

The background image for the cover is a photograph of a cross-section of a stream bed. The left side shows a steep, green, vegetated bank. The right side shows a steep, brown, eroded bank with exposed rocks and soil. The water in the stream is clear and flows over the rocks.

Geoenvironmental Appraisal

Land at Lidgett Lane, Pilley

For Barratt & David Wilson Homes
Yorkshire West

Report no: 2222/5

Date: May 2018



SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2222	Site area/ha	2.4ha
Client:	Barratt & David Wilson Homes Yorkshire West	NGR:	SE 337 003
Site:	Lidgett Lane, Pilley	Nearest postcode:	S75 3AG

The site is located off Pilley Green, approximately 6km south of Barnsley town centre, and currently comprises an overgrown grassed field (c. 2.4 hectares) sloping down to the southeast at a gradient of approximately 1 in 10. Hedgerows and (semi)mature trees are located on all boundaries. The site has remained undeveloped throughout history.

Lithos were commissioned by BDW to provide a geoenvironmental appraisal of the site. It is understood that the site is to be redeveloped with 75 no. traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. Lithos' investigation included a review of 3rd party reports, the site's history and environmental setting, and a ground investigation comprising 13 trial pits and 17 rotary open probeholes.

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

Issue	Remarks
Made ground	No made ground has been identified during the investigation.
Natural ground	Topsoil (typically 0.3m thick) is present across the site underlain by Cohesive (firm to stiff gravelly clay) and Granular (sandy gravel) Residual Soil to a typical depth of 2.0m. Sandstone bedrock was encountered in the north with mudstone and siltstone in the centre and south. The Flockton Thick Coal (c. 1.5m thick) outcrops in the far south.
Contamination	Testing of topsoil suggests it is chemically suitable for re-use.
Mining & quarrying	The site is located within a Coal Mining Development High Risk Area. Rotary probing suggests there are no shallow mineworkings. The possibility of bell pits cannot be discounted and consideration should be given to a geophysical survey. A former opencast, which extracted the Flockton Thick coal is present 80m west.
Hazardous gas	The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level. Based on gas monitoring results, the site can be classified as having a GREEN (NHBC) and Characteristic Situation 2 (Wilson & Card) gas regime.
Preparatory works	General site clearance and strip and stockpile of topsoil. Regrading to required levels.
Foundations	The majority of plots will be founded on traditional strip/trenchfill footings at a minimum depth of 0.9m in residual soils, overdeepened where necessary due to the influence of trees. Significantly deeper foundations may be required in the far south due to the presence of the Flockton Thick coal outcrop.
Groundwater & excavations	Stability of excavations in natural ground is generally good. Seepages of groundwater were noted between 0.4m and 3.0m depth. Monitoring indicates groundwater lies at a typical depth of c.3.1m.
Flooding & drainage	The site is not located within an indicative floodplain. Based on observations made during the investigation, soakaways will not provide a suitable means of surface water disposal, and consequently there will be a need for surface water balancing.
Highways	The in-situ natural soils present at formation level should provide a CBR value of at least 3%. This should be verified by field trials.

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

- Given existing topography (much of the site is sloping, with gradients of up to 1 in 4 in the far west), some site regrade is anticipated, with the need for underbuild and retaining walls.
- Significantly deeper foundations may be required in the far south due to the presence of the Flockton Thick coal outcrop

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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
2222/W/1	-	Site location plan
2222/W/2	-	Proposed site layout
2222/W/3	-	Geological & site features
2222/W/4	-	Site photographs
2222/W/5	-	Preliminary conceptual site model
2222/W/6	-	Exploratory hole locations
2222/W/7	-	Revised conceptual site model
2222/W/8	-	Geological map overlay
2222/W/9	-	Dip calculations
2222/W/10	-	Abandonment plan Flockton Thick seam
2222/W/11	-	Abandonment plan Parkgate seam
2222/W/12	-	Abandonment plan Opencast

Appendix C - Commission

Appendix D - Historical OS plans#

Appendix E - Search responses#

From	Date	Content
Landmark	24 th September 2015	Environmental search data
Coal Authority	24 th September 2015	Mining report

Appendix F to G - Exploratory records

Appendix F	TP201 to TP213
Appendix G	PH101 to 109, PH101A to 106A & PH201 to PH208

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

LIDGETT LANE, PILLEY

1 INTRODUCTION

1.1 The commission and brief

- 1.1.1 Lithos Consulting Limited were commissioned by Barratt & David Wilson Homes Yorkshire West to carry out a geoenvironmental appraisal of land at Lidgett Lane, Pilley.
- 1.1.2 Lithos have previously issued the following reports:
- Desk Study & Mining Risk Assessment for Land at Lidgett Lane & New Road, Pilley (Ref 2222/1 dated October 2015)
 - Geoenvironmental Appraisal Report for Land at New Road, Pilley (Ref 2222/2 date June 2016)
 - Earthworks Specification for Land at New Road, Pilley (Ref 2222/3 dated May 2017)
- 1.1.3 Report 2222/1 relates to two separate sites, this site (Lidgett Lane) and another at New Road, while Reports 2222/2 and 2222/3 relate solely to the New Road site. Report 2222/1 was originally issued to Redrow Homes Yorkshire, and it is understood that Barratt now have reliance on this data. Therefore, the information contained in Report 2222/1, relating to this site, has been incorporated within this Report.
- 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 review of third party reports
 - 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 13 trial pits and 8 rotary open-probeholes
 - 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 investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable BDW to obtain budget costs for: foundations; gas protection measures; and site preparatory works.

1.2 The proposed development

- 1.2.1 It is understood that consideration is being given to redevelopment of the site with 75no. traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A site layout has been provided by BDW (Drawing reference 16 5016 SK07, date unknown) which is reproduced as Drawing 2222/W/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
- 1.3.2 General notes and limitations relevant to all Lithos geoenvironmental investigations are described in the Foreword and should be read in conjunction with this report. The text of the report draws specific attention to any modification to these procedures and to any other special techniques employed.
- 1.3.3 In accordance with the agreed scope of works, the ground investigation reported here is not fully compliant with Eurocode 7 (EC7) and this report does not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. The ground appraisal, parametric assessment and preliminary design guidance presented are intended to assist others as they prepare the design of the proposed works.

2 SITE DESCRIPTION

2.1 General

- 2.1.1 The site's location is shown on Drawing 2222/W/1 presented in Appendix B to this report. Site details are summarised in the Table below.

Detail	Remarks
Location	6 km south of Barnsley town centre
NGR	SE 337 003
Approximate area	2.4ha (5.9 acres)
Known services	Underground telecom, water & sewer

2.2 Site features

- 2.2.1 Existing salient features, at the time of the walkover are presented on Drawing 2222/W/3 in Appendix B to this report, and summarised in the Table below.

Feature	Remarks
Current Access	Off Pilley Green
Topography	Generally slopes down to the southeast at 1 in 10 with a steeper slope (1 in 4) in the far west
Approximate areas	24,000m ² grass
Nature of boundaries	North – mature hedge & dry stone wall East – wooded area South & west – mature hedge and trees
Surrounding land uses	North – Lidgett Lane with houses and fields beyond East – wooded area South – houses West – church & Pilley Green with houses beyond

- 2.2.2 A selection of site photographs is included on Drawing 2222/W/4.
- 2.2.3 Lithos completed a walkover survey of the site on 13th March 2018.

- 2.2.4 The site can be accessed via a driveway off Pilley Green in the northwest, and currently comprises a single parcel of overgrown grassland which slopes down to the southeast at a gradient of around 1 in 10. A steeper slope (1 in 4) is present in the far west.
- 2.2.5 Hedgerows are present on the north and south boundaries with (semi)mature trees located on the east, south and west boundaries.
- 2.2.6 An unofficial footpath crosses the south of the site from east to west.
- 2.2.7 A fire hydrant is situated in the site entrance.

3 SITE HISTORY

- 3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1855 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
1855	Open fields.	Lidgett Lane and Pilley Green immediately north and west respectively with open fields beyond in all directions. Pilley village 200m northwest. Wharncliffe Silkstone Colliery 500m south.
1893	No significant changes.	Mission Church adjacent to northwest corner. Spoil heap associated with colliery within 200m of southern boundary.
1905		Railway running northeast-southwest immediately beyond eastern boundary. Houses shown immediately south of Pilley Green.
1931		Expansion of spoil heaps associated with Wharncliffe Silkstone Colliery.
1957		Railway no longer shown. Expansion of Pilley residential area 100m northwest.
1963		Further expansion of residential area to within 20m north. Former spoil heap labelled Slag Heap.
1978		Former slag heap labelled Tip (disused).
2015		Further expansion of residential area immediately south.

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 response from the Coal Authority are presented in Appendix E. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 87) 1:10,000 BGS map (Sheet SE30SW) BGS Memoir/Technical Report	Drift – None recorded. Solid – Predominantly Pennine Lower Coal Measures (sandstone, siltstone & mudstone) with Middle Coal Measures (sandstone) in the far northeast and northwest. Shallowest coal seam – Flockton Thick outcropping in the south. See further details in Section 4.2 below. Strata dip – Gentle to the northeast. Faults – Two faults cross the site; see Drawing 2222/W/3 for orientation and downthrow.
Mining	Coal Authority	This site is located within a Coal Mining Development High Risk Area. Further details in Section 4.2 below.
Quarrying	Historical OS plans	No known quarries within 50m.
Landfills	Envirocheck Report	No known landfills within 250m.
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 recorded. Soil leaching potential - High. Pollution incidents? None recorded.
Hydrology	Environment Agency Envirocheck Report	Nearest watercourse(s) – Birdwell Dike (culverted) 160m south flowing east. Water quality – Site is located within Rockley Dike from Source to River Dove catchment area rated as ecologically moderate and chemically good. Pollution incidents? None recorded. Abstractions? None recorded. Discharge consents? Nearest consent 500m southeast discharging trade effluent to unnamed freshwater stream/river (revoked November 1994).
Flood risk	Environment Agency	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. In accordance with Chapter 10 of the National Planning Policy Framework, a site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency).

4.2 Coal & mining

- 4.2.1 In July 2011 the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology relating to coal mining development areas. This Section (and Section 8.6) provides the necessary mining risk assessment required by the proposed planning application.
- 4.2.1 The majority of the site lies within a High Risk Area - an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.
- 4.2.2 Coal has been mined in Yorkshire for centuries; the first mining probably took place in the fifteenth century. Early mining methods included drifts or adits from outcrop. Where mining extended further from the crop, bell pits were often sunk, and as the coal got deeper still, shafts were used to access gallery workings (pillar & stall).
- 4.2.3 The shafts associated with bell pits are typically only about 1.2m in diameter, and the bell pit itself was typically 5m to 10m in diameter (bell pit size would have been constrained by roof stability).
- 4.2.4 The depth limit of bell pit mining is almost certainly 15m, and this is considered a deep bell pit; the vast majority were probably less than half this depth.
- 4.2.5 At greater depths, pillar and stall workings appear to have been the preferred method, and such workings were often accessed via a single shaft. Consequently, shafts associated with such workings are more widely spaced.
- 4.2.6 Bell pits may be present beneath this site, and given the absence of loose superficial deposits, it is considered unlikely that such mine entries would have been lined.
- 4.2.7 Faults are believed to present beneath this site, and such features are usually bordered by a shatter zone where the coal is degraded. The nature and extent of a shatter zone varies according to the intensity of the faulting. Early and modern mining practice was to leave the coal in the shatter zone untouched as it was of little economic value. Thus there is usually a margin between the workings and the fault, which based on observations elsewhere might be about 60m wide (30m either side of the fault).
- 4.2.8 The 1:10,000 BGS geological map shows the site to be mostly underlain by undivided Coal Measures bedrock, with unnamed sandstone units in the northeast and northwest. The strata are shown to dip to the north-east at an unspecified angle. No drift deposits are shown.
- 4.2.9 There are two faults affecting the site which make the geology somewhat complex. One fault is conjectured to run northeast-southwest dissecting the northwest corner and the second trends northwest-southeast dissecting the northeast corner. The faults downthrow to the northwest and northeast respectively. Geological features are presented on Drawing 2222/W/3 in Appendix B.
- 4.2.10 The Flockton Thick Coal outcrops in the south trending northwest to southeast. The Tankersley Ironstone overlies the Flockton Thick coal by about 4m, and is shown to outcrop in the centre of the site. The Tankersley Ironstone is a seam rich in iron-ore which is, in some areas known to be worked from outcrop and via bell pits.
- 4.2.11 Geological maps suggest that two coal seams underlie the site at shallow depth, with approximate outcrops shown on Drawing 2222/W/3. These are the:
- Flockton Thick Coal, (between 0.8m and 2.9m thick) outcropping in the south, and
 - Flockton Thin Coal (between 0.3m and 2.0m thick), at approximately 28m depth

4.2.12 Significant seams at greater depth are:

- Fenton Coal (up to 0.5m thick) at approximately 50m depth
- Parkgate Coal (maximum recorded thickness of 4.0m) at approximately 70m depth

4.2.13 Given dip, topography and faulting, the Flockton Thick seam is expected to underlie an area of about 1.8ha in the centre of the site. The Flockton Thin Coal on the stratigraphic column is only shown to be present partially across the 1:10,000 BGS plan area and therefore may not exist beneath the site.

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

4.2.15 A CA mining report states that:

- *The property is in the likely zone of physical influence on the surface from past underground workings within 7 seams of coal at 50m to 290m depth, last worked in 1954. Any movement in the ground due to coal mining activity should have stopped. This is likely a reference to the Fenton, Parkgate, and deeper seams.*
- *However, 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. This means there could be unrecorded shallow mineworkings, and probably relates to the presence of the Flockton Thick Coal.*
- *The property is not within a surface area that could be affected by present underground coal workings.*
- *The property is not in an area for where the Coal Authority has plans to grant a licence to remove coal using underground methods.*
- *Within, or within 20 metres of, the boundary of the property there are no mine entries.*
- *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.*
- *The property is not within the boundary of an opencast site from which coal has been removed by opencast methods. However, there is a former opencast 80m to the east, from which the Flockton Thick was extracted (further details below).*
- *The Coal Authority has no record of a mine gas emission requiring action.*
- *The property is in an area where notices of to withdraw support was given in 1951. The property is not in an area for which a notice has been given under Section 41 of the Coal Industry Act 1994, revoking the entitlement to withdraw support. This means that coal could be extracted from depth beneath the site in the future. However, given the decline of coal mining in the UK this is highly unlikely.*
- *A damage notice or claim for alleged subsidence damage was made in July 1998 for 1 Knoll Drift, Lidgett Lane, Tankersley S75 3BT for repair to the value of £9,590.68.*

4.2.16 The aforementioned seams with workings in from 50m to 290m depth are considered to be at sufficient depth for and mineworkings not to cause a risk of ground movement at the surface.

4.2.17 The property for which damages were claimed is located approximately 70m to the east and is in close proximity to two former mine entries (adits). The direction of entry of the mine entries is shown to the north, heading into the hillside away from the site, indicating that they were targeting coal beneath land to the north which is topographically higher than the site.

4.2.18 It should be noted that it did not become a statutory requirement to maintain and preserve plans of abandoned mines until the Mine (Coal) Regulations Act of 1872 and consequently there may be mineworkings beneath the site for which the Coal Authority have no records.

- 4.2.19 Of the seams detailed above, that which poses the most significant risk of subsidence is the Flockton Thick (due its shallow depth and thickness).
- 4.2.20 Abandonment plans for the Parkgate and the Flockton Thick seams; and for the opencast to the east have been examined and have yielded the following information:
- No recorded mineworkings are present within the Flockton Thick beneath the site
 - Workings exist within the Parkgate seam across the majority of the site at around 80m depth (therefore at sufficient depth to not cause significant risk of subsidence)
 - The Flockton Thick Seam was extracted from the former opencast to the east to a maximum depth of around 16m; no other seams were extracted as part of the opencast mining; no 'old-workings' are shown to have been encountered within the opencast
- 4.2.21 The abandonment plans support the stratigraphic column of the 1:10,000 BGS plan. Based on the Parkgate Seam abandonment plan, the seams underlying the south of the site would be at the following depths:
- Flockton Thin – 33m
 - Fenton – 55m
 - Parkgate – 80m
- 4.2.22 Copies of the abandonment plans are presented as Drawings 2222/W/10, 2222/W/11 & 2222/W/12 in Appendix B.
- 4.2.23 Based on the above, even if it is conservatively assumed that the full thickness of each of the above seams has been worked beneath the site, they are all at sufficient depth so as to not pose any significant risk of instability at the surface.
- 4.2.24 The only seam of concern with regards to risks of subsidence is the Flockton Thick, and possibly any bell pits associated with the Tankersley Ironstone.

4.3 Mineral safeguarded areas

- 4.3.1 The site is underlain by the Flockton Thick Coal and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).
- 4.3.2 MSAs are areas of known mineral resources that are of sufficient economic or conservation value to warrant protection for generations to come. The purpose of MSAs is not to preclude automatically other forms of development, but to make sure that mineral resources are adequately and effectively considered in land-use planning decisions.
- 4.3.3 Specialist guidance on Mineral Safeguarding "A Guide to Mineral Safeguarding in England" has been produced by The Coal Authority and the British Geological Survey.
- 4.3.4 Paragraph 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.
- 4.3.5 NPPF Paragraph 144 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.

- 4.3.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require BDW to consider the opportunity to recover (extract) the coal. Applicants submitting planning applications may need to demonstrate to the Local Authority that they will extract the coal, unless:
- It can be shown it is not economically viable to do so, or
 - It is not environmentally acceptable to do so, or
 - The need for the development outweighs the need to extract the coal, or
 - The coal will not be sterilised by the development
- 4.3.7 The viability of coal extraction at this site is considered later in this Report (Section 14.6) in light of the findings of Lithos' intrusive mining investigation, which comprised the drilling of 17 rotary probeholes to depths of between 6.0m and 36.0m (see Section 8.6).

5 PREVIOUS INVESTIGATION FINDINGS

5.1 General

- 5.1.1 The following report has been made available to Lithos: Phase 1 & 2 Engineering and Environmental Assessment for Land Adjacent Lidgett Lane, Pilley (Ref. 7217 Rev. A), issued by CoDa Structures in March 2015.
- 5.1.2 The report includes a review of data from a Landmark Envirocheck report and historical OS maps dating back to 1855. A site walkover was also undertaken March 2012. Sections 1 to 4 of this Report include similar content to the CoDa's report, but with further detail.

5.2 Summary of CoDa's findings

5.2.1 CoDa's ground investigation works comprised:

- Trial pits (TPs 1 to 12) excavated across the site to between 2.4m and 4.0m depth
- Trial trenches (TTs 1 to 4) excavated to between 3.0m and 3.6m depth to locate a fault
- Rotary probeholes (R1 to R3) advanced to between 27.0m and 30.0m depth
- Monitoring wells were installed in Rs 1 to 3, with response zones sealed in bedrock.
- Geotechnical classification tests (Atterberg Limits, pH & soluble sulphate).
- Chemical laboratory tests on 4 samples of topsoil (pH, metals & PAHs).
- Gas monitoring; 6 visits between October 2014 and March 2015, with atmospheric pressures in range 992mb to 1005mb. Flows were recorded on 3 occasions in R1.

