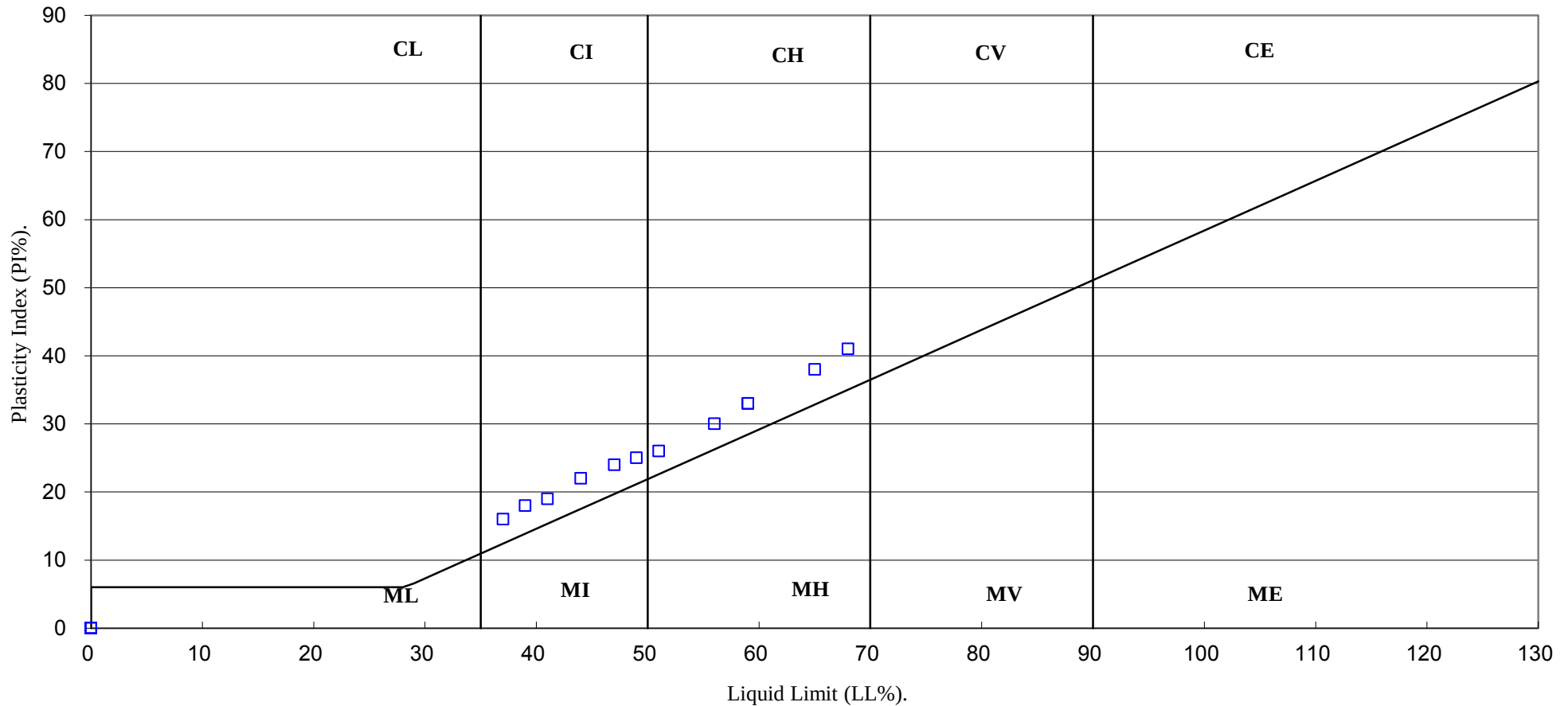
PSL17/4756

Client Ref:

2409

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



PSL
Professional Soils Laboratory

Lundhill Road, Wombwell

Contract No:

PSL17/4756

Client Ref:

2409



Certificate of Analysis

Certificate Number 17-12130

11-Oct-17

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 17-12130

Client Reference PSL17/4756

Order No (not supplied)

Contract Title Lundhill Road, Wombwell

Description 13 Soil samples.