5.2.2 Ground conditions encountered by CoDa are summarised in the Table below:

Hole	Final depth (m)	Depth to base of (m):					Depth to Bedrock [penetration] (m)	Bedrock
		Topsoil	Made Ground	Cohesive Residual Soil	Granular Residual Soil	Coal		
TP1	2.5	0.3	-	0.6	-	-	0.6[1.9]	Sandstone
TP2	3.0	0.4	1.0	-	-	-	1.0[2.0]	Mudstone /Siltstone
TP3	3.5	0.4	-	2.6*	-	-	2.6[0.9]	Mudstone
TP4	3.5	0.2	-	2.0*	-	-	2.0[1.5]	Mudstone
TP5	3.5	0.2	-	1.7*	-	-	1.7[1.9]	Mudstone
TP6	3.5	0.6	-	1.6*	-	-	1.6[1.9]	Mudstone
TP6A	3.5	0.2	-	2.1	-	-	2.1[1.4]	Mudstone
TP7	3.9	0.3	-	0.9*	-	2.6, 3.1 & >3.9	0.9[0.8], 2.6[0.2] & 3.1[0.5]	Mudstone
TP8	3.2	0.3	-	1.6	-	-	1.6[1.6]	Mudstone /Siltstone
TP9	4.0	0.4	-	1.4	-	2.3, 2.8 & 3.8	1.4[0.3], 2.3[0.2], 2.8[0.6] & 3.8 [0.2]	Mudstone
TP10	3.5	0.3	-	1.4*	-	-	1.4	Mudstone
TP11	3.2	0.3	-	1.4	-	-	1.4[1.9]	Mudstone
TT1	3.6	0.3	-	1.6	-	-	1.6[2.0]	Mudstone
TT1A	3.6	0.2	-	-	2.5*	-	2.5[1.1]	Siltstone
TT2	3.0	0.3	-	1.0	-	-	1.0[2.0]	Sandstone
TT3	3.0	0.1	-	1.1	-	-	1.1[1.9]	Sandstone/ Mudstone
TT4	3.0	0.3	-	0.7	-	-	1.0[2.0]	Mudstone
TT5	3.0	0.3	-	1.6	-	-	1.6[1.4]	Mudstone

* Poor logging - difficult to determine depth to bedrock

- 5.2.3 CoDa recorded 'possible made ground' in TP2, comprising sand, gravel and cobbles of sandstone to a depth of 1.0m. No other made ground was encountered.
- 5.2.4 Natural ground typically comprised topsoil overlying firm to stiff clay (cohesive residual soil) to an average of 1.5m with Mudstone, Siltstone and/or Sandstone bedrock below from depths of between 0.6m (TP1) and 2.6m (TP3).
- 5.2.5 Coal was encountered within TPs 7 and 10 at total thicknesses of 2.2m and 1.7m respectively; in both cases interbedded with mudstone. This is likely to be the Flockton Thick coal seam.
- 5.2.6 In addition, a bed of ironstone was noted in TP5 from 1.7m to 2.5m; this might be the Tankersley Ironstone.
- 5.2.7 It should be noted that the logging of materials within a number of trial pits (namely TPs 3, 4, 5, 6, 7, 10 & TT1A) is poor, with boundaries between cohesive residual soils (clay) and solid bedrock often vague (they are grouped as the same stratum on the log).
- 5.2.8 CoDa advance 3 probeholes across the site, one of which encountered the Flockton Thick Coal at 3.7m depth. Further discussion of the drilling is included in Section 8.6.

5.3 Lithos comments

- 5.3.1 In reviewing the information within the CoDa report, Lithos have noted a number of issues, most notably, those mentioned below.
- 5.3.2 The site description is very limited and lacks detail.
- 5.3.3 An insufficient number of topsoil samples were scheduled for analysis which did not include asbestos ID and TOC. In addition, only limited geotechnical testing has been undertaken (afterbergs on 4 samples).
- 5.3.4 The mining search report obtained by CoDa (prepared by D Bellis Consulting) contains very questionable information; most notably the Flockton Thick coal seam is said to underlie the site and be worked at 52m depth; it is clear from the BGS plans that it outcrops on site.
- 5.3.5 No Coal Authority mining report is referred to, or is included, within the appendices of the report.
- 5.3.6 No 'raw' gas monitoring data is included in the appendices of the CoDa report. Gas monitoring carried out by CoDa is discussed further in Section 11.
- 5.3.7 CoDa state that plots within 20m of the fault will require semi-rigid rafts; reinforced foundations should suffice.
- 5.3.8 The standard of logging in the trial pits and trial trenches is poor, often not showing clear boundaries between clay and bedrock.
- 5.3.9 The CoDa report is generally of poor quality and include large amounts of 'generic' information. Numerous mistakes are present including: incorrect references to exploratory holes; incorrect references to information within the appendices; and technically incorrect information. This indicates that the report has not been thoroughly reviewed prior to issue and brings its integrity into question.

6 GROUND INVESTIGATION DESIGN

6.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	Possible made ground in the vicinity of CoDa TP2
Natural soils	Topsoil over weathered coal measures (gravelly clay/clayey gravel)
Bedrock	Coal Measures (sandstone, siltstone and mudstone) at shallow depth (c. 2.0m depth)
Mineworkings	Not likely to be encountered although uncertain regarding the Flockton Thick Coal
Groundwater	Groundwater likely at depth in bedrock

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

Type of issue	Specific issue	Remarks
Potential on-site contamination sources	1. naturally occurring contaminants 2. shallow mineworkings	1. metals in topsoil 2. migration of hazardous gas
Potential off-site contamination sources	1. backfilled opencast 2. shallow mineworkings	1. migration of hazardous gas 2. migration of hazardous gas
Potential geotechnical hazards	1. steep slopes 2. shallow workings	1. potentially unstable slopes of up to 1 in 4 in the far west 2. possible unrecorded workings in the Flockton Thick Coal
Other potential constraints	1. underground utilities	1. underground telecom, water & sewer

6.2 Preliminary conceptual site model

- 6.2.1 A preliminary conceptual site model, presented as Drawing 2222/W/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 6.1 inclusive of this report.
- 6.2.2 Historical plans show that the site has been occupied by arable farmland which is not considered likely to have caused significant ground contamination. Nonetheless, activities such as slurry spreading, the discharge of chemicals to ground, and unregulated burial have all occurred on farmland.

6.2.3 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
Plant & animal protection	Pesticides & herbicides
Soil conditioners	Metals, sulphates, PAH
Field sports	Lead shot
Waste burial, land levelling, backfilling ponds/quarries	Methane, metals, PAH etc
Naturally occurring contaminants	Arsenic, metals

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

6.2.5 Potential contaminant 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

6.2.6 Potential contaminant receptors include:

- The environment – Secondary A aquifer
- End users of the site (residents)

6.3 Ground investigation design & strategy

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

Exploratory holes	Purpose
13 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
8 Probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings

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

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

7 FIELDWORK

7.1 Objectives

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

7.2 Scope of works

7.2.1 Fieldwork was initially undertaken in September 2015, which comprised an intrusive mining investigation (rotary open probeholes). Additional fieldwork was supervised by Lithos on 16th March (trial pitting) and 4th April (supplementary probing) 2018. All fieldwork undertaken is summarised below:

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 201 to 213	1.7m to 3.4m	Vane tests in cohesive soils
Rotary open-hole probeholes	PHs 101 to 109 PHs 201 to 208	9.0m to 36.0m 6.0m to 24.0m	Monitoring wells installed in PHs 101 to 106

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

7.2.3 Exploratory hole locations are shown on Drawing 2222/W/6 presented in Appendix B. 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

8 GROUND CONDITIONS

8.1 General

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

8.1.2 Typical ground conditions encountered at the site are described below in Section 8.2 (natural ground), with a summary provided in the Table on page 14.

8.2 Natural ground

8.2.1 No made ground was encountered. Natural ground typically comprised:

- **Topsoil:** clayey, friable topsoil was identified across the site to a typical depth of 300mm.
- **Cohesive Residual Soil:** firm to stiff gravelly clay encountered across the site to between 1.0m and 3.2m depth (average 1.6m).
- **Granular Residual Soil:** encountered in the majority of exploratory holes from c. 1.6m to c. 2.0m depth as clayey sandy gravel with occasional cobbles.
- **Coal Measures:** weak to strong fine-grained sandstone encountered in the north with very weak to weak siltstone and/or mudstone in the centre and south. Rockhead encountered between 1.4m depth in north and 2.8m depth in the south (typically 2.0m)
- **Flockton Thick Coal:** encountered in two trial pits in the far southwest (TPs 210 & 211) at 1.1m and 2.1m depth with a thickness of 0.3m and 0.9m respectively.

8.3 Visual & olfactory evidence of organic contamination

8.3.1 No evidence of significant organic contamination was noted in any of the exploratory holes.

8.4 Groundwater

8.4.1 No significant inflows of groundwater were encountered during the investigation. Seepages were noted in 3 trial pits between 0.4m and 3.0m depth.

8.4.2 Groundwater levels recorded in the monitoring wells (6 visits between October 2015 and January 2016) are summarised below.

Hole ID	Response zone (depth range & strata)	Groundwater body	Typical standing water level	
			m bgl	m AoD [#]
PH101	1.3m – 4.5m	Deep (Solid)	2.5	145.5
PH102			2.4	143.1
PH103			4.3	138.7
PH104			N.D.	N.D.
PH105			2.7	147.3
PH106			3.8	148.7

[#] estimated from topo survey data

N.D. – None detected

8.5 Stability

8.5.1 Stability of excavations was generally good.

Summary of Ground Conditions

Hole	Final depth (m)	Depth to base (m)				Depth to Rockhead (m)	Bedrock
		Natural Soils					
		Topsoil	Cohesive Residual Soil	Granular Residual Soil	Flockton Thick Coal		
TP201	2.6	0.3	1.6	2.4	-	2.4	Sandstone
TP202	1.9	0.3	1.4	1.6	-	1.6	Sandstone
TP203	2.1	0.3	1.0	1.4	-	1.4	Sandstone
TP204	2.4	0.3	1.8	2.1	-	2.1	Sandstone
TP205	1.7	0.3	1.1	1.5	-	1.5	Sandstone
TP206	3.2	0.2	1.4	2.0	-	2.0	Mudstone
TP207	2.8	0.4	1.4, then 2.2	1.7, then 2.5	-	2.5	Siltstone
TP208	3.0	0.3	1.1	1.4	-	1.4	Mudstone & siltstone
TP209	3.4	0.3	2.8	-	-	2.8	Siltstone
TP210	2.5	0.4	1.1	-	1.4	2.0	Siltstone
TP211	3.2	0.3	2.1, then >3.2	-	3.0	-	-
TP212	3.2	0.4	1.8	2.1	-	2.1	Mudstone & siltstone
TP213	3.0	0.3	2.0	2.7	-	2.7	Siltstone

8.6 Mining investigation

- 8.6.1 It is clear from the desk study that the site is underlain at shallow depth by the Flockton Thick Coal which may have unrecorded mineworkings.
- 8.6.2 The conjectured outcrop of the Flockton Thick seam is shown on Drawing 2222/W/3 in Appendix B to this report.
- 8.6.3 A total of 17 probeholes have been drilled to determine whether the site is underlain by unrecorded shallow mine workings. In addition, CoDa drilled 3 probeholes as part of their investigation in March 2015. The strata encountered are summarised below.

Hole ID	Final depth (m)	Depth to rockhead (m)	Depth to coal (m)	Thickness of coal (mm)	Remarks
Coda 2015					
R1	30.0	2.5	-	-	
R2	30.0	1.8	3.7	2.1	Seam split by mudstone (0.8m thick)
R3	27.0	0.6	-	-	
Lithos 2016					
PH101	36.0	4.0	9.5	1.5	
PH102	15.0	1.0	11.7	1.5	
PH103	12.0	1.0	5.9	1.5	
PH104	12.0	1.0	4.1	1.5	
PH105	24.0	1.0	-	-	
PH106	15.0	1.0	11.5	1.5	
PH107	12.0	1.0	7.2	1.5	
PH108	15.0	1.0	9.5	1.5	
PH109	9.0	1.0	4.6	1.5	
Lithos 2018					
PH201	21.0	1.3	17.5	1.5	
PH202	21.0	1.0	17.0	1.5	Seam split by mudstone (0.3m thick)
PH203	21.0	2.0	16.5	1.8	Seam split by mudstone (0.3m thick)
PH204	14.0	2.0	10.0	1.5	Seam split by mudstone (0.3m thick)
PH205	9.5	1.7	6.5	1.0	Seam split by mudstone (0.3m thick)
PH206	9.0	0.8	-	-	
PH207	6.0	1.3	2.0	0.8	
PH208	24.0	2.5	-	-	Traces of coal between 15.0m and 15.5m Fractured rock between 18.0m and 18.2m

- 8.6.4 Analysing the data obtained from the 20 probeholes, it is apparent that:
- The Flockton Thick seam of coal underlies about 1.5 ha of the site, outcropping in the south as shown on BGS plans
 - None of the 20 holes advanced encountered evidence of workings
 - The seam is between 0.8m and 2.1m thick (average 1.5m) and is occasionally spilt by a mudstone band (typically 0.3m thick)
 - The thickness of competent (rock) cover is typically less than 10 times seam thickness
 - Linear triangulation suggests the coal seams dip at about 6° to the northeast
 - A single probehole (PH208) encountered fractured rock from 18.0m to 18.2m depth

- 8.6.5 Given the number of probeholes drilled, and the absence of any evidence of voids or broken ground, it is considered highly unlikely that the site is underlain by shallow mineworkings in the Flockton Thick seam.
- 8.6.6 In addition, whilst ironstone seams cannot be readily identified within probeholes (compared to coal seams), a large number of the probeholes were drilled north of the Tankersley Ironstone outcrop, therefore will have penetrated through it in order to reach the Flockton Thick seam. No evidence of mineworkings was encountered at shallower depths than the Flockton Thick seam which could be attributed to workings within the ironstone.
- 8.6.7 A further 6 probeholes were taken to shallow depth to enable the installation of gas monitoring wells.

Risk Assessment

- 8.6.8 There are 3 fault blocks shown on the BGS plan:

Central fault block (majority of site):

- 8.6.9 The drilling has confirmed the presence of the Flockton Thick beneath the majority of the site at depths of between 2.0m and 17.5m, at typical thickness of 1.5m. Insufficient competent cover would be present above any workings within the Flockton Thick. However, no workings were recorded within any of the 15 Lithos probeholes (nor 1 CoDA probehole) where the seam was encountered. This concurs with the information abandonment plans; It is therefore considered unlikely that this seam has been worked.
- 8.6.10 Drilling has confirmed the dip of the strata to the northeast, at a rate of 6°, see Drawing 2222/W/9 in Appendix B.
- 8.6.11 The Flockton Thin was not encountered within 36m depth in PH101. Given a maximum thickness of 2m, at over 36m depth, any associated workings should not pose a risk to surface stability.

North-east & north-west fault blocks:

- 8.6.12 PH105 and R1, located within the north-eastern fault block, encountered no coal within 24m and 30m respectively. R3, located within the north-western fault block encountered no coal within 27m depth. PH208 encountered traces of coal between 15.0m and 15.5m with fractured rock at 18.0m, likely due to the close proximity of a fault.
- 8.6.13 The shallowest seam within these fault blocks should be the Joan Coal which has a maximum thickness of 0.7m. Therefore, if present at depths in excess of 24m, any associated mineworkings would be at sufficient depth not to pose a risk of ground movement at the surface.

8.7 Revised conceptual ground model (ground conditions)

- 8.7.1 The Preliminary Conceptual Site Model has been revised in light of data obtained during the ground investigation, most notably with respect to:
- The presence of coal, but no apparent mineworkings
 - The nature and distribution of contamination (based on visual/olfactory evidence only)
- 8.7.2 The revised Conceptual Site Model is presented in Appendix B, as Drawing 2222/W/7.
- 8.7.3 Further refinement of the Conceptual Site Model is presented in Section 10.2, where the results of laboratory testing for contaminants have been considered.

9 CONTAMINATION (ANALYSIS)

9.1 General

- 9.1.1 The site has been formerly used as arable farmland which is considered unlikely to have given rise to any significant ground contamination. Furthermore, no significant made ground was encountered during the ground investigation. However, samples of topsoil have been recovered in order to confirm its suitability for re-use.
- 9.1.2 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 6.2.
- 9.1.3 In the context of risks to human health associated with residential redevelopment, the Tier 1 Soil Screening Values referenced in this report have been derived via the CLEA default conceptual site model (CSM) used for generating SGVs, but amended, where appropriate, to be more specific to redevelopment within the planning process.
- 9.1.4 Where available, Category 4 Screening Levels (C4SL) have also been referenced.
- 9.1.5 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

9.2 Testing scheduled

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

Type of sample	No. of samples	Determinands
Topsoil	6	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID TOC and speciated Polycyclic Aromatic Hydrocarbons (PAH)
Natural soil	9	pH and water soluble sulphate
	4	Calorific Value (CV)

- 9.2.2 Whilst it is likely that pesticides have been applied during arable use of the land, these are not likely to include the persistent organochloride pesticides such as Dieldrin, Aldrin, DDT etc. Pesticides routinely used on arable crops the UK (Phenoxy Acetic acid herbicide or PAAH) rapidly degrade in soils or leach via rainwater infiltration to groundwater. It is highly unlikely these would be detected by soil sampling and therefore these have not been included within the proposed sampling suite.

9.3 Soil contamination results

- 9.3.1 The soil contamination test results are summarised in the Tables on page 18.
- 9.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix H to this report.

Summary of degree of soils contamination (inorganics)

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 \$	PAH		Asbestos I.D.
				37	5	26	3000	200	200	169	127	350	200	5	8	
TP201	0.1	Topsoil	6.8	18	1.2	0.3	18	40	65	0.1	20	< 0.5	84	< 0.03	< 0.03	N.D.
TP203	0.1	Topsoil	6.9	14	1.5	0.3	18	30	41	0.1	19	< 0.5	79	< 0.03	< 0.03	N.D.
TP204	0.1	Topsoil	6.6	16	1.3	0.3	18	32	47	0.1	19	< 0.5	350	< 0.03	< 0.03	N.D.
TP207	0.1	Topsoil	6.9	12	1.3	0.3	19	36	53	0.1	31	0.7	100	< 0.03	< 0.03	N.D.
TP208	0.1	Topsoil	7.3	14	1.7	0.3	21	29	50	0.1	21	0.7	92	< 0.03	< 0.03	N.D.
TP211	0.1	Topsoil	7.1	15	1.6	0.3	21	30	53	0.1	19	< 0.5	93	< 0.03	< 0.03	N.D.