Date Received 05-Oct-17

Date Started 05-Oct-17

Date Completed 11-Oct-17

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



Summary of Chemical Analysis Soil Samples

Our Ref 17-12130

Client Ref PSL17/4756

Contract Title Lundhill Road, Wombwell

Lab No	1239331	1239332	1239333	1239334	1239335	1239336	1239337	1239338	1239339	1239340	1239341
Sample ID	TP02	TP04	TP05	TP13	TP15	TP16	TP17	TP24	TP9	TP19	TP23
Depth	0.60	0.90	0.90	1.00	1.00	1.50	1.10	1.20	0.80	0.60	2.00
Other ID	2	1	2	2	2	2	2	2	2	1	2
Sample Type	D	D	D	D	D	D	D	D	D	D	D
Sampling Date	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units											
Inorganics														
pH	DETSC 2008#			7.0	5.5	6.7	7.3	7.4	7.4	7.7	7.2	7.2	7.6	7.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	26	240	42	47	33	16	43	47	14	25	29

Summary of Chemical Analysis

Soil Samples

Our Ref 17-12130

Client Ref PSL17/4756

Contract Title Lundhill Road, Wombwell

Lab No	1239342	1239343
Sample ID	TP10	TP17
Depth	0.90	1.80
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#			7.4	7.3
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	24	25

Information in Support of the Analytical Results

Our Ref 17-12130
 Client Ref PSL17/4756
 Contract Lundhill Road, Wombwell

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1239331	TP02 0.60 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239332	TP04 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239333	TP05 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239334	TP13 1.00 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239335	TP15 1.00 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239336	TP16 1.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239337	TP17 1.10 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239338	TP24 1.20 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239339	TP9 0.80 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239340	TP19 0.60 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239341	TP23 2.00 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239342	TP10 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1239343	TP17 1.80 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 J

Gas Monitoring Results

Job Title:										Job No:					
Lundhill Road, Wombwell										2409					
Client:										Sheet :					
Persimmon										1 of 1					
Date:		Arrival Time:		Depart Time:		Operator:									
06/10/2017		15:20		17:00		M Naylor									

Gas Monitoring Results:													
Ambient Concentration (% Volume):		CH ₄ :		0.0		CO ₂ :		0.0		O ₂ :		20.7	

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum litre / hr	Steady litre / hr	Time to fall from highest to steady secs		
		CH ₄ % v / v	CO ₂ (%)	CH ₄ % v / v	CO ₂ (%)	O ₂ (%)					
PH02A	3.40	ND	1.5	ND	1.5	5.0	ND	ND	ND	5.60	
PH04A	4.72	NR	NR	NR	NR	NR	NR	NR	NR	5.84	Gas concentrations and flow not measured as groundwater levels too high to allow pumping of gas
PH05A	1.70	ND	0.3	ND	0.3	19.9	ND	ND	ND	5.80	Bung tap open on arrival
PH06A	2.31	ND	0.2	ND	0.2	20.3	120.0	2.1	120.0	5.78	CO ₂ = 10ppm
PH07A	3.00	NR	NR	NR	NR	NR	NR	NR	NR	5.75	Gas concentrations and flow not measured as groundwater levels too high to allow pumping of gas
PH08A	1.20	ND	ND	ND	ND	20.4	120.0	16.0	300.0	5.80	Flow rate slowly dropping
PH09A	ND	ND	1.8	ND	1.8	18.9	41.5	ND	180.0	5.85	Gas concentrations and flow measured but groundwater entered gas monitor tubes during monitoring
PH11A	3.38	ND	0.9	ND	0.9	19.2	ND	ND	ND	5.88	Monitor tubes cleared of water before monitoring PH11A. Atmospheric readings: CH ₄ =0.0, CO ₂ =1.1, O ₂ =19.2
PH12A	4.05	NR	NR	NR	NR	NR	NR	NR	NR	5.86	Gas concentrations and flow not measured as groundwater levels too high to allow pumping of gas
PH14A	2.76	NR	NR	NR	NR	NR	NR	NR	NR	5.80	Gas concentrations and flow not measured as groundwater levels too high to allow pumping of gas