Key		Source of guidance trigger level	
36	Parameter tested for and found to be in excess of Tier 1 value.	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.	
179	Parameter tested for and found to be > 5 x Tier 1 value.		
12	Parameter tested for but not found to be in excess of Tier 1 value.	∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
	Parameter not tested for.	\$	MAFF. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
♣	Tier 1 Value is pH dependent.	~	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.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.		
ND	No fibres detected (asbestos screen)	*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.

Inorganic determinands

- 9.3.3 Of the 6 samples of Topsoil analysed for inorganic parameters, 5 can be classified as uncontaminated and one could be classified as contaminated.
- 9.3.4 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).
- 9.3.5 A single sample (TP204) yielded an elevated concentration of zinc.
- 9.3.6 Statistical analysis of 6 results has been carried out in general accordance with the methods outlined in "Guidance on Comparing Soil Contamination Data with a Critical Concentration", CIEH/CL:AIRE (2008) (see comments in Appendix A, Contamination Testing) and the results are summarised below.

Stratum	No. of samples	US ₉₅ values for contaminants that have yielded one or more Tier 1 exceedances for a given made ground type
		Zinc (200)
Topsoil	6	97

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

n/a = none of the samples retrieved from this made ground type yielded a concentration in excess of the relevant Tier 1 value.

- 9.3.7 Where there is 95% confidence or greater that the true mean concentration of a given contaminant within a particular soil type is less than the Tier 1 value, it can be concluded that the contaminant does not pose a significant risk to human health.
- 9.3.8 This statistical analysis indicates that the upper 95th percentile bound values (US₉₅) for zinc in Topsoil is not elevated in comparison with relevant Lithos Soil Screening Values.
- 9.3.9 A single sample of Topsoil (TP204) failed the outlier test for zinc. It is possible that this concentration is simply a result of a small amount of zinc rich material in the sample and therefore not significant. Further sampling of the Topsoil in this vicinity could be undertaken to determine whether this is the case, or whether significant copper contamination is more widespread.
- 9.3.10 However, zinc is a phytotoxic compound. Plants are the more sensitive receptor to phytotoxic compounds i.e. detrimental effects are seen in plants at concentrations which do not present a risk to human health. Consequently, for zinc, consideration and protection of flora would also be protective of human health.
- 9.3.11 Allowable concentrations of heavy metals in arable soils are set out in Defra's Code of Good Agricultural Practice 2009¹. The value for zinc is 200mg/kg, and is based on a continued annual application of heavy metal rich fertiliser (sludge); as such it is not representative of activity in a standard UK garden.
- 9.3.12 Lithos have also derived a value for zinc in relation to risks to human health, using the CLEA model, assuming a residential end use with consumption of home grown produce in a sandy loam soil with 6% SOM. The reported value is 2,170mg/kg, ten times greater than the potential phytotoxic concentration.

¹ Defra – Protecting our Water, Soil & Air – A Code of Good Agricultural Practice for farmers, growers and land managers. 2009

- 9.3.13 On balance, given the context of a residential development and the relatively low concentrations recorded, the single elevated concentration of 350mg/kg of zinc in TP204 0.1m is not considered significant and no special remedial measures are considered necessary.

Calorific value

- 9.3.14 The calorific value of 4 samples of coal, have yielded a range of CVs between 4.5 MJ/kg and 28.3 MJ/kg (average 17.2 MJ/kg). Materials whose CVs exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn.

Asbestos

- 9.3.15 No asbestos fibres were identified in any of the 6 samples screened.

Organic determinands

- 9.3.16 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).
- 9.3.17 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.
- 9.3.18 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.
- 9.3.19 In order to check the validity of Lithos' Tier 1 Soil Screening Values, the average TOC for each common fill type (beyond any areas of obvious hydrocarbon impact) have been determined.

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Topsoil	4.7%	No

Polycyclic Aromatic Hydrocarbons (PAH)

- 9.3.20 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.
- 9.3.21 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).
- 9.3.22 Speciated analysis has confirmed the absence of significant concentrations of both benzo(a)pyrene and naphthalene in the soils beneath this site.

10 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

10.1 Topsoil

- 10.1 Topsoil, typically 300mm thick underlies the entire site. Testing suggests this material is chemically suitable for re-use.
- 10.2 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.

10.2 Revised conceptual ground model (contamination)

- 10.2.1 No plausible contaminant linkages have been identified.
- 10.2.2 The Preliminary Conceptual Site Model has been amended in light of data obtained during the ground investigation. A revised Conceptual Site Model is presented as Drawing 2222/W/7 in Appendix B.

10.3 Waste classification

- 10.3.1 Some excess arisings may be generated by excavations for foundations, sewers etc.
- 10.3.2 Classification of soils as inert, non-hazardous or hazardous should be undertaken in accordance with the Environment Agency's Technical Guidance WM3², and is quite a complex process. However, all soil arisings generated by excavations at this site are likely to be classified inert.
- 10.3.3 Off-site disposal to landfill is not recommended. In accordance with the CL:AIRE Code of Practice³ 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.

11 HAZARDOUS GAS

11.1 General

- 11.1.1 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
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	Moderate: no significant thickness of low permeability drift or bedrock above workings
	Buildings	Explosion		
Off-site opencast	Human health	Asphyxiation & explosion	lateral migration, ingress & accumulation	Low: Backfill likely to be essentially inert, re-worked natural deposits
	Buildings	Explosion		

- 11.1.2 Given the above gas monitoring wells have been installed in 6 boreholes across the site. Details of the installations are given on the probehole logs presented in Appendix G to this the report.

² Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015

³ The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

11.1.3 CoDa originally carried out gas monitoring as part of their investigation in 2014. Review of the CoDa report suggests:

- Wells were installed in CoDa boreholes R1 to R3.
- 6 gas monitoring visits were undertaken between the 28th October 2014 and 3rd March 2014.
- No 'raw' data (i.e. gas monitoring record sheets) are included within the appendices
- Significantly elevated methane (between 24.1% and 51.3%) was recorded on 4 of the 6 visits within R1, along with an elevated result of 5% on visit 2.
- Positive flow readings were recorded in R1 in 3 of the 6 visits, including 2 visits where flows reached 33.9l/hr and 73.0l/Hr.
- A gas sample was collected from R1 by CoDa which yielded results of 4,758 ppm ethane, 31%v/v methane and 2.4% carbon dioxide.
- CoDa requested that British Gas inspect one of their mains which lies on Lidgett Lane, within the vicinity of R1 (although a distance is not given by CoDa). The findings of this inspection are unknown.

11.1.4 CoDa's borehole R1 was clearly of concern, and it seems that CoDa thought a ruptured gas main was the likely source of the high methane, although this is not known for certain.

11.1.5 Installation details for the monitoring well within R1 are not available as the first sheet of the log for BH R1 is missing from the CoDa report.

11.1.6 Given the above, the lack of reliability that can be placed on the CoDa data (as discussed in Section 5), and following discussions with the Local Authority, it was deemed appropriate for Lithos to reassess the gas regime at the site by carrying out a 'new' gas monitoring programme and assessment.

11.2 Scope of works

11.2.1 The generation potential of the gas source was initially considered to be Moderate, but this was revised to Low in light of the initial monitoring results obtained. Consequently, in accordance with CIRIA Report C665, given the proposed residential end use, 6 visits have been completed over a 3 month period, between 8th October 2015 and 14th January 2016.

11.2.2 A standard procedure was followed in accordance with CIRIA guidance; this procedure involved measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration on site immediately prior to and on completion of monitoring
- Methane, oxygen and carbon dioxide concentrations and flow rates using a Gas Data GFM430 infra-red gas analyser
- Standing water level using a dipmeter

11.3 Gas monitoring results

11.3.1 The monitoring results are enclosed and summarised below:

Well	Response zone	Range of methane concentrations (% v/v)	Range of carbon dioxide concentrations (% v/v)	Range of steady flow rates (litre/hour)
PH101	1.3m – 4.5m (Mudstone & Sandstone)	None detected	0.4 – 2.7	0.0 – 0.1
PH102			0.5 – 2.2	0.0 – 0.1
PH103			0.8 – 2.7	0.0 – 0.1
PH104	1.3m – 4.5m (Mudstone, Sandstone & Coal)		0.1 – 4.3	0.0 – 0.6
PH105	1.3m – 4.5m (Mudstone & Sandstone)		0.8 – 4.1	0.0 – 0.1
PH106			1.5 – 3.5	0.0 – 3.0

Note: Atmospheric pressures varied between 987.4mb and 1024.3mb.

- 11.3.2 In accordance with the DETR approach, a default value of 0.1 litres/hour has been used in the absence of any recorded flows; i.e. the limit of detection of the flow rate equipment.
- 11.3.3 During 1 of the 6 monitoring visits, atmospheric pressure was falling, and during 1 of the 6 visits the pressure was below 1000mb. Plots of atmospheric pressure versus time, with the monitoring visits indicated, are included within Appendix J.

11.4 Current guidance

- 11.4.1 Generic Notes (01 Site Characterisation) outlining how monitoring results are interpreted are enclosed.

11.5 Current gas regime

- 11.5.1 The proposed development comprises low rise residential housing. Consequently, the gas regime has been characterised in accordance with the Situation B (traffic light) methodology outlined in CIRIA Report C665.
- 11.5.2 Based on worst-case (peak) gas concentrations and steady flows, Gas Screening Values (GSVs) for methane and carbon dioxide are 0.00 and 0.13 respectively. These GSVs equate to a Green gas regime (traffic light) for this site.
- 11.5.3 Where Green, Lithos also consider the site in accordance with Situation A methodology (which does not assume a ventilated sub-floor) to check whether or not it lies within Characteristic Situation 1 (in which case no measures would be appropriate), or Characteristic Situation 2 (in which case a ventilated sub-floor void and membrane should be required). The carbon dioxide GSV of 0.13 classes as Characteristic Situation 2. In addition, depleted oxygen concentrations (less than 16%, minimum of 3.7%) have been recorded in multiple wells during all of the 6 visits.
- 11.5.4 Given the above results, it appears unlikely that the high methane recorded by CoDa was ground gas. Therefore, Barratt should make enquiries with National Grid regarding the status of the apparatus in the local area and any knowledge of recent damages and repair works.

11.6 Scope of protection measures

- 11.6.1 Based on the site characterisation (Traffic Light) discussed above, the proposed foundation solution, and with reference to the gas protection "scoring" system outlined in BS 8485:2015, Lithos consider that the following protective measures should be incorporated in all new dwellings:

Traffic light classification and "score" req'd by BS8485#	Floor slab (BS8485 "score")	Protective measures	
		Sub-floor ventilation (BS8485 "score")	Membrane
			Type (BS8485 "score")
Green & CS2 (Wilson & Card) 2.5*	<i>Select one from:</i> i. Block & Beam – (0) . ii. Reinforced ground bearing slab – (0.5) . iii. Reinforced, cast in-situ suspended slab (with minimal and suitably sealed service penetrations & joints) – (1.5) . iv. Reinforced ground bearing raft (with limited service penetrations cast into slab). Note: the venting area through any downstand beam should be 3 times greater than that provided by the side ventilation (air bricks) – (1.5) .	<i>Select one from:</i> Passive sub-floor ventilation; venting layer could be: i. A min. 150mm clear void (2.5) , or ii. A proprietary void former providing an equivalent clear void depth of 60mm; see Section B7 in BS8485:2015 (2.5) , or iii. Min. 300mm thick blanket of min. 20mm single size gravel (1.0) . Min. ventilation = 1,500 mm ² /m run of external wall (via air bricks on each of 2 opposite sides), with 100mm pipes at 1.75m centres or honeycombing of any sub-floor sleeper walls.	Waterproof DPM (2000 gauge polyethylene). Lapped & sealed in accordance with BR 414. (0)

Footnotes:

#Scores are broadly based on those outlined in BS8485:2015 (for Characteristic Situations 2 & 3, and Building Type A).

*Modified from BS8485:2015 by Lithos. Monitoring data has also been reviewed using Wilson & Card methodology and found to be Characteristic Situation 2; consequently a lapped/sealed membrane & ventilation are recommended.

1. A combination of two or more of the three types of protection measures (slab, ventilation & membrane) should be used to achieve the BS8485 score.

2. The membrane should always be lapped and sealed in accordance with BRE\Environment Agency Report BR 414 (2001) – "Protective Measures for housing on gas-contaminated land". The membrane should be **continuous** across internal walls & the cavity, and there should be a **cavity tray** in external walls.

3. In all cases there should be minimum penetration of floor slab by **services**; any penetrations should be suitably sealed.

4. Integral **garages** with occupied rooms above, or direct access through a doorway from the garage to the house, should be provided with the same protective measures as the rest of the dwelling. Buildings with basement car parks (with ventilation in accordance with Building Regulations) may not require gas resistant membranes.

- 11.6.2 BRE\Environment Agency Report BR 414 (2001) – "Protective Measures for housing on gas-contaminated land" provides a practical guide to good practice for the detailing and construction of passive soil gas protection measures for new residential development. Of particular relevance are a list of 'Watchpoints', which offer practical information for installation and buildability.

11.7 Radon

- 11.7.1 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%).
- 11.7.2 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.
- 11.7.3 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.

12 GEOTECHNICAL TESTING

12.1 General

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

12.1.2 The geotechnical laboratory test results are presented in Appendix I to this report.

12.2 Atterberg limits

12.2.1 The plasticity indices of 8 samples of cohesive soil have been determined; results are summarised below.

Soil type	No. samples tested	Moisture content range (average)	Range of Plasticity Indices* (average)	Shrinkability
Cohesive Residual Soil	8	18-29 (22)	18-38 (26)	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.

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

12.3 Soluble sulphate and pH

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

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

12.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 15 samples were determined.

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

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Cohesive Residual Soil	6	6.4	38
Granular Residual Soil	5	6.3	17
Coal	4	5.5	50

12.3.5 pH values were all 5.5 or above, therefore concentrations of chloride and nitrate are considered insignificant.

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

12.4 Compaction tests

- 12.4.1 Laboratory compaction tests are useful wherever ground improvement is anticipated, for example to provide a satisfactory CBR beneath proposed highways.
- 12.4.2 In accordance with BS5930:2015 engineered fill is defined as material which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.
- 12.4.3 Grading and moisture content control the degree to which materials can be effectively compacted. If the grading or moisture content of an in-situ material is not suitable to facilitate its compaction then screening, wetting, or lime addition may be required.
- 12.4.4 Laboratory compaction testing was scheduled on 4 samples of residual soil (using a 2.5kg rammer) to determine their suitability for re-engineering.
- 12.4.5 Laboratory compaction tests are only appropriate if:
- At least 90% of the material passes the 37.5mm sieve; and/or
 - At least 70% of the material passes the 20mm sieve
- 12.4.6 It is apparent from the gradings tabulated below, that the samples scheduled for compaction tests are suitable (i.e. at least 70% of the material is finer than 20mm).
- 12.4.7 The material particle density (G_s) is required in order to plot the 0, 5 and 10% air voids lines on the compaction graph for each material type.
- 12.4.8 The results are summarised in the Tables below:

Sample location & depth	Material description	% passing 37.5mm sieve	% passing 20mm sieve
TP210, 0.7m	Cohesive Residual Soil (Slightly gravelly clay)	100	100
TP211, 1.1m	Cohesive Residual Soil (gravelly clay)	96	96
TP212, 2.0m	Granular Residual Soil (clayey sandy gravel)	100	100
TP213, 2.4m	Granular Residual Soil (clayey sandy gravel)	100	100

Sample location & depth	Material description	G_s (Mg/m ³)	MDD (Mg/m ³)	OMC (%)	Allowable mc range for 95% MDD & <5% air voids	Typical in-situ moisture content (%)
TP210, 0.7m	Cohesive Residual Soil (Slightly gravelly clay)	2.75	1.69	21	20.0 – 26.0	23*
TP211, 1.1m	Cohesive Residual Soil (gravelly clay)	2.75	1.92	14	13.1 – 17.8	23*
TP212, 2.0m	Granular Residual Soil (clayey sandy gravel)	2.75	1.90	15	13.7 – 18.4	17
TP213, 2.4m	Granular Residual Soil (clayey sandy gravel)	2.75	1.95	12	12.4 – 16.6	17

* Takes into account results presented in Section 12.2

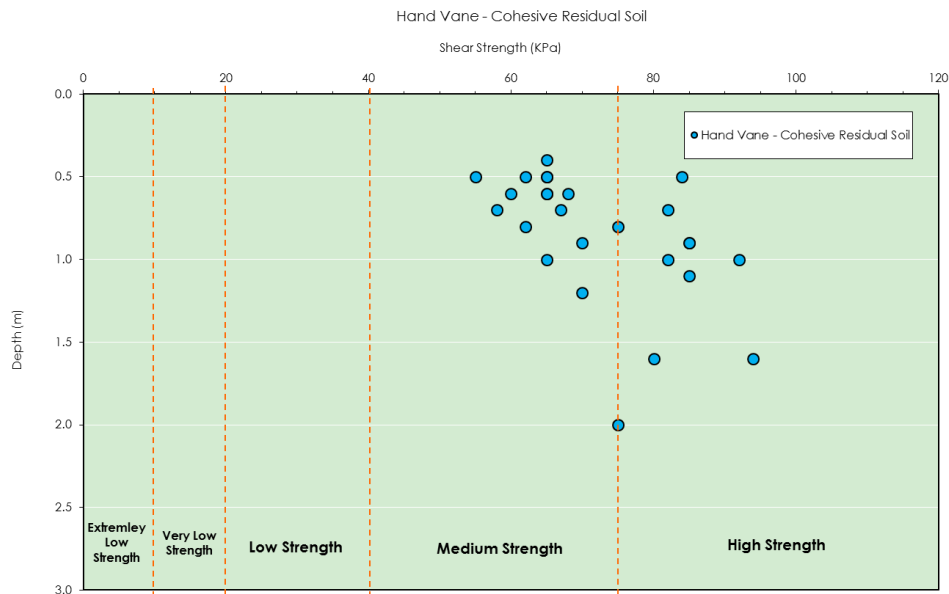
- 12.4.9 The average in-situ moisture content of the natural soil is typically slightly too wet to achieve 95% MDD. Therefore, the Cohesive and Granular Residual Soils are likely to require some drying out before they can be utilised for engineered fill.

- 12.4.10 Drying out of these soils will require careful management on site. They should be placed in sealed stockpiles during periods of wet weather, or while the site is unattended. During periods of favourable weather (ideally warm & windy) the soils should be spread in thin layers over as wide an area as possible and aerated by turning with an excavator. Alternatively, consideration could be given to lime stabilisation
- 12.4.11 Acceptability of the natural soils for use in the proposed controlled earthworks will need detailed appraisal by the Earthworks Designer in light of the required performance characteristics.