Notes													
Equipment Used:						Next Calibration Date			Key				
Gas Data GFM436 Infrared Gas Analyser						30/01/2018			ND None Detected				
Geotechnical Instruments Dipmeter									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 (Wombwell Station)									
	Temp (°C):	9 to 16		Barometric Pressure Trend:			Rising						
Time:	15:20	17:00		00:02	03:00	07:05	12:01	15:00	18:02	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1020	1018		1015.8	1016.8	1018.2	1020.2	1019.9	1020.2	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Cloudy and sunny, slight breeze										
	Surface Ground Conditions:		Damp										
Remarks:													



Job Title:				Job No:
Lundhill Road, Wombwell				2409
Client:				Sheet :
Persimmon				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
26/10/2017	09:30	15:30	M Naylor	

Gas Monitoring Results:											
Ambient Concentration (% Volume):				CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.6		
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		
PH02A	3.35	ND	1.8	ND	1.8	2.5	-25.0	ND	15.0	5.59	Bailed to 3.44m but couldn't get bailer down further due to blockage
PH04A	5.06	ND	2.2	ND	2.2	9.5	ND	ND	ND	5.86	
PH05A	1.78	ND	0.5	ND	0.5	19.1	-31.0	-1.2	30.0	5.78	Bailed to 4.80m - water recharging
PH06A	1.93	ND	0.2	ND	0.2	19.8	120.0	0.6	120.0	5.81	Bailed to 5.56m
PH07A	2.78	ND	2.6	ND	2.6	0.0	100.1	ND	300.0	5.82	Bailed to 3.51m - recharging quickly.
PH08A	0.65	ND	-0.1	ND	-0.1	18.7	111.5	7.0	300.0	5.82	Flow dropping very slowly after 10l/hr. Bung loose on arrival. Bailed to 5.07m.
PH09A	0.00	NR	NR	NR	NR	NR	NR	NR	NR	5.80	Unable to gas monitor as the water level was very high. Bailed to 1.65m but recharging extremely quickly.
PH11A	3.40	ND	7.4	ND	7.4	9.7	ND	ND	ND	5.87	Bailed to 5.04m.
PH12A	4.21	ND	2.8	ND	2.8	9.0	ND	ND	ND	5.92	Bailed to 4.55m - water recharging.
PH14A	2.73	ND	0.3	ND	0.3	19.6	38.5	ND	60.0	5.83	Bailed to 4.50m.

Notes													
Equipment Used:						Next Calibration Date			Key				
Gas Data GFM436 Infrared Gas Analyser						30/01/2018			ND	None Detected			
Geotechnical Instruments Dipmeter									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 (Wombwell Station)									
Temp (°C):	9 to 14			Barometric Pressure Trend:				Rising					
Time:	09:30	14:45	15:30	00:03	03:04	07:03	12:04	15:02	18:00	Trigger level 1	1.0 5.0 16.0		
Pressure (mb):	1019	1019	1018	1022.6	1022.2	1022.6	1024.9	1024.6	1024.6	Trigger level 2	5.0 10.0 10.0		
Weather Conditions:				Cloudy, little breeze									
Surface Ground Conditions:				Wet									

Remarks:	
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Job Title:										Job No:					
Lundhill Road, Wombwell										2409					
Client:										Sheet :					
Persimmon										1 of 1					
Date:		Arrival Time:		Depart Time:		Operator:									
14/11/2017		09:50		13:20		M Naylor									

Gas Monitoring Results:															
Ambient Concentration (% Volume):				CH ₄ :		0.0		CO ₂ :		0.0		O ₂ :		20.6	