12.5 Undrained shear strength testing

Hand shear vane testing

- 12.5.1 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.
- 12.5.2 The results are summarised within the plot below and illustrate a broad 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 60kPa (medium strength).



13 GEOTECHNICAL ISSUES

13.1 Conceptual site model

- 13.1.1 The site is underlain by Cohesive Residual Soils (firm to stiff gravelly clay) to c.1.6m with Granular Residual Soil encountered across the majority of the site to c.2.0m. Bedrock was encountered between 1.4m and 2.8m depth (typically 2.0m) and comprises sandstone in the north with siltstone and mudstone in the centre and south.
- 13.1.2 The Flockton Thick Coal (c. 1.5m thick) seam underlies the majority of the site and outcrops in the far south.

13.2 Mining & quarrying

- 13.2.1 This site is located within a Coal Mining Development High Risk Area.
- 13.2.2 There are no known quarries on, or within 50m of the site.
- 13.2.3 Lithos' mining investigation has found the presence of shallow coal (Flockton Thick seam) underlying the majority of the site, outcropping in the south trending roughly east to west.
- 13.2.4 No evidence of any workings was encountered within the Flockton Thick seam, nor the Tankersley Ironstone.
- 13.2.5 Abandonment plans suggest the Flockton Thin, Fenton and Parkgate seams lie at around 28m, 50m, and 70m respectively.
- 13.2.6 Given the information contained on CA abandonment plans, the number of probeholes drilled, and the absence of any evidence of voids or broken ground, it is considered unlikely that the site is underlain by mineworkings at shallow enough depth to pose a risk of subsidence at surface.
- 13.2.7 Whilst evidence of underground mineworkings has not been encountered, there is a slight possibility of localised bell pits being present, perhaps due to 'exploratory' working of the Flockton Thick and/or Tankersley Ironstone seams, although no evidence of their existence has been encountered to date. Consideration should be given to a geophysical survey, although success would be dependent on the "contrast" between shaft backfill and the surrounding ground (i.e. the survey is likely to be more successful if shaft backfill is significantly different material or less dense than the surrounding ground). Follow-up intrusive investigation (pitting) would be recommended to determine the cause of any anomalies identified by the geophysics.
- 13.2.8 Given the absence of loose superficial deposits, if bell pits are present, it is considered unlikely that such mine entries would have been lined.
- 13.2.9 Whilst the Coal Authority (and NHBC) discourage development over or adjacent to shafts, such features are typically of less concern where they only extend to relatively shallow seams. Consequently, any unrecorded bell pits would not be expected to result in the need for "no-build" zones, but any found will require grouting, and any plots built over or adjacent to mine entries will require appropriate foundation design.

13.3 Site regrade and/or ground improvement

- 13.3.1 Given existing topography (much of the site is sloping, with gradients of up to 1 in 4 in the far west), some site regrade is anticipated, with the need for underbuild and retaining walls.
- 13.3.2 Careful consideration will need to be given to earthworks design, and implications for slope stability, retaining walls, foundations, highway gradients and drainage.
- 13.3.3 Consideration will also need to be given to the presence of coal (Flockton Thick) which outcrops in the south. Shallow coal beneath the footprints of plots will have an impact on both foundation depths (see Section 13.4) and soil cover in garden areas (see Section 14.7). Where possible, final site levels should be designed in order to minimise the impact that the Flockton Thick seam will have on these two issues.
- 13.3.4 Any digital terrain modelling undertaken or commissioned by BDW should consider implications for the foundation recommendations outlined below.
- 13.3.5 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.
- 13.3.6 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 10.3 should apply.

13.4 Foundation recommendations

General

- 13.4.1 Foundation recommendations assume that development will be two or three storey construction and that line loads will not exceed 90kN/m run. If this is not the case significant alteration to these recommendations will be required.
- 13.4.2 Although some site regrading is anticipated, final levels are not yet known. Therefore, at this stage, we have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation. Any digital terrain modelling undertaken, or commissioned by, BDW should consider implications for the foundation recommendations outlined below.
- 13.4.3 Sub-surface concrete in contact with the natural ground should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.

Strip/trench fill footings

- 13.4.4 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for the majority of two or three storey houses constructed at the site. Footings will be founded in firm clay, granular soils or competent rock.
- 13.4.5 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.
- 13.4.6 Foundations will be required to be placed below a line drawn up at 45° from the base of any service or similar excavation.
- 13.4.7 Overdeepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.

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

- 13.4.10 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.
- 13.4.11 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.
- 13.4.12 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 50% of the site may be affected by trees.
- 13.4.13 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.
- 13.4.14 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, foundations being deeper than 2.5m.
- 13.4.15 It would therefore be prudent to prepare a detailed foundation schedule and seek approval from NHBC in order to determine likely foundation abnormalities.
- 13.4.16 A safe bearing capacity of at least 150kPa 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
 - An undrained shear strength of 60kPa for the firm clay (typical minimum recorded on site)
- 13.4.17 Assuming the foundation geometry detailed above, settlements of less than 25mm would be anticipated. This is considered likely to be acceptable. However, further advice should be sought from the Structural Engineer responsible for foundation design.

Residual soils (completely weathered bedrock)

- 13.4.18 As a possible result of the site re-grade, or where over-deepened due to tree influence, foundation excavation will encounter granular residual soils at, or before, the minimum foundation depth required within the clay.
- 13.4.19 The weathered in-situ sandstone, siltstone and mudstone (sand, gravel and cobbles) are assumed to have a relative density of at least medium dense (in accordance with BS5930:2015).
- 13.4.20 A safe bearing capacity of at least 150kPa 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 0.6m
 - An angle of shearing resistance of $\phi=33^\circ$ for the granular deposits
- 13.4.21 Assuming the foundation geometry detailed above, settlements of less than 25mm would be anticipated. This is considered likely to be acceptable. However, further advice should be sought from the Structural Engineer responsible for foundation design.
- 13.4.22 In accordance with NHBC Standards, a minimum founding depth of 450mm (due to potential frost susceptibility) is required in granular soils. This depth should be taken from finished ground level to the underside of the footing. If finished ground level is to be above existing ground level then the foundation excavation simply needs to ensure that there is sufficient depth of excavation to allow casting of the footing entirely within natural ground (not made ground or topsoil).
- 13.4.23 However, if the excavation is dug from original ground level in cold conditions when freezing is expected, then foundation depth should be taken from the existing, not finished, ground level.
- 13.4.24 It should be noted that founding at shallow depth (450mm), whilst desirable from an excavation stability viewpoint, may not provide sufficient bearing capacity due to the lesser depth of (resisting) overburden. Consequently, a minimum founding depth of 600mm is recommended.
- 13.4.25 Where ground level is being raised, it would be prudent to proof roll the exposed granular soils after stripping topsoil (to mitigate any near-surface disturbance), and ideally fill should be placed prior to construction (otherwise the Developer will need to consider the potential for movement associated with placement of the fill).
- 13.4.26 It should also be noted that the footing may require deepening or stepping in order to allow plot drainage to exit the plot footprint (either over or under the footing).

Bedrock

- 13.4.27 Bedrock may be encountered at founding depth within over-deepened foundations (i.e. due to tree influence) and/or as a result of regrading.
- 13.4.28 The bedrock is generally considered to have a safe bearing capacity of at least 300kPa and minimal settlements would be anticipated.
- 13.4.29 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.

- 13.4.30 Bedrock in the centre and south of 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

- 13.4.31 Some excavations for foundations in far south 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.
- 13.4.32 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. This could, result in some significantly over-deepened foundations (>3m), depending on final site levels. 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).
- 13.4.33 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.
- 13.4.34 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).
- 13.4.35 It should be noted that any coal requiring disposal will fall under mining waste directive (i.e. cannot go to landfill. Instead, it will need to be sent to facility permitted to accept mining waste. This will avoid coal being inadvertently being classified as hazardous waste due to its high TOC, thus reducing disposal costs.

Geological fault

- 13.4.36 Drawing 2222/W/2 shows the approximate line of two faults superimposed on the proposed housing layout; the faults cross the northeast and northwest corners of the site.
- 13.4.37 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 residual soils; they can only be seen where long trenches are excavated into bedrock.
- 13.4.38 At this site, no movement associated with past, 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.
- 13.4.39 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; i.e. Plots 1 to 25, 43 to 49 and 71 to 76.
- 13.4.40 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.

Piled foundations

- 13.4.41 In the far south the Flockton Thick Coal is present at shallow depth with a maximum thickness of 1.8m. Depending on final levels and proposed earthworks this may result in foundation excavations of >3m. As an alternative to engineer-designed trench-fill foundations, piles could be a viable option. However, given the relatively small number of plots likely to be affected, they are unlikely to be the most economical option.

13.5 Floor slabs

- 13.5.1 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).
- 13.5.2 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.
- 13.5.3 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. 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.
- 13.5.4 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.
- 13.5.5 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.
- 13.5.6 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.
- 13.5.7 In the event that coal is 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.

13.6 Designated concrete mixes

- 13.6.1 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.
- 13.6.2 Consequently, BDW should seek advice from their appointed Structural Engineer.

13.7 Excavations

- 13.7.1 Groundwater should be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".
- 13.7.2 Based on the results of the investigation it is considered unlikely that major groundwater flows will be encountered in shallow excavations.
- 13.7.3 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.
- 13.7.4 Bedrock was encountered in the majority exploratory holes. Based on the exploratory hole logs, excavation greater than 2.5m is likely to prove difficult across the site (possibly shallower in the north where sandstone is encountered). 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.
- 13.7.5 Some excavations in far south 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.

13.8 Drainage

- 13.8.1 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.
- 13.8.2 Given existing topography it is considered possible that springs will appear down-gradient which may preclude the use of soakaways as a means of surface water disposal.
- 13.8.3 Whilst the site may not lend itself to the adoption of discrete soakaways, ground should have the capacity to absorb surface water run-off, and systems which spread infiltration over a wider area (e.g. an infiltration basin, swales and/or pervious paving) may provide the best solution.
- 13.8.4 Alternative SUDS options (see CIRIA C753:2015 for further details) include:
 - Swales – linear grassed features in which surface water can be stored or conveyed. Where suitable, swales can be designed to allow infiltration.
 - Infiltration basins – vegetated depressions designed to store runoff and infiltrate it gradually into the ground.
 - 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.
- 13.8.5 Yorkshire Water have published a guide⁴ for developers and designers outlining their design requirements for surface water attenuation assets.

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

- 13.8.6 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.
- 13.8.7 The guide also discusses required access to flow control chambers, large diameter (i.e. >900mm) surface water storage pipes, and surface water storage tanks.
- 13.8.8 Land drains were encountered within the site investigation trial pits. Provision of surface drainage infrastructure will negate the need for field drainage. However, field drainage encountered during construction of the infrastructure works, should where practicable and where the layout allows, be maintained.
- 13.8.9 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.

13.9 Highways

- 13.9.1 This site is greenfield and the routes, formation level and total length, of proposed estate roads are unknown. Consequently, there was no merit in obtaining CBR values at this stage.
- 13.9.2 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 Cohesive Residual Soil would be expected to provide a CBR value of at least 3%. This value should be verified prior to or during construction.
- 13.9.3 Whilst the CBRs estimated above should be achievable, significant deterioration during/after periods of significant rainfall and/or site trafficking is likely. Consequently, it would be prudent to consider flexibility in the groundworks programme to enable highway construction during prolonged dry/warm weather (typically between May and September) when formation will be least vulnerable to deterioration. Alternatively, a minimum 200mm thickness of suitable granular fill (ie a "blanket" of 6F2) could be placed along the line of proposed highways to protect formation during the construction phase.

13.10 External works

- 13.10.1 Any digital terrain modelling undertaken, or commissioned by BDW should be made available to their Engineering Designer prior to issue of an External Works Drawing.
- 13.10.2 Given the sloping nature of the site there is likely to be a need for underbuild and retaining walls.

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

14 REDEVELOPMENT ISSUES

14.1 General

- 14.1.1 This report has presented options with respect to foundation solutions, re-use of topsoil etc that are considered technically feasible and in line with current good practice. Consequently, we would expect to obtain regulatory approval for whichever option is adopted, although this cannot be guaranteed. Copies of this report should be forwarded to the relevant regulatory authorities (Warranty Provider & Local Authority) for their comment/approval.
- 14.1.2 If unanticipated ground is encountered during the site preparatory works, the Contractor should immediately seek further advice from the Engineer.

14.2 Control of excavation arisings

- 14.2.1 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; general construction waste etc.
- 14.2.2 Most importantly, any coal encountered within foundation excavations or during earthworks should be segregated from other material (i.e. residual soils, bedrock etc) and placed in a designated stockpile awaiting its fate. Mixing of coal with other material arisings could result in large quantities of soil being generated which are unsuitable for use on site, or another development site, and therefore abnormal disposal costs.
- 14.2.3 Whilst a Materials Management Plan is not required on this site, a similar protocol should be put in place for the groundworkers which specifies the importance of segregation of coal from other material types.
- 14.2.4 Further characterisation of stockpiled materials is likely to be required if off-site disposal is proposed.
- 14.2.5 Natural ground arisings (excluding coal) should be suitable for use as subsoil in the proposed soil cover.

14.3 Good practice guidance

- 14.3.1 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:
 - PPG6 - Working at construction and demolition sites
 - PPG2 - Above ground oil storage tank
 - PPG7 – The safe operation of refuelling facilities.
 - PPG21 – Incident Response Planning

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

14.4 New utilities

- 14.4.1 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.
- 14.4.2 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.
- 14.4.3 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.
- 14.4.4 Consequently, the use of 'standard' polyethylene water supply pipes should be acceptable, although BDW should consult Yorkshire Water at the earliest opportunity to confirm this.

14.5 Health & safety issues - construction workers

- 14.5.1 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.
- 14.5.2 Before site operations are started, the necessary COSHH statements and Health & Safety Plan should be drafted in accordance with the CDM regulations.

14.6 Coal extraction

- 14.6.1 The Flockton Thick Coal (c. 1.5m thick) underlies the site, at very shallow depths in the south (from 2.0m) becoming deeper to the north. This seam has been worked by opencast methods c. 80m east of the site, suggesting the coal is of reasonable quality.
- 14.6.2 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; which is the case across much of the site area.
- 14.6.3 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.
- 14.6.4 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.
- 14.6.5 However, in this case, there does not appear to be a need to treat any mineworkings and therefore if not extracted, there should not be a need for any expenditure associated with drilling and grouting.

14.6.6 Additional drawbacks associated with coal extraction at this site include:

- The creation of 'high-walls' around the margins of the extraction area, across much of the northern site boundary against Lidgett Lane. The batter associated with such high walls would significantly reduce the area available for coal extraction
- Coal close to outcrop was found to be weathered and consequently of poor quality (typically slightly clayey sandy gravel of coal), resulting in a further reduction of the true area available for extraction
- The time required to ensure significant settlement of the replaced overburden (anticipated residual settlement must be less than 25mm) is typically at least 12 to 18 months. NHBC generally require 12 months of monitoring before any new houses are built on deep, engineered fill. However, the actual delay to build programme might be longer, since it is impossible to predict the actual time required for ongoing creep settlements to fall to tolerable levels. Prediction is hampered by uncertainties associated with groundwater rebound and the nature of the excavated material with respect to suitability for compaction.
- Local environmental issues associated with noise and dust.
- Traffic movements associated with coal export, especially given that there is no need for traffic movement associated with the import of PFA etc which would be required if mineworkings were present and required grouting.
- Public perception issues. Any application to extract coal is likely to generate considerable anxiety amongst local residents.

14.6.7 Given all the above, it is considered unlikely that extraction of coal from this site prior to development would be economically viable.

14.7 Shallow coal in garden areas

14.7.1 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), it should either be removed, or covered with inert subsoil/topsoil so that it lies at greater than 1m depth.

14.7.2 Given seam dip and topography it seems likely that coal will only be present at such shallow depth beneath less than 10% of the area.

14.7.3 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.

14.7.4 As with foundation arisings, the developer will need to contact the Coal Authority to dig or carry away excavated (incidental) coal.

14.8 Potential development constraints

14.8.1 Some 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.

14.8.2 The underground telecom, water and sewer utilities 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.

- 14.8.3 Yorkshire Water may seek to restrict changes in site level if the depth of cover above their sewer were adversely affected by any development proposals. This aspect requires further clarification.
- 14.8.4 Significant regrading of the site is likely to be required in order to create development platforms. This could result in abnormal costs relating to foundations close to the Flockton Thick coal outcrop in the south.

15 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

15.1 General

- 15.1.1 The site is located off Pilley Green, approximately 6km south of Barnsley town centre, and comprises an overgrown grassed field (c. 2.4 hectares) sloping down to the southeast at a gradient of approximately 1 in 10 (locally up to 1 in 4). Hedgerows and (semi)mature trees are located on all boundaries.
- 15.1.2 It is understood that consideration is being given to redevelopment of the site with 75no. traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers.
- 15.1.3 The site is underlain by Cohesive Residual Soils (firm to stiff gravelly clay) to c. 1.6m depth with Granular Residual Soil encountered across the majority of the site to c. 2.0m depth. Bedrock was encountered between 1.4m and 2.8m depth (typically 2.0m) and comprises sandstone in the north with siltstone and mudstone in the centre and south.
- 15.1.4 The Flockton Thick Coal (c. 1.5m thick) seam underlies the majority of the site and outcrops in the far south.

15.2 Mining

- 15.2.1 This site is located within a Coal Mining Development High Risk Area and is underlain at shallow depth by the Flockton Thick coal seam (typically 1.5m thick) and the Tankersley Ironstone. No evidence of mineworkings has been encountered and therefore there should not be a need for treatment (i.e. drilling & grouting) prior to development.
- 15.2.2 However, given the shallow depth of the coal and the presence of the Tankersley Ironstone outcrop across the centre of the site, the possibility of localised bell pitting cannot be entirely discounted. Consideration should be given to a geophysical survey.
- 15.2.3 There are no known quarries on or within 50m of the site, although a former opencast, which extracted the Flockton Thick coal seam to depths of up to 16m, is present 80m to the east.

15.3 Hazardous gas

- 15.3.1 The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level.
- 15.3.2 The site is underlain by a shallow coal seam and therefore monitoring wells were installed in 6 probeholes which were subsequently monitored 6 times over a period of 3 months.
- 15.3.3 Based on the data obtained, the site can be classified as Green (NHBC) and Characteristic Situation 2 (Wilson & Card). Details of protection measures are given in Section 11.

15.4 Contamination & remediation

- 15.4.1 No made ground has been encountered at the site.
- 15.4.2 Topsoil (typically 300mm thick) underlies the site. Testing suggests this material is chemically suitable for re-use.
- 15.4.3 The Flockton Thick coal seam is considered potentially combustible and therefore will need to be beneath 1,000mm cover (topsoil/subsoil) in garden areas.

15.5 Foundations

- 15.5.1 The majority of plots will be founded on traditional strip/trench-fill footings at a minimum depth of 0.9m, overdeepened where necessary due to the influence of trees.
- 15.5.2 In the far south, depending on the final layout and levels, significantly deeper foundations (>3.0m) may be required due to the presence of the Flockton Thick coal at shallow depth.

15.6 Flooding

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

15.7 Drainage

- 15.7.1 Given the topography of the site, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off. Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

15.8 Highways

- 15.8.1 Based on visual inspection of the shallow natural materials and published guidance, the shallow cohesive soils 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 Bq m⁻³ and 100 Bq m⁻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 Bq m⁻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).

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

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

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

Current UK guidance

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

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

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

Soil screening values used by Lithos

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

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

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

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

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

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

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

- A - Residential with gardens, but no cover (or only up to 300mm)
- B - Residential with gardens and 600mm 'clean' cover
- C - Residential apartments with landscaping (i.e. no home grown produce)
- D - Commercial/industrial with landscaping
- E - Importation of soil cover

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

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

Lithos have assumed the source of contamination is directly below the building foundations; i.e. a depth 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

04 - Contamination analysis & interpretation (including WAC)

Generic notes – geoenvironmental investigations



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 ICRC 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 149ⁱ 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*.

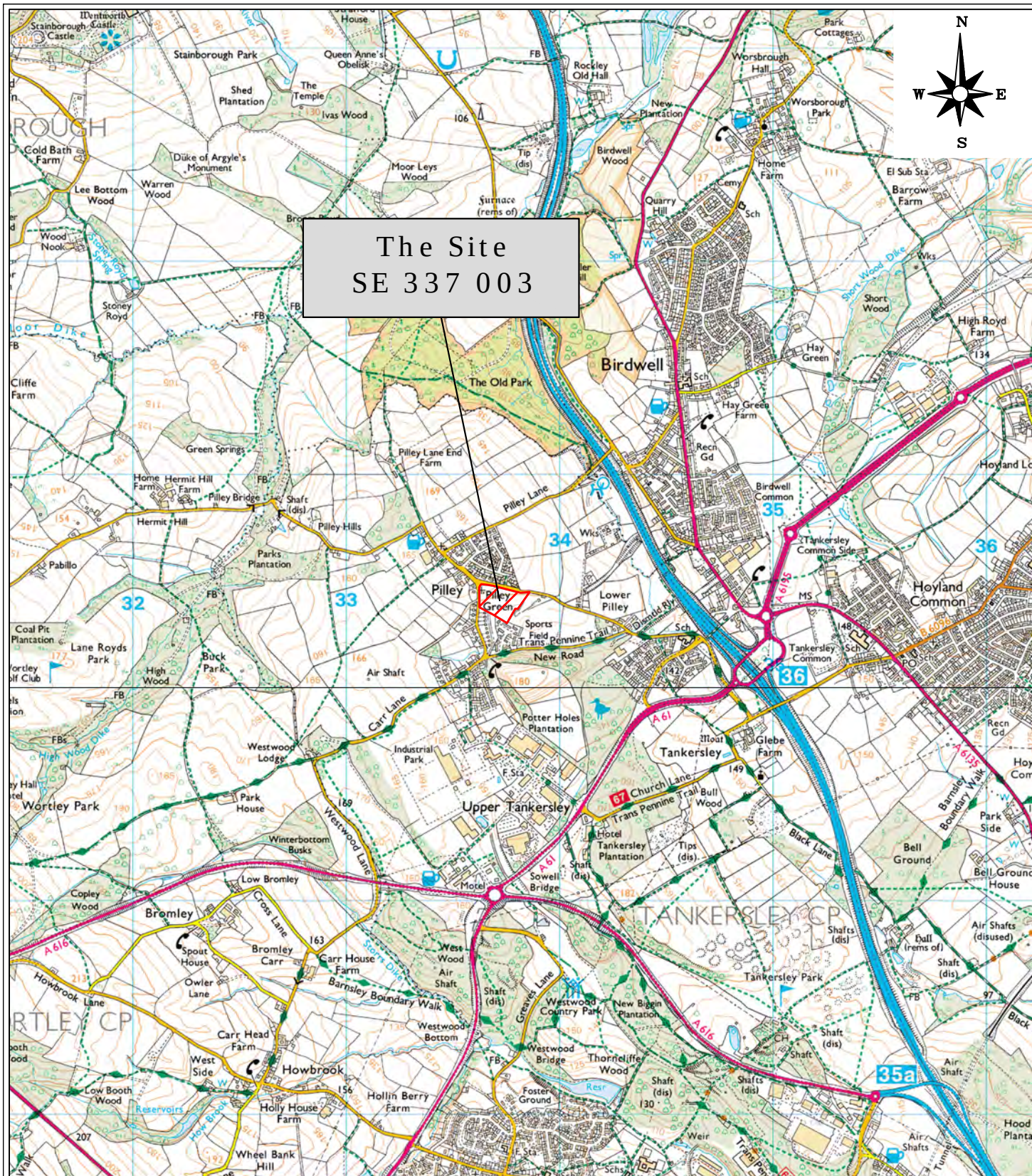
ⁱⁱⁱ Wilson SA and Card GB (February 1999). *Reliability and Risk in Gas Protection Design*. Ground Engineering.

^{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.

Appendix B

Drawings



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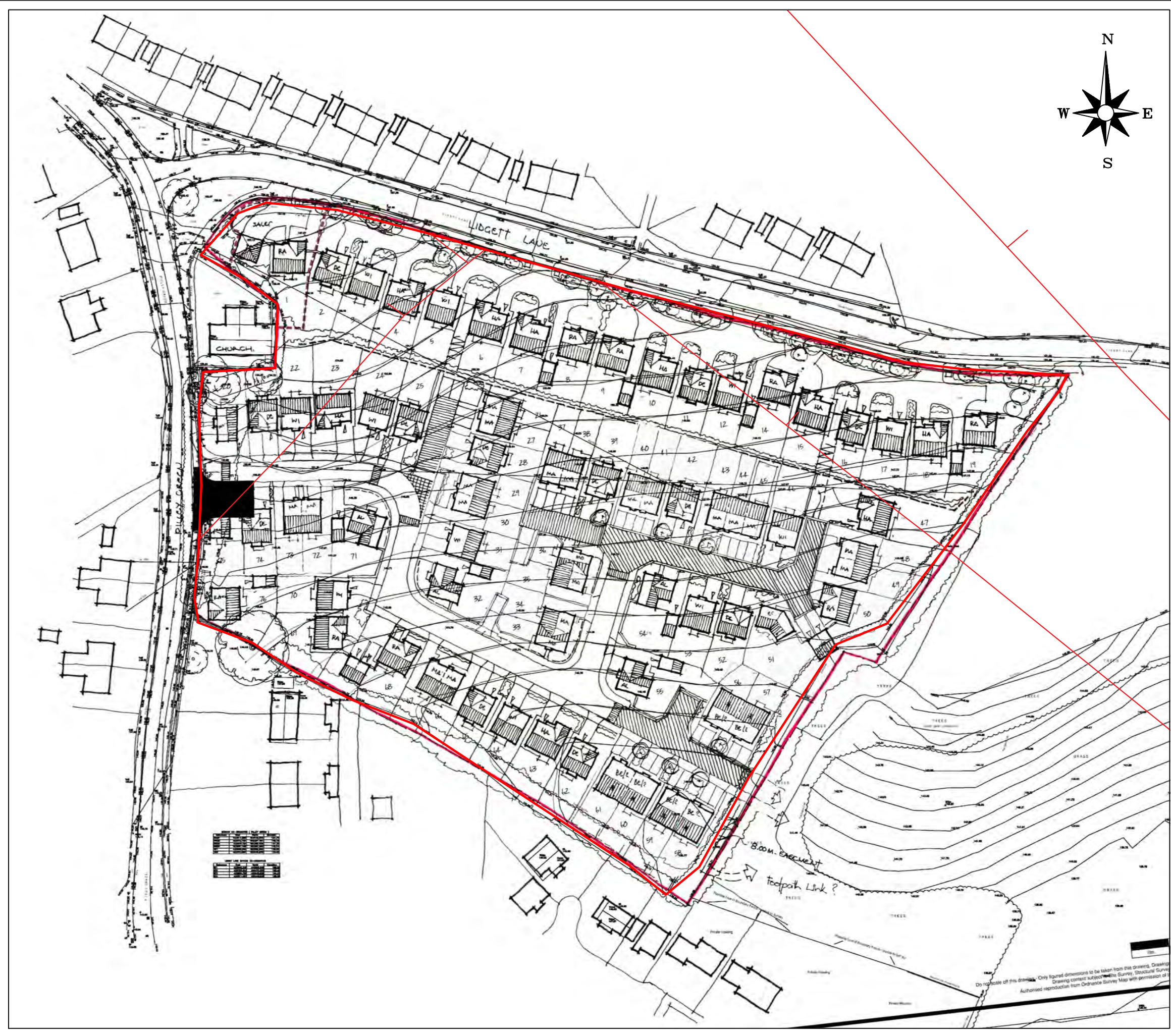
info@lithos.co.uk
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BARRATT & DAVID
WILSON HOMES
YORKSHIRE WEST

PILLEY, BARNSELY

SITE LOCATION
PLAN

DRAWN	LEW	DATE	21 03 18
CHECKED	MJT	DATE	21 03 18
STATUS	FOR COMMENT ☐	DRAFT	☐
	FOR APPROVAL ☐	FINAL	☒
SCALE	1:25,000	SHEET	A4
DRAWING NO.	2222/W/1	REVISION	



NOTES

— PUBLISHED FAULT

— APPROXIMATE SITE BOUNDARY

REPRODUCED FROM BDW DRAWING
REFERENCE 16 5016 SK07, DATE UNKNOWN

REV.	DESCRIPTION	DATE



info@lithos.co.uk
www.lithos.co.uk

Tel 01937 545330

CLIENT

**BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST**

JOB TITLE

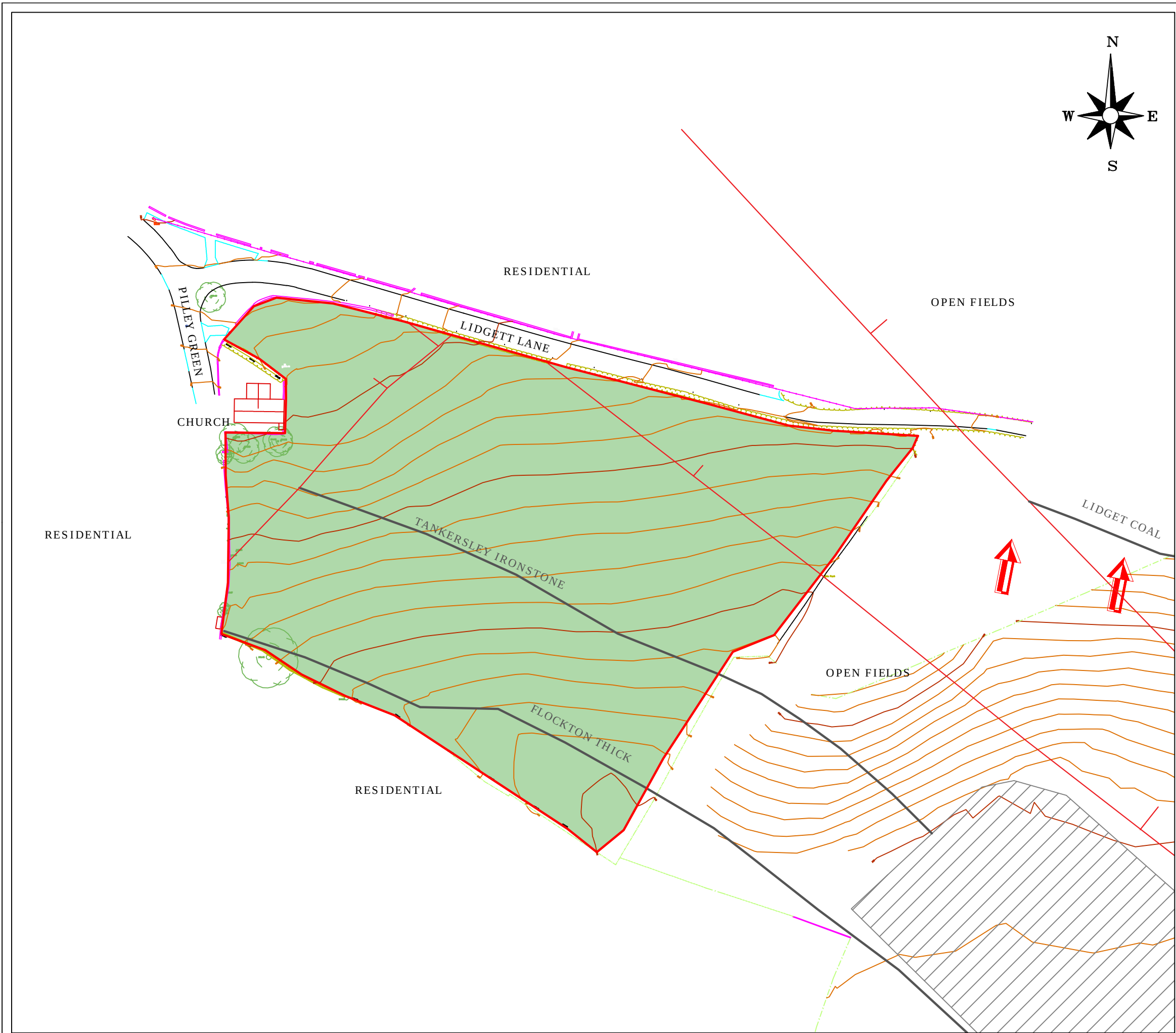
PILLEY, BARNSELY

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
LEW	21 03 18	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	21 03 18	DRAFT ☐
		FINAL ☒

SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	2222/W/2	



NOTES		
	APPROXIMATE SITE BOUNDARY	
	COAL OUTCROP	
	FAULT	
	FORMER OPENCAST	
	ADIT	
	GRASS & OVERGROWN AREAS	
REV.	DESCRIPTION	DATE

info@lithos.co.uk
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CLIENT

**BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST**

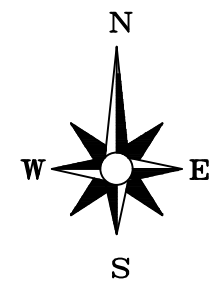
JOB TITLE

**PILLEY,
BARNSELY**

DRAWING TITLE

GEOLOGICAL & SITE FEATURES

DRAWN	DATE	STATUS	
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CHECKED	DATE	FOR APPROVAL	☐
MJT	21 03 18	DRAFT	☐
		FINAL	☒
SCALE	SHEET	DRAWING NO.	REVISION
1:1250	A3	2222/W/3	