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						
		% v/v	(%)	% v/v	(%)	(%)						
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m		
PH02A	3.44	ND	2.0	ND	2.0	8.4	ND	ND	ND	5.60		
PH04A	5.17	ND	3.2	ND	3.2	12.6	-0.7	0.0	2.0	5.87	Bung not properly in well on arrival.	
PH05A	1.82	ND	ND	ND	ND	20.5	14.7	0.0	2.0	5.79	Bailed to 4.00m at 11:53am.	
PH06A	0.77	ND	ND	ND	ND	20.5	ND	ND	ND	5.83	Bung not properly in well on arrival. Bailed to 4.13m at 12:01pm.	
PH07A	2.83	-0.1	1.8	-0.1	1.8	14.4	90.1	0.0	300.0	5.77	Bailed to 3.77m at 12:11pm.	
PH08A	0.23	ND	0.2	ND	0.2	20.3	ND	ND	ND	5.86	Bung not properly in well on arrival. Bailed to 4.03m at 12:19m.	
PH09A	0.00	ND	2.7	ND	2.7	18.6	120.0	0.4	240.0	5.83	Initially took bung out to make sure water wasn't at the rim. After gas monitoring water had rose to the rim. Bailed to 0.72m at 12:26pm, recharging quickly.	
PH11A	3.38	ND	8.0	ND	8.0	9.3	ND	ND	ND	5.85		
PH12A	4.20	ND	3.7	ND	3.7	8.0	ND	ND	ND	5.88		
PH14A	3.30	ND	1.2	ND	1.2	18.6	120.0	9.0	420.0	5.88	Flow dropping very slowly after 15l/hr.	

Notes																	
Equipment Used:						Next Calibration Date				Key							
Gas Data GFM436 Infrared Gas Analyser						30/01/2018				ND				None Detected			
Geotechnical Instruments Dipmeter										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 (Wombwell Station)								Trigger level 1	CH ₄	CO ₂	O ₂				
	Temp (°C):	6 to 13		Barometric Pressure Trend:				Steady											
		09:50	11:40	13:20	00:02	03:00	07:00	12:03	15:00	15:58									
Time:	09:50	11:40	13:20	00:02	03:00	07:00	12:03	15:00	15:58										
Pressure (mb):	1014	1014	1014	1020.5	1018.8	1018.8	1020.5	1020.5	1020.5										
	Weather Conditions:			Sunny and windy.															
	Surface Ground Conditions:			Damp.															

Remarks:	Results after bailing are on the next sheet.															
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Job Title:										Job No:					
Lundhill Road, Wombwell										2409					
Client:										Sheet :					
Persimmon										1 of 1					
Date:		Arrival Time:		Depart Time:		Operator:									
29/11/2017		11:50		13:00		M Naylor									

Gas Monitoring Results:									
Ambient Concentration (% Volume):				CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.6

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum litre / hr	Steady litre / hr	Time to fall from highest to steady secs		
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂					
		% v / v (%)	% v / v (%)	% v / v (%)	% v / v (%)	% v / v (%)					
PH02A	3.53	ND	2.4	ND	2.3	8.6	ND	ND	ND	5.62	O2 steady at 8.7%.
PH04A	5.22	ND	2.3	ND	2.3	12.8	ND	ND	ND	5.85	
PH05A	1.93	0.9	1.7	0.4	1.3	19.3	ND	ND	ND	5.78	LEL rose to 22.2%. O2 steady at 19.5%.
PH06A	0.87	ND	ND	ND	ND	20.4	ND	ND	ND	5.83	Bung not on well on arrival. Bailed to 4.10m at 12:21pm.
	2.49	0.0	0.4	0.0	0.4	19.7	59.2	3.7	180.0	5.83	Re-monitored at 13:28pm after bailing out of groundwater. Bung had popped off when re-monitoring.
PH07A	2.86	ND	1.6	ND	1.6	13.1	63.3	0.0	300.0	5.78	
PH08A	0.20	ND	0.2	ND	0.2	15.2	-16.0	0.0	30.0	5.81	
PH09A	0.00	NR	NR	NR	NR	NR	NR	NR	NR	5.81	Water level to high to use gas monitor.
PH11A	3.35	ND	8.9	ND	8.9	9.6	ND	ND	ND	5.88	
PH12A	4.25	ND	4.2	ND	4.2	8.6	ND	ND	ND	5.88	
PH14A	2.83	ND	1.3	ND	1.3	17.9	120.0	0.9	600.0	5.83	Flow fluctuating, but overall flow dropping slowly after 20l/hr. Bailed to 4.06m at 13:18pm.
	3.31	0.0	0.6	0.0	0.6	19.2	120.0	9.2	600.0	5.83	Re-monitored at 13:47pm after bailing of groundwater. Flow dropping slowly after 20 l/hr.