NOTES

— APPROXIMATE SITE BOUNDARY

◀ LOCATION & ORIENTATION OF PHOTOGRAPH

REV.	DESCRIPTION	DATE



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CLIENT

**BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST**

JOB TITLE

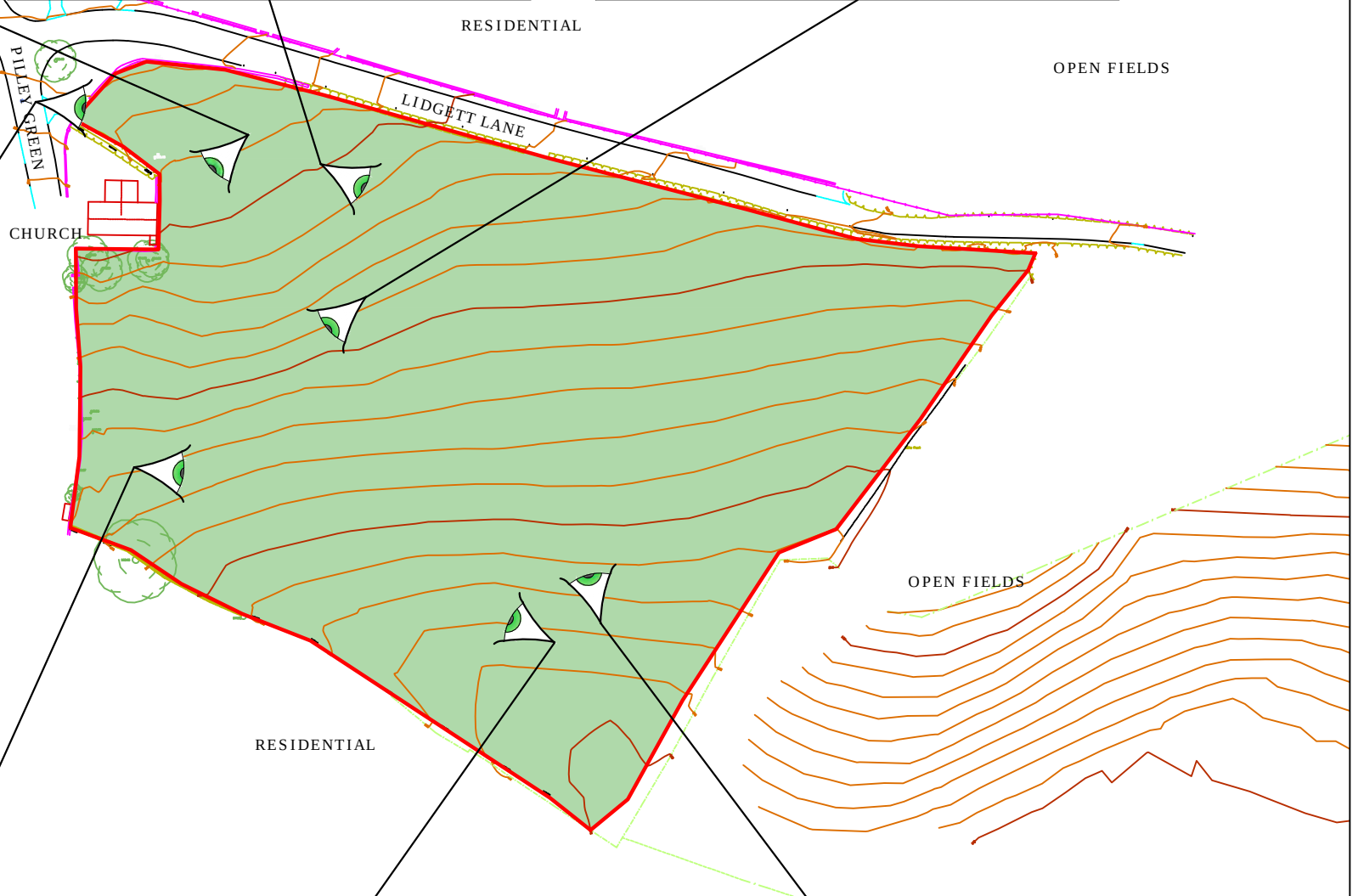
PILLEY, BARNSELEY

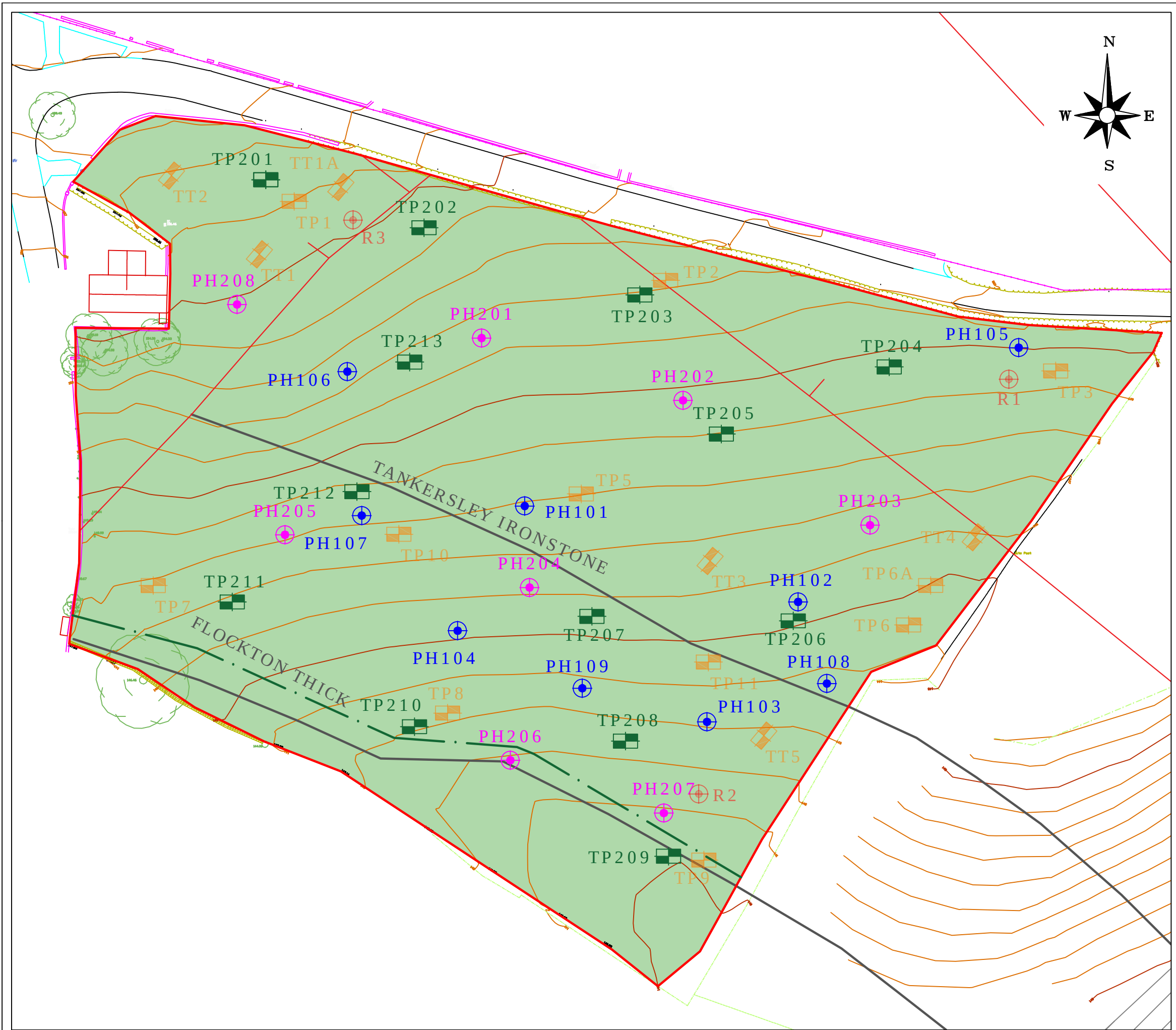
DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL
MJT	21 03 18	DRAFT
		FINAL

SCALE	SHEET	DRAWING NO.	REVISION
1:1500	A3	2222/W/4	





NOTES

- CODA PROBEHOLE (2014)
- LITHOS PROBEHOLE (2015)
- LITHOS PROBEHOLE (2018)
- CODA TRIAL PIT LOCATION (2014 & 2015)
- LITHOS TRIAL PIT LOCATION (2018)
- PUBLISHED OUTCROP
- INFERRED OUTCROP
- PUBLISHED FAULT
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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www.lithos.co.uk
Tel 01937 545330

CLIENT

**BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST**

JOB TITLE

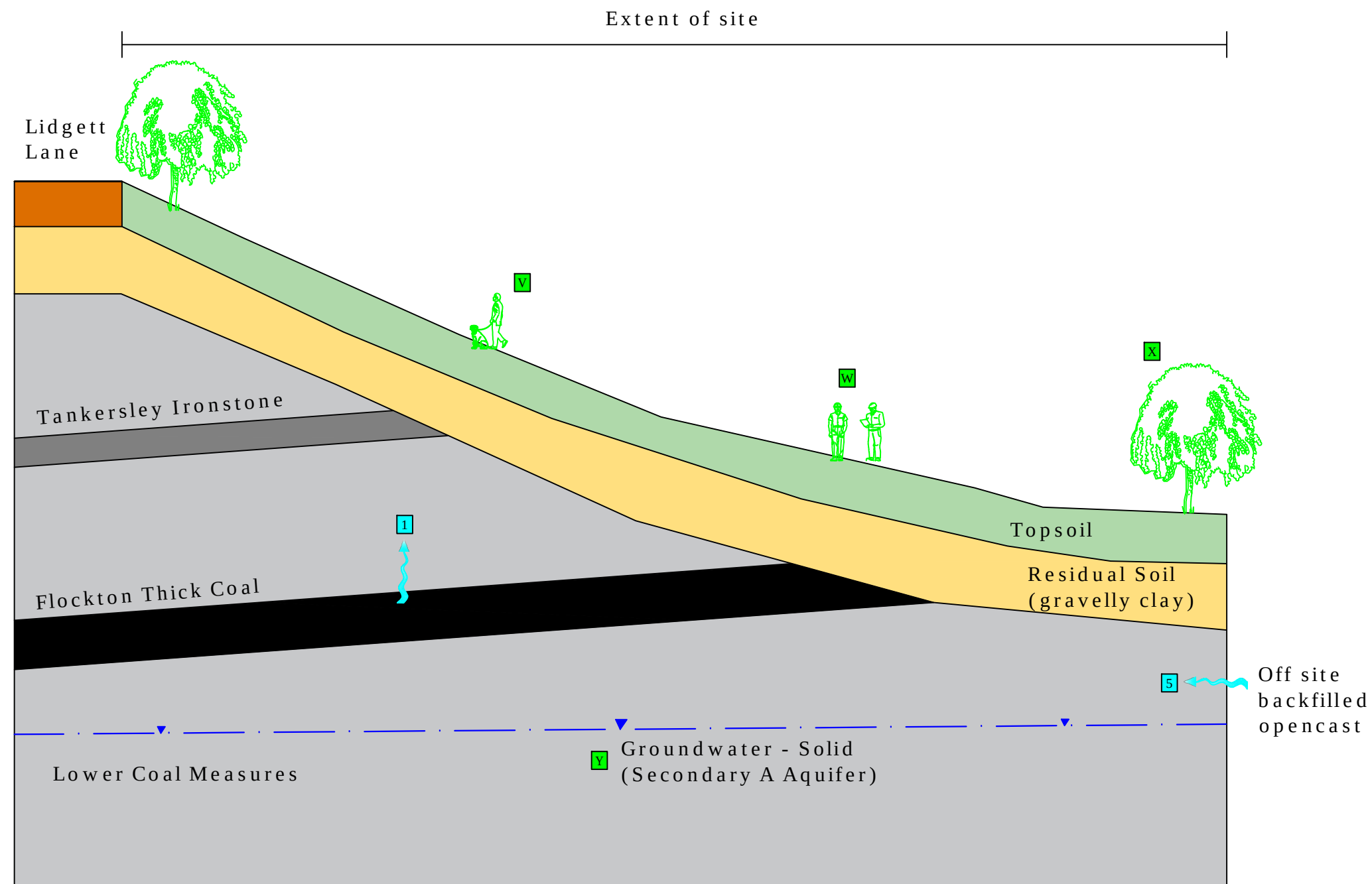
**PILLEY,
BARNSELEY**

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
LEW	17 04 18	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
		DRAFT ☒
		FINAL ☐

SCALE	SHEET	DRAWING NO.	REVISION
1:2,000	A3	2222/W/6	



SOURCES
NO SOURCES IDENTIFIED

PATHWAYS
1 MIGRATION OF GAS

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

NOTES		
REV.	DESCRIPTION	DATE



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www.lithos.co.uk
Tel 01937 545330

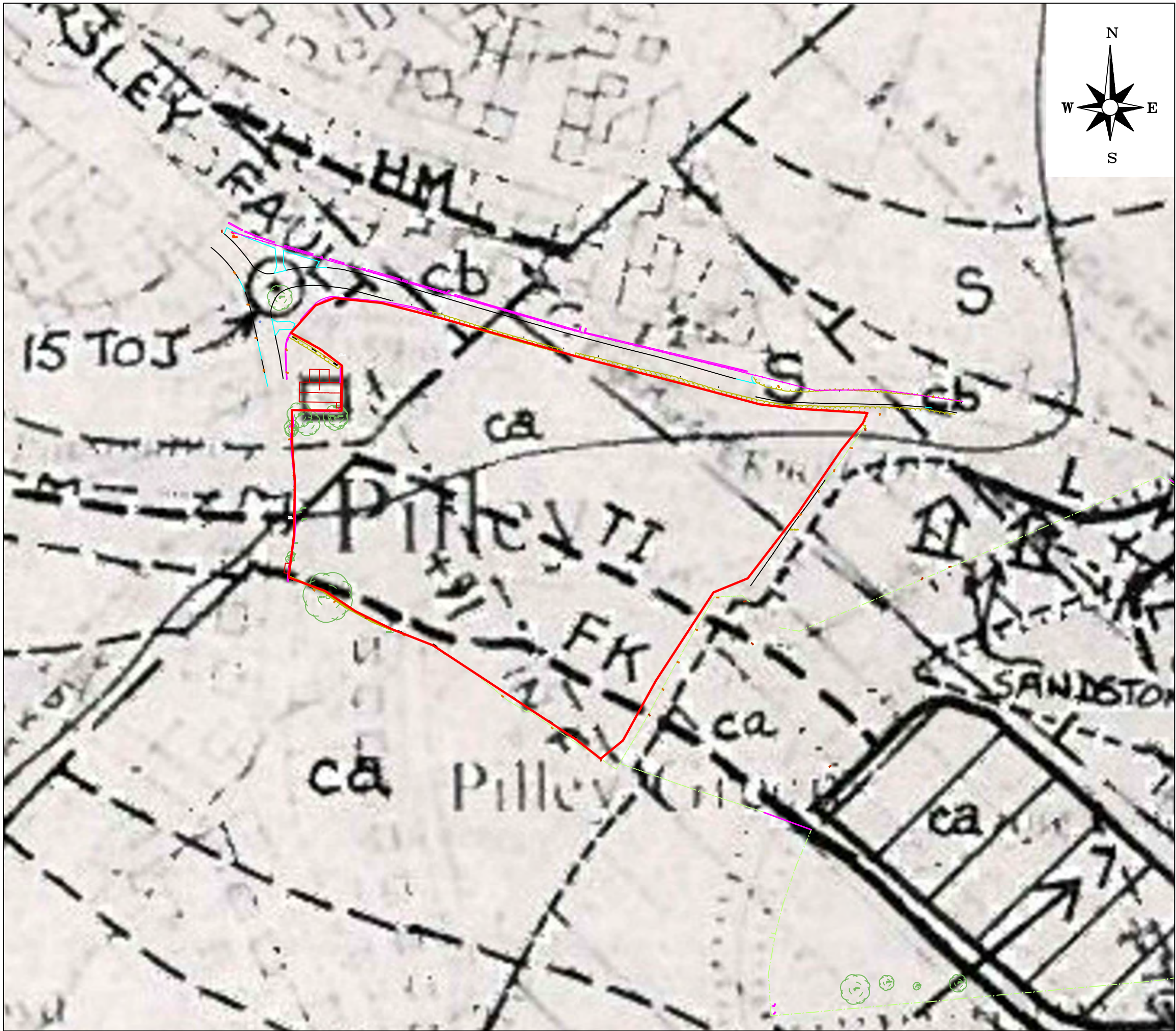
CLIENT
BARRATT & DAVID WILSON HOMES YORKSHIRE WEST

JOB TITLE
PILLEY, BARNSELEY

DRAWING TITLE
REVISED CONCEPTUAL SITE MODEL

DRAWN LEW	DATE 17 04 18	STATUS FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☒
CHECKED MJT	DATE 17 04 18	

SCALE Not to scale	SHEET A3	DRAWING NO. 2222/W/7	REVISION
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NOTES

— APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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www.lithos.co.uk
Tel 01937 545330

CLIENT

BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST

JOB TITLE

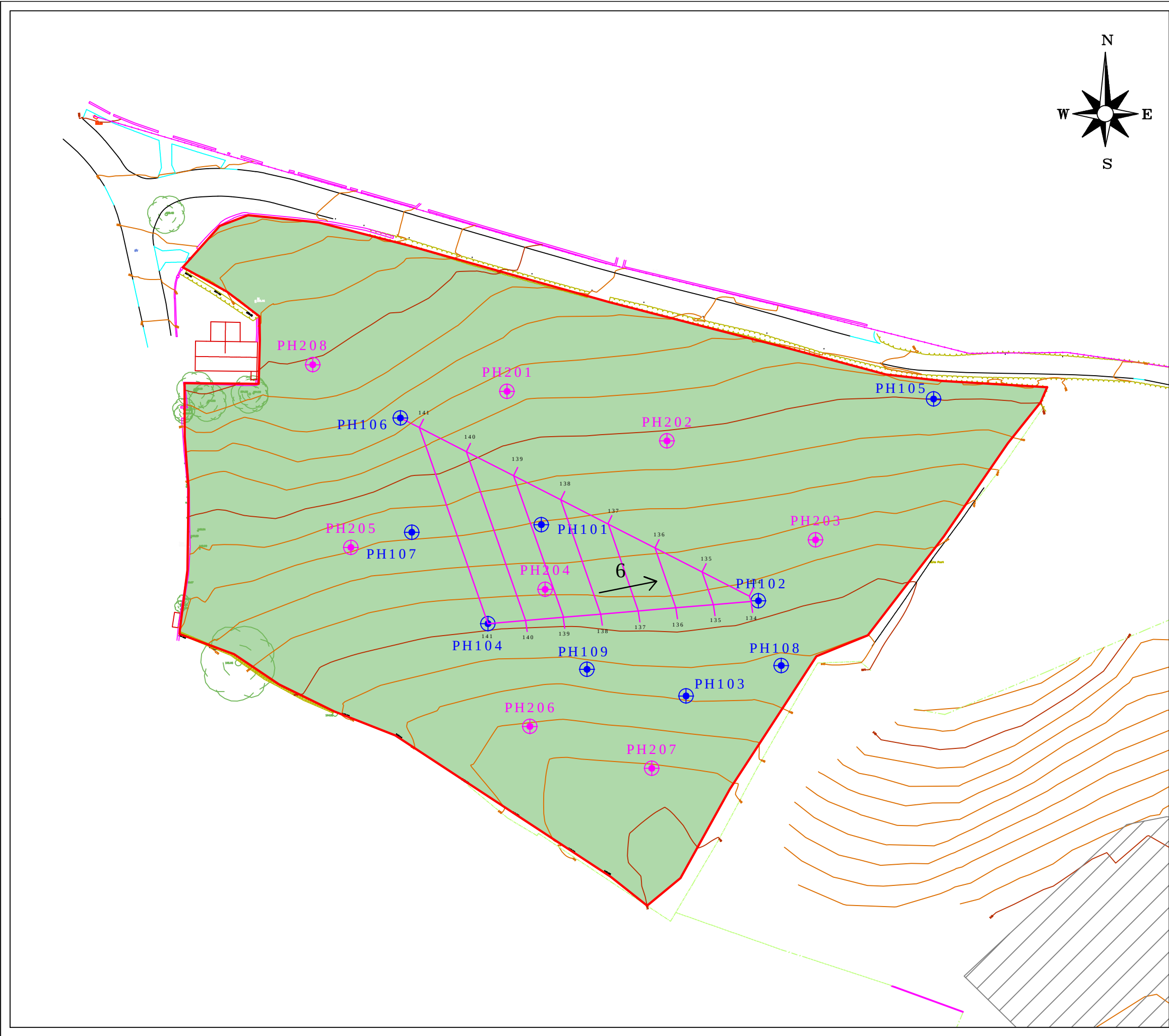
PILLEY,
BARNSELY

DRAWING TITLE

GEOLOGICAL MAP OVERLAY

DRAWN	DATE	STATUS FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☒ FINAL ☐
CHECKED	DATE	
LEW	21 03 18	
MJT	21 03 18	

SCALE	SHEET	DRAWING NO.	REVISION
1:1500	A3	2222/W/8	



NOTES

135 STRIKE LINE & DEPTH (mOD)
6 DIP (DEGREES)

REV.	DESCRIPTION	DATE
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www.lithos.co.uk
Tel 01937 545330