Notes									
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Equipment Used:						Next Calibration Date				Key			
Gas Data GFM436 Infrared Gas Analyser						30/01/2018				ND None Detected			
Geotechnical Instruments Dipmeter										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 (Wombwell Station)							CH ₄	CO ₂	O ₂	
	Temp (°C):	0 to 5		Barometric Pressure Trend:			Rising							
Time:	11:50	12:45	13:00	00:00	03:04	07:04	12:06	15:04	18:13	Trigger level 1	1.0	5.0	16.0	
Pressure (mb):	1006	1006	1007	1010.4	1009.7	1010.4	1012.8	1013.1	1015.1	Trigger level 2	5.0	10.0	10.0	
	Weather Conditions:		Cloudy, chance of showers, cold.											
	Surface Ground Conditions:		Wet.											

Remarks:	PHs 06A & 14A monitored twice, once before bailing and again after bailing of groundwater.													
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Job Title:				Job No:	
Lundhill Road, Wombwell				2409	
Client:				Sheet :	
Persimmon				1 of 1	
Date:	Arrival Time:	Depart Time:	Operator:		
14/12/2017	10:50	12:15	M Naylor		

Gas Monitoring Results:					
Ambient Concentration (% Volume):		CH ₄ :	-0.1	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		
PH02A	3.20	ND	4.3	ND	4.2	7.1	ND	ND	ND	5.58	
PH04A	5.72	-0.1	2.8	-0.1	2.8	7.6	-0.3	-0.3	NR	5.80	
PH05A	1.56	2.0	3.8	2.0	3.8	17.8	98.4	0.0	180.0	5.72	LEL rose to 47.0%.
PH06A	0.72	ND	1.0	ND	0.6	19.0	ND	ND	ND	5.73	
PH07A	2.83	ND	2.1	ND	2.1	11.0	97.4	0.0	300.0	5.74	
PH08A	0.10	ND	0.1	ND	0.1	14.1	-22.0	0.0	5.0	5.81	
PH09A	0.00	NR	NR	NR	NR	NR	NR	NR	NR	5.81	Water level to high to use gas monitor.
PH11A	3.25	ND	9.8	ND	9.8	7.8	ND	ND	ND	5.84	
PH12A	4.15	ND	4.4	ND	4.4	5.0	ND	ND	ND	5.89	
PH14A	2.68	ND	0.9	ND	0.9	18.9	100.8	0.0	600.0	5.77	

Notes													
Equipment Used:						Next Calibration Date			Key				
Gas Data GFM436 Infrared Gas Analyser						30/01/2018			ND None Detected				
Geotechnical Instruments Dipmeter									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 (Wombwell Station)									
		Temp (°C):		1 to 5		Barometric Pressure Trend:		Falling					
Time:		10:50		11:40		12:15		00:03		03:00			
Pressure (mb):		982		980		979		986		986.7			
								986.3		985.3			
								983.6		982.3			
		Weather Conditions:		Sunny but cold.								Trigger level 1	
		Surface Ground Conditions:		Wet.								Trigger level 2	

Remarks:	
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