CLIENT

BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST

JOB TITLE

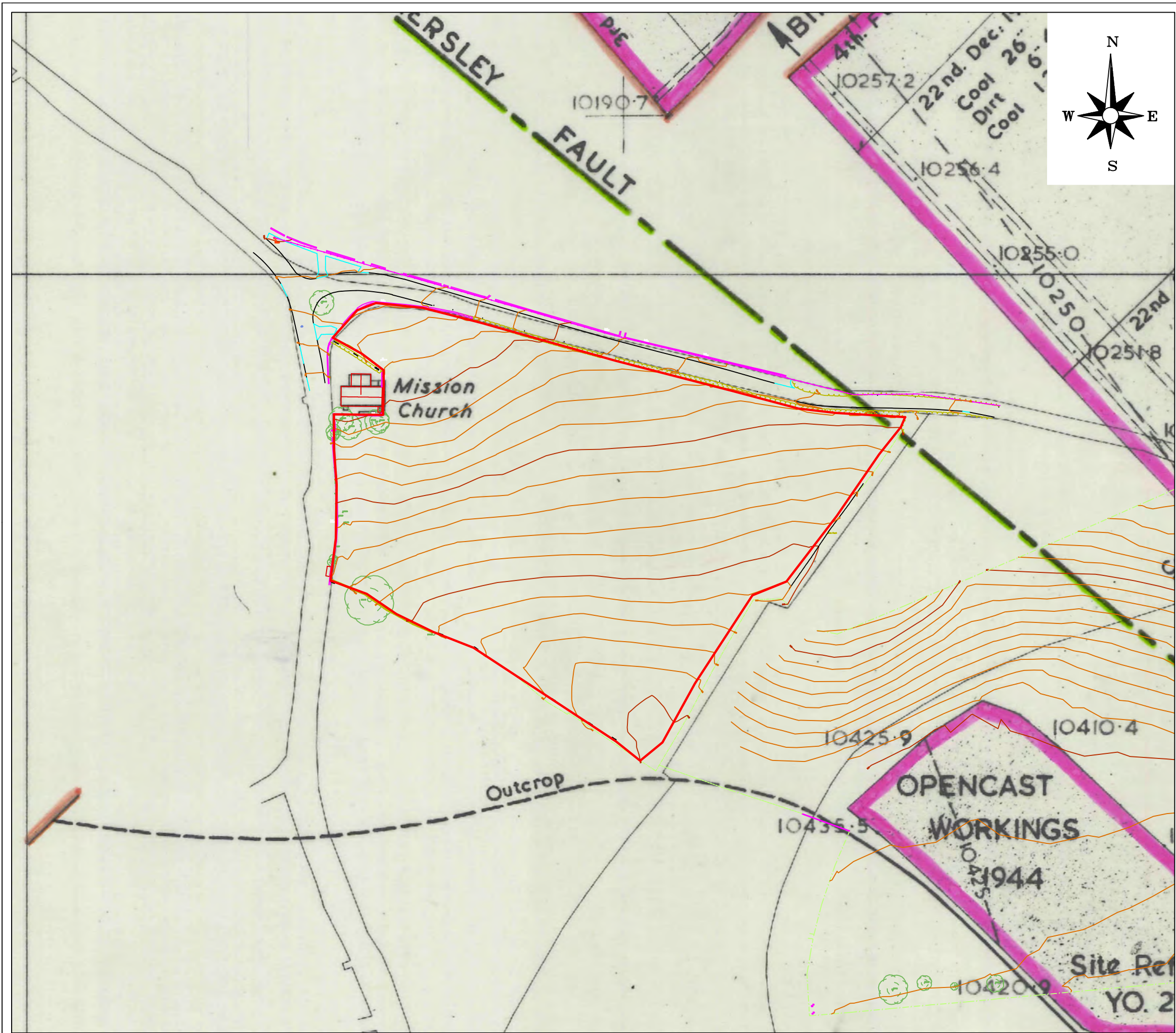
PILLEY, BARNSELEY

DRAWING TITLE

DIP CALCULATIONS

DRAWN	DATE	STATUS
LEW	17 04 18	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	17 04 18	DRAFT ☐
		FINAL ☒

SCALE	SHEET	DRAWING NO.	REVISION
1:1,000	A3	2222/W/9	



NOTES

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS
CONSULTING

info@lithos.co.uk
www.lithos.co.uk

Tel 01937 545330

CLIENT

BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST

JOB TITLE

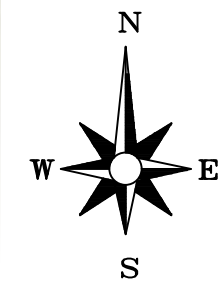
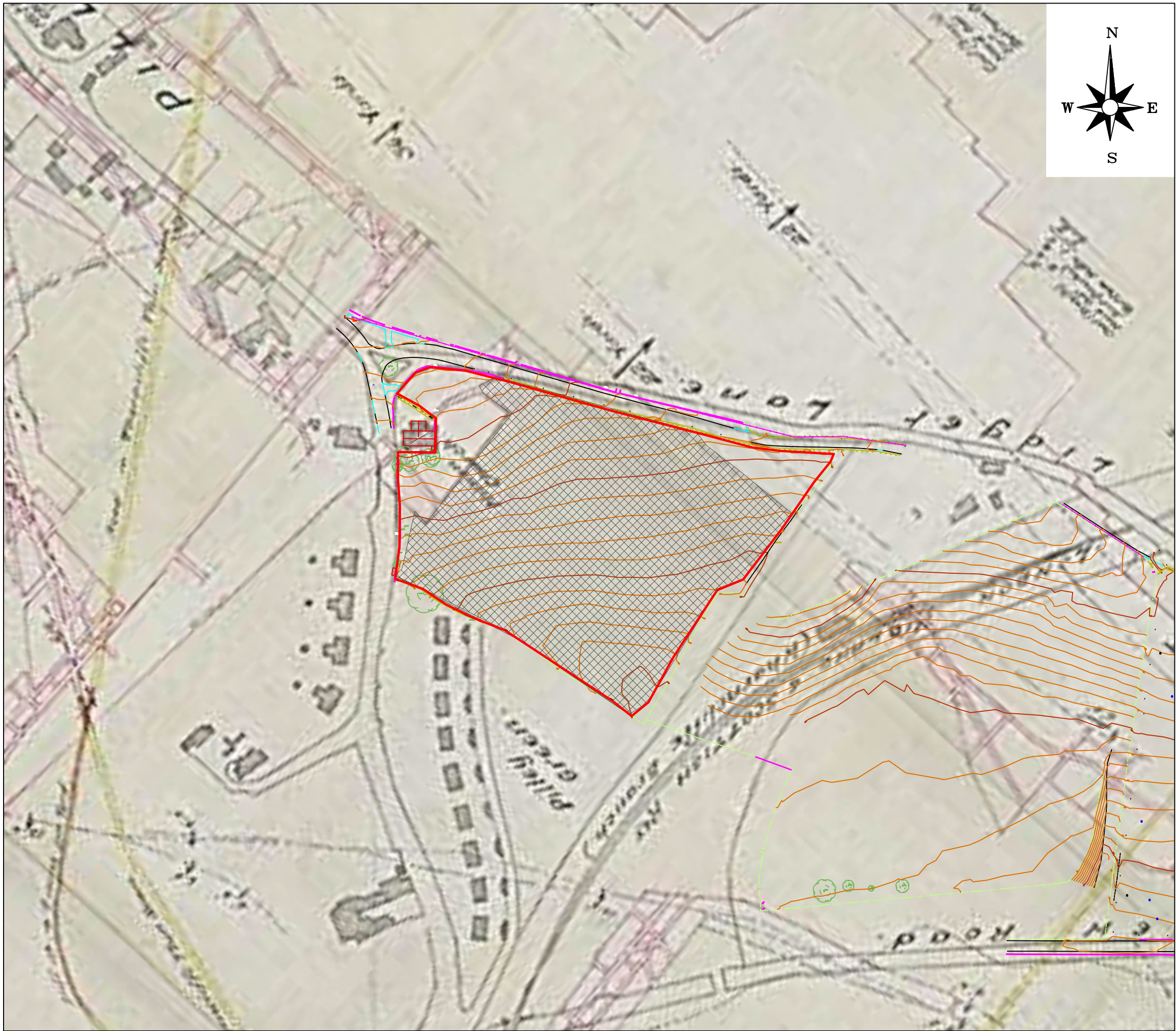
PILLEY,
BARNSELEY

DRAWING TITLE

ABANDONMENT PLAN
FLOCKTON THICK SEAM

DRAWN LEW	DATE 28 03 18	STATUS FOR COMMENT ☐
CHECKED MJT	DATE 28 03 18	FOR APPROVAL ☐
		DRAFT ☐
		FINAL ☒

SCALE 1:1500	SHEET A3	DRAWING NO. 2222/W/10	REVISION
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NOTES		
APPROXIMATE SITE BOUNDARY EXTENT OF WORKINGS		
REV.	DESCRIPTION	DATE



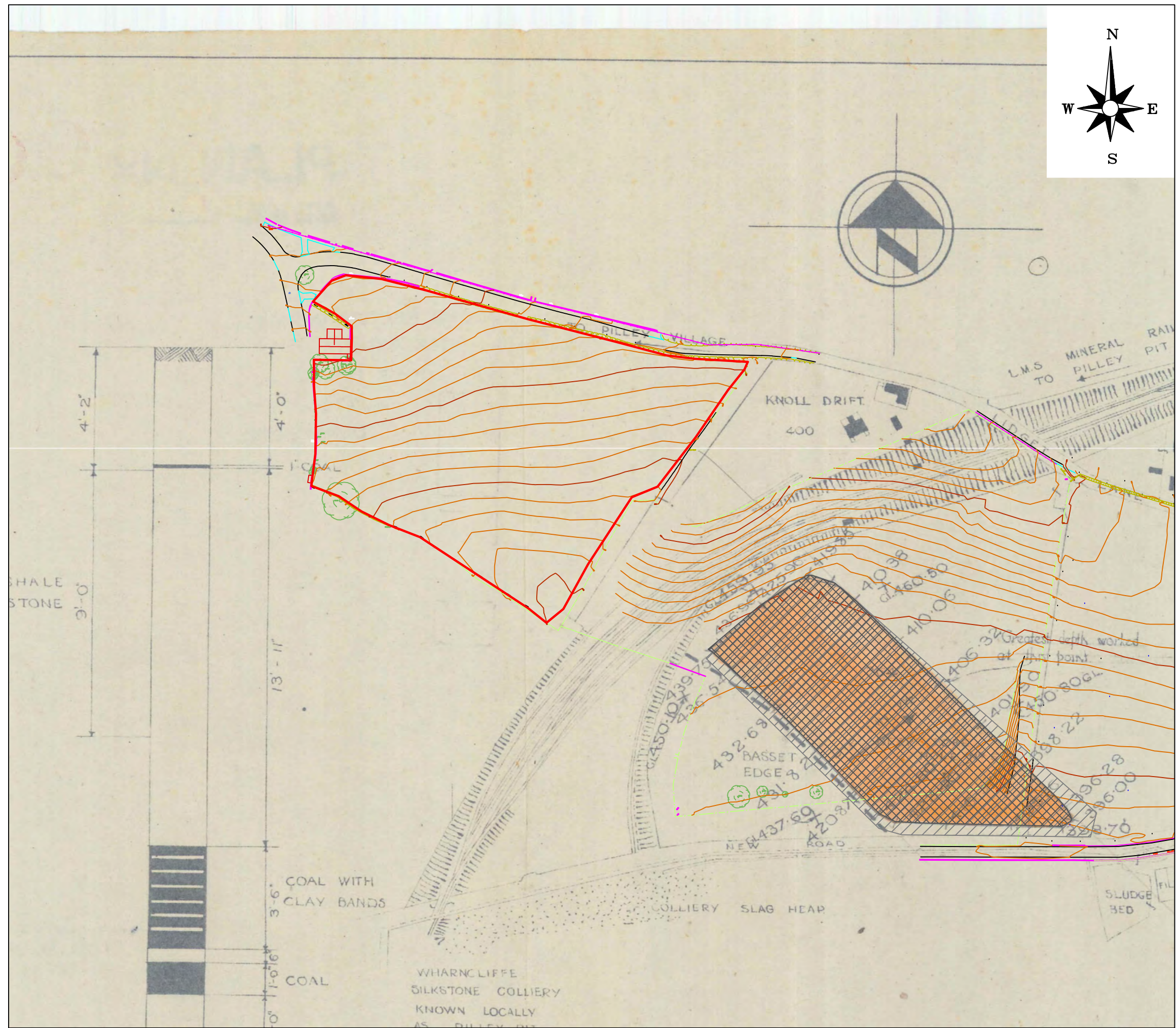
info@lithos.co.uk
www.lithos.co.uk
Tel 01937 545330

CLIENT
BARRATT & DAVID WILSON HOMES YORKSHIRE WEST

JOB TITLE
PILLEY, BARNSELEY

DRAWING TITLE
ABANDONMENT PLAN PARKGATE SEAM

DRAWN LEW	DATE 28 03 18	STATUS FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☒
CHECKED MJT	DATE 28 03 18	
SCALE 1:2,000	SHEET A3	DRAWING NO. 2222/W/11
		REVISION



NOTES

- APPROXIMATE SITE BOUNDARY
- EXTENT OF WORKINGS

REV.	DESCRIPTION	DATE
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LITHOS CONSULTING

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www.lithos.co.uk

Tel 01937 545330

CLIENT

**BARRATT & DAVID WILSON
HOMES YORKSHIRE WEST**

JOB TITLE

**PILLEY,
BARNSELEY**

DRAWING TITLE

**ABANDONMENT PLAN
OPENCAST**

DRAWN	LEW	DATE	28 03 18	STATUS	FOR COMMENT	☐
CHECKED	MJT	DATE	28 03 18	FOR APPROVAL	DRAFT	☐
				FINAL		☒

SCALE	1:2,000	SHEET	A3	DRAWING NO.	2222/W/12	REVISION	
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Appendix C

Commission

027/2222/MJT

1st August 2016

Daria Matkowska
Barratt & David Wilson Homes Yorkshire West
Raynham Close
Morley
Leeds
LS27 0WH



Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330

www.lithos.co.uk

Dear Daria

Lidgett Lane, Pilley

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

Lithos have previously issued a report relating to this site to a third party, which we understand has been made available to Barratts – 'Desk Study and Mining Risk Assessment, Land at Lidgett Lane & New Road, Pilley' ref. 2222/1 dated October 2015.

The above report included a review of 3rd party SI reports (by CoDa structures), an intrusive mining investigation and a hazardous gas investigation.

In addition, Lithos have carried out gas monitoring at the site.

The aforementioned documents should be read in conjunction with this fee proposal, but in summary, outstanding issues relating to the Lidgett Lane (west) site are:

- Limited geotechnical analysis (Atterbergs) has been carried out to date
- Very limited topsoil testing has been undertaken, more samples are required
- Poor logging within 3rd party reports means that additional trial pitting should be undertaken to confirm ground conditions encountered
- No mineworkings were encountered within the shallow Flockton Thick seam, but some residual uncertainty remains

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:

Desk study: Environmental search data already obtained will be incorporated and updated where necessary for use within our final report.

Fieldwork: We have allowed for one day's trial pitting and one day's rotary probing, to be supervised and logged by an experienced geoenvironmental engineer.

The purpose of the trial pitting is to confirm ground conditions encountered by CoDa and to enable additional geotechnical analysis on samples of natural soils.



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.

The site is underlain by the Flockton Thick coal seam, and therefore we have allowed for the drilling of around 8 rotary probeholes in order to resolve residual uncertainties regarding the presence of mineworkings at shallow depth.

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 site's size and location, we should be able to avoid the need to drill holes within 50m of surrounding residential properties and therefore, in accordance with CA requirements, we should be able to use air as the flushing medium.

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.

Soils testing: This will comprise routine geotechnical soils analysis, including 8 moisture content & Atterberg limits, and 8 pH & water soluble sulphate.

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

The site is understood to be essentially Greenfield, and therefore testing of potentially contaminated samples should only be required if made ground is encountered in the exploratory holes. However, we have allowed for analysis of topsoil (6 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH; two samples will also be analysed for pesticides.

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

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

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

Fieldwork could be commenced within 2 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion.

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 our invoice for this project with the final report.

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

Details of welfare will be included within the Method Statements, however, this investigation is expected to be completed within 2 working days and therefore it is not considered reasonably practicable to provide formal welfare facilities, and our proposal makes no allowance for so doing.

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

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 "Matt Thompson".

Matt Thompson
Senior Engineer
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 as set out in the Proposal and shall include any additions or amendments thereto made in accordance with these Terms;
- "Terms" means these terms entitled "Lithos Consulting Terms of Appointment".

- 1.2 Words importing the singular only shall also include the plural and vice versa, where the context requires.
- 1.3 Words importing persons or parties shall include firms, corporations and any organisation having legal capacity and vice versa, where the context requires; and words importing a particular gender include all genders.
- 1.4 The sub-headings to the clauses of these Terms are for convenience only and shall not affect the construction of the Agreement.
- 1.5 A reference to legislation includes that legislation as from time to time amended, re-enacted or substituted and any Orders in Council, orders, rules, regulations, schemes, warrants, by-laws, directives or codes of practice issued under any such legislation.
- 1.6 In the event of conflict between the documents forming part of the Agreement, the Proposal shall prevail, followed by the Terms.

2 APPOINTMENT

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

3 OBLIGATIONS OF LITHOS

- 3.1 Lithos shall perform the Services using the reasonable standard of skill and care normally exercised by similar professional Environmental firms in performing similar services under similar conditions.
- 3.2 Lithos shall use all reasonable endeavours to perform the Services in accordance with all relevant environmental and safety legislation.

4 OBLIGATIONS OF THE CLIENT

- 4.1 Throughout the period of this Agreement the Client shall afford to Lithos or procure the affording to Lithos of access to any site where access is required for the performance of the Services.
- 4.2 The Client accepts responsibility for ensuring that Lithos is notified in writing of all special site and/or plant conditions, including without prejudice to the generality of the foregoing, the existence and precise location of all underground services, cables, pipes, drains or underground buildings, constructions or any hazards known or suspected by the Client, which the Client shall clearly mark on the ground or identify on accurate location plans supplied to Lithos prior to the commencement of the Services. The Client shall also inform Lithos in writing of any relevant operating procedures including any site safe operating procedures and any other regulations relevant to the carrying out of the Services. The Client shall indemnify Lithos against all costs, claims, demands and expenses arising as a result of any non-disclosure in this respect, including but not limited to indemnification against any action brought by the owner of the land or otherwise.
- 4.3 If the Client discovers any conflict, defect or other fault in the information or designs provided by Lithos pursuant to the Agreement, he will advise Lithos in writing of such defect, conflict or other fault and Lithos shall have the right to rectify the same or where necessary, to design the solution for rectification of any works carried out by others pursuant the conflicting, defective or in any other way faulty information or designs.

5 INTELLECTUAL PROPERTY

- 5.1 The copyright in all Intellectual Property prepared by or on behalf of Lithos in connection with the Project for delivery to the Client shall remain vested in Lithos.
- 5.2 The Client shall have a non-exclusive licence to copy and use such Intellectual Property for purposes directly related to the Project. Such licence shall enable the Client to copy and use the Intellectual Property but solely for its own purposes in connection with the Project and such use shall not include any licence to reproduce any conceptual designs or professional opinions contained therein nor shall it include any licence 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.

From: Rhodes, Graham <graham.rhodes@barratthomes.co.uk>
Sent: 22 February 2018 12:06
To: Matt Thompson; Reg
Cc: Brown, Martin; Lloyd, Gareth (Yorkshire West)
Subject: RE: *EXTERNAL: RE: Lidgett Lane, Pilley - Additional SI
Attachments: 2018.01.08 2222_3A (Lithos SI - BDW Lidget Lane).pdf

Follow Up Flag: Follow up
Flag Status: Completed

Hi Matt,

We've now been given the go-ahead to get the Additional SI work carried out at the Lidgett Lane site. I have attached an order for the quote back in Jan, When do you think that you could get onto site and give some initial findings.

Thanks Graham.

Graham Rhodes – Senior Engineer
Barratt David Wilson Homes Yorkshire West
Raynham House
2 Capitol Close
Morley
Leeds
LS27 0WH

OfficeTelephone No: 0113 307 6850
Extension Number: 50 6887
Direct Line: 0113 307 6887
Fax No: 0113 307 6929



Appendix D

Historical OS Plans



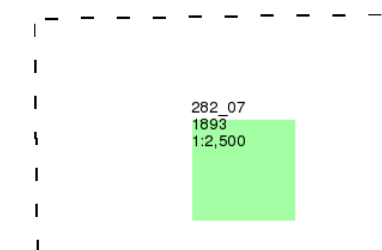
Yorkshire

Published 1893

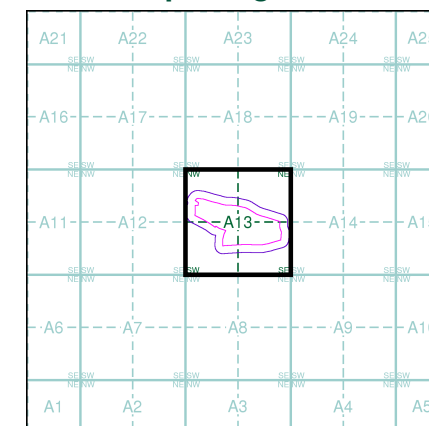
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

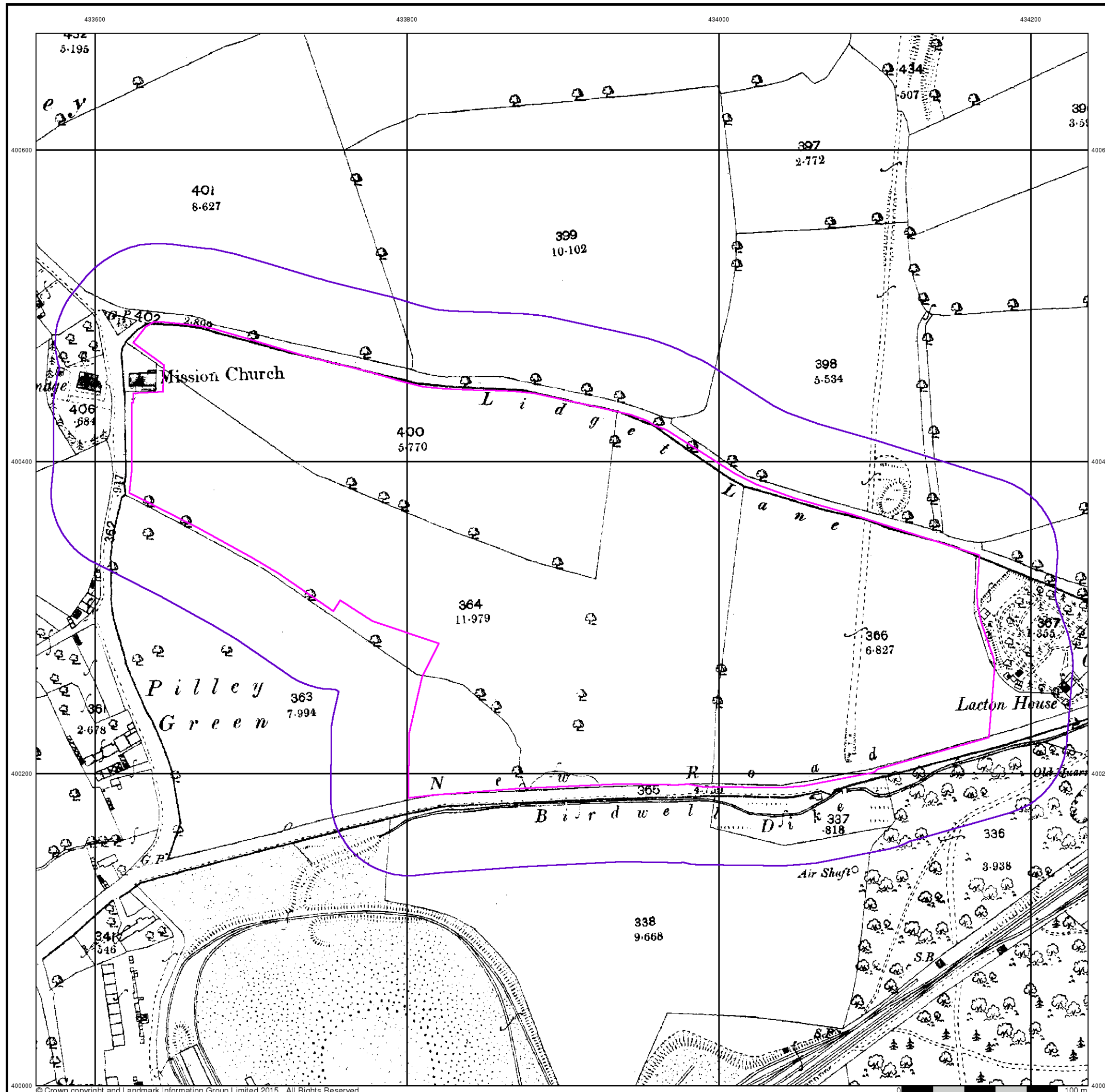
Order Number: 72903369_1_1
Customer Ref: 2222
National Grid Reference: 433890, 400330
Slice: A
Site Area (Ha): 10.09
Search Buffer (m): 50

Site Details

84 Lidgett Lane, Tankersley, BARNSELY, South Yorkshire, S75 3AG



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





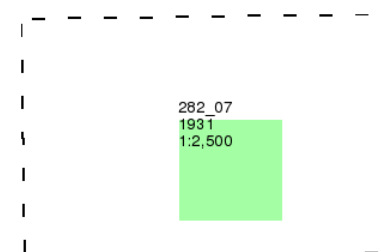
Yorkshire

Published 1931

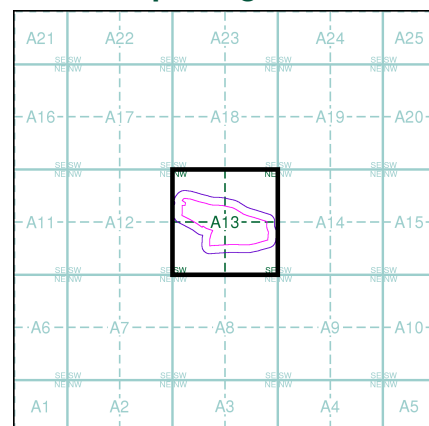
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number: 72903369_1_1
Customer Ref: 2222
National Grid Reference: 433890, 400330
Slice: A
Site Area (Ha): 10.09
Search Buffer (m): 50

Site Details

84 Lidgett Lane, Tankersley, BARNSELY, South Yorkshire, S75
3AG



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Large-Scale National Grid Data

Published 1993

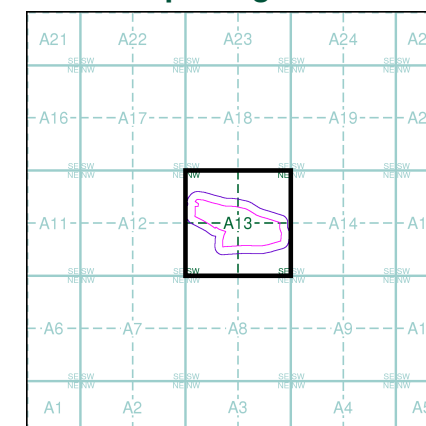
Source map scale - 1:2,500

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SE3300	SE3400
1993	1993
12,500	12,500
SK3399	SK3499
1993	1993
12,500	12,500

Historical Map - Segment A13



Order Details

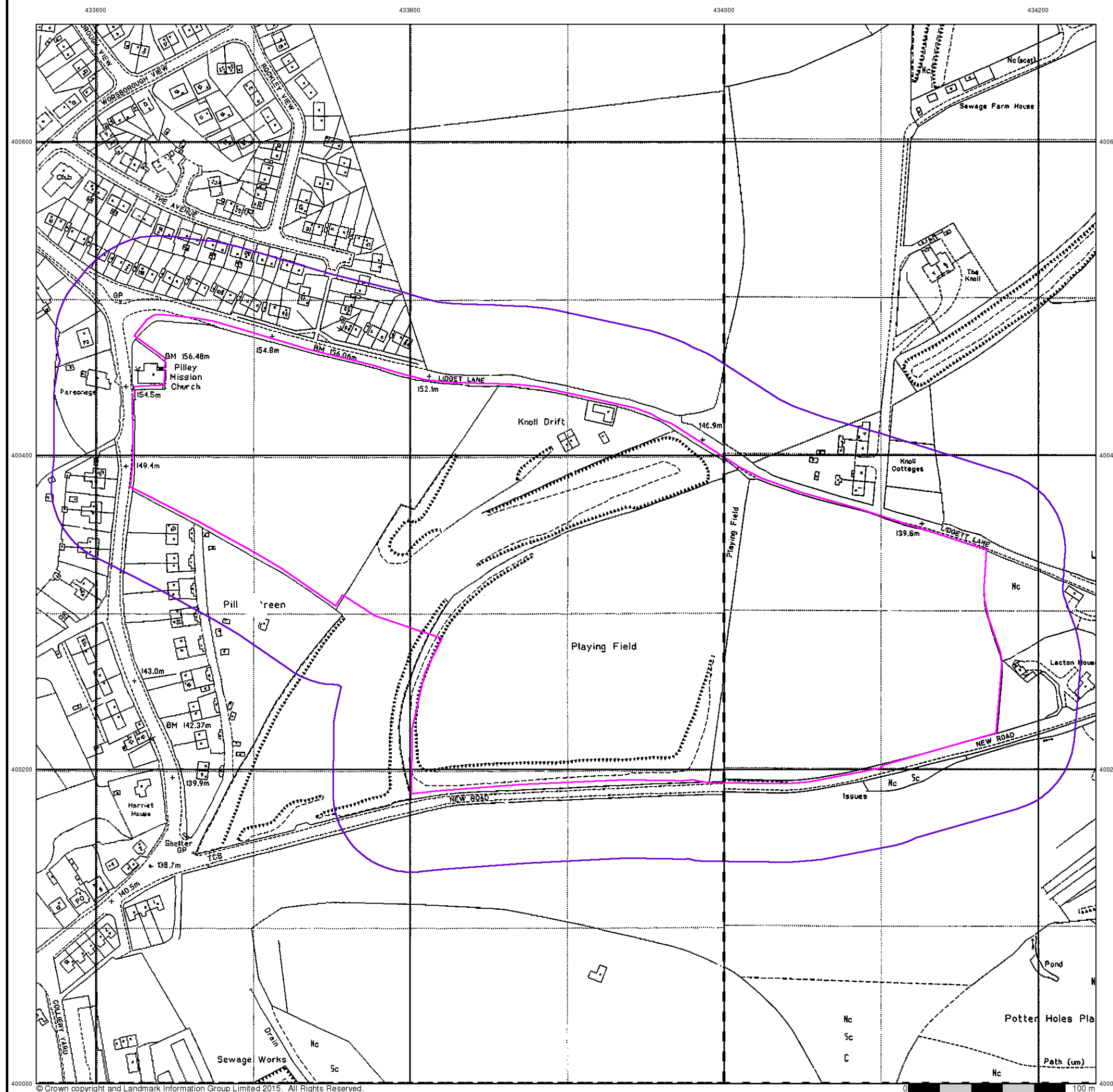
Order Number: 72903369_1_1
Customer Ref: 2222
National Grid Reference: 433890, 400330
Slice: A
Site Area (Ha): 10.09
Search Buffer (m): 50

Site Details

84 Lidgett Lane, Tankersley, BARNSELY, South Yorkshire, S75 3AG



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



Appendix E

Search Responses & other Correspondence

Envirocheck[®] Report:

Datasheet

Order Details:

Order Number:

72903369_1_1

Customer Reference:

2222

National Grid Reference:

433890, 400330

Slice:

A

Site Area (Ha):

10.09

Search Buffer (m):

500

Site Details:

84 Lidgett Lane
Tannersley
BARNSELY
South Yorkshire
S75 3AG

Client Details:

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

Report Section	Page Number
Summary	-
Agency & Hydrological	1
Waste	8
Hazardous Substances	9
Geological	10
Industrial Land Use	-
Sensitive Land Use	25
Data Currency	26
Data Suppliers	30
Useful Contacts	31

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.

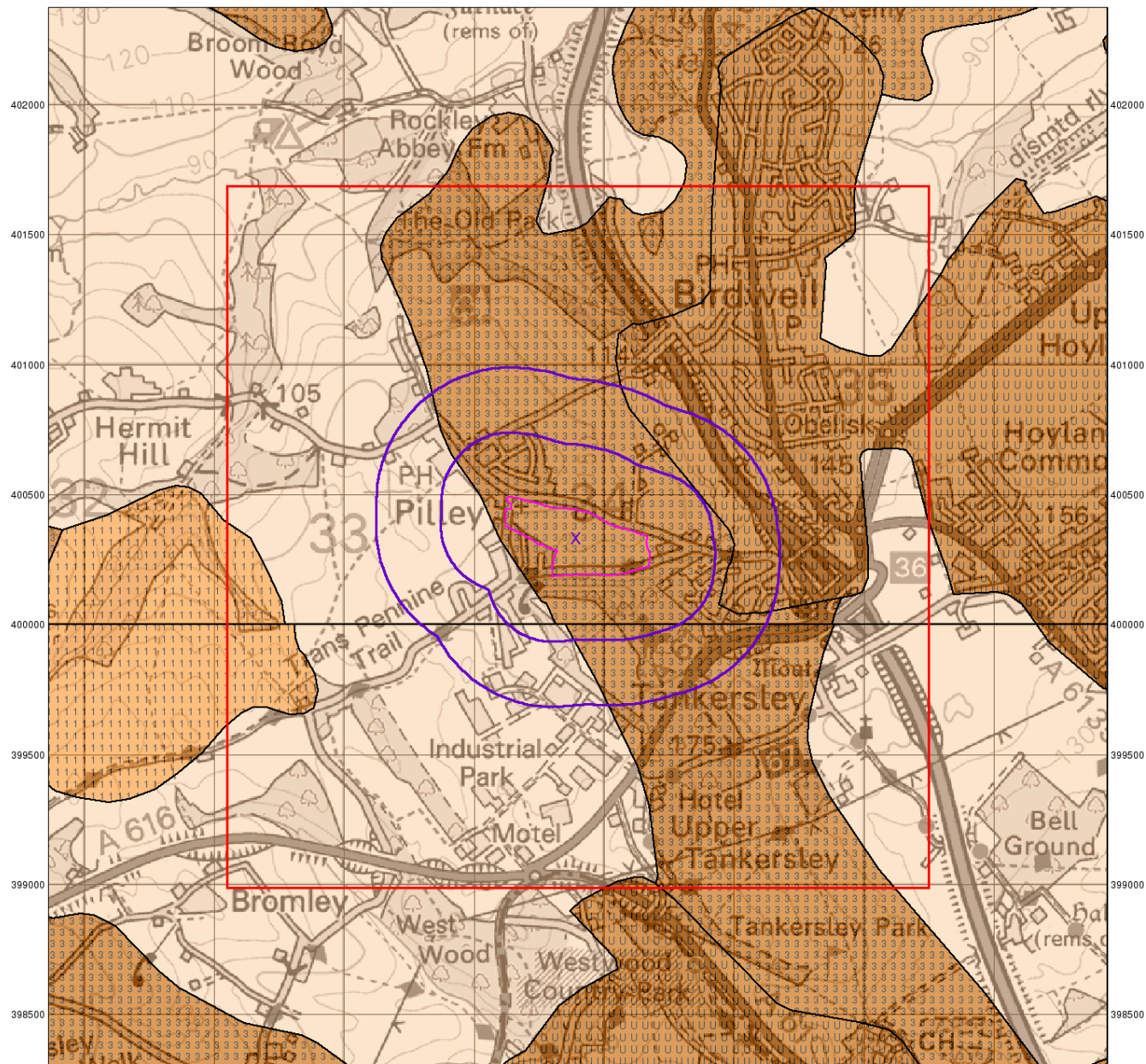
Report Version v50.0

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

Data Type	Page Number	On Site	0 to 250m	251 to 500m (*up to 1000m)
Waste				
BGS Recorded Landfill Sites				
Historical Landfill Sites	pg 8			2
Integrated Pollution Control Registered Waste Sites				
Licensed Waste Management Facilities (Landfill Boundaries)				
Licensed Waste Management Facilities (Locations)				
Local Authority Recorded Landfill Sites	pg 8			2
Registered Landfill Sites				
Registered Waste Transfer Sites				
Registered Waste Treatment or Disposal Sites				
Hazardous Substances				
Control of Major Accident Hazards Sites (COMAH)				
Explosive Sites				
Notification of Installations Handling Hazardous Substances (NIHHS)				
Planning Hazardous Substance Consents	pg 9			1
Planning Hazardous Substance Enforcements				
Geological				
BGS 1:625,000 Solid Geology	pg 10	Yes	n/a	n/a
BGS Estimated Soil Chemistry	pg 10	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 16	3	5	20
BGS Urban Soil Chemistry				
BGS Urban Soil Chemistry Averages				
Brine Compensation Area			n/a	n/a
Coal Mining Affected Areas	pg 21	Yes	n/a	n/a
Mining Instability	pg 21	Yes	n/a	n/a
Man-Made Mining Cavities				
Natural Cavities				
Non Coal Mining Areas of Great Britain	pg 21	Yes	Yes	n/a
Potential for Collapsible Ground Stability Hazards	pg 22	Yes	Yes	n/a
Potential for Compressible Ground Stability Hazards	pg 22	Yes	Yes	n/a
Potential for Ground Dissolution Stability Hazards				n/a
Potential for Landslide Ground Stability Hazards	pg 22	Yes	Yes	n/a
Potential for Running Sand Ground Stability Hazards	pg 23	Yes	Yes	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 23	Yes	Yes	n/a
Radon Potential - Radon Affected Areas	pg 24	Yes	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a

Data Type	Page Number	On Site	0 to 250m	251 to 500m (*up to 1000m)
Industrial Land Use				
Contemporary Trade Directory Entries (50m)				n/a
Fuel Station Entries				
Sensitive Land Use				
Areas of Adopted Green Belt	pg 25	1		
Areas of Unadopted Green Belt				
Areas of Outstanding Natural Beauty				
Environmentally Sensitive Areas				
Forest Parks				
Local Nature Reserves	pg 25		1	
Marine Nature Reserves				
National Nature Reserves				
National Parks				
Nitrate Sensitive Areas				
Nitrate Vulnerable Zones	pg 25	1		
Ramsar Sites				
Sites of Special Scientific Interest				
Special Areas of Conservation				
Special Protection Areas				

432000 432500 433000 433500 434000 434500 435000 435500



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0 1 km



Groundwater Vulnerability

General

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

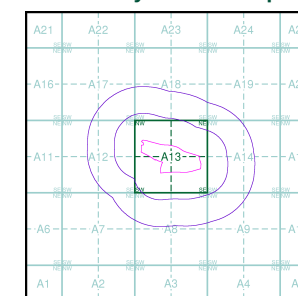
Agency and Hydrological

Geological Classes

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

Soil Classes

Site Sensitivity Context Map - Slice A



Order Details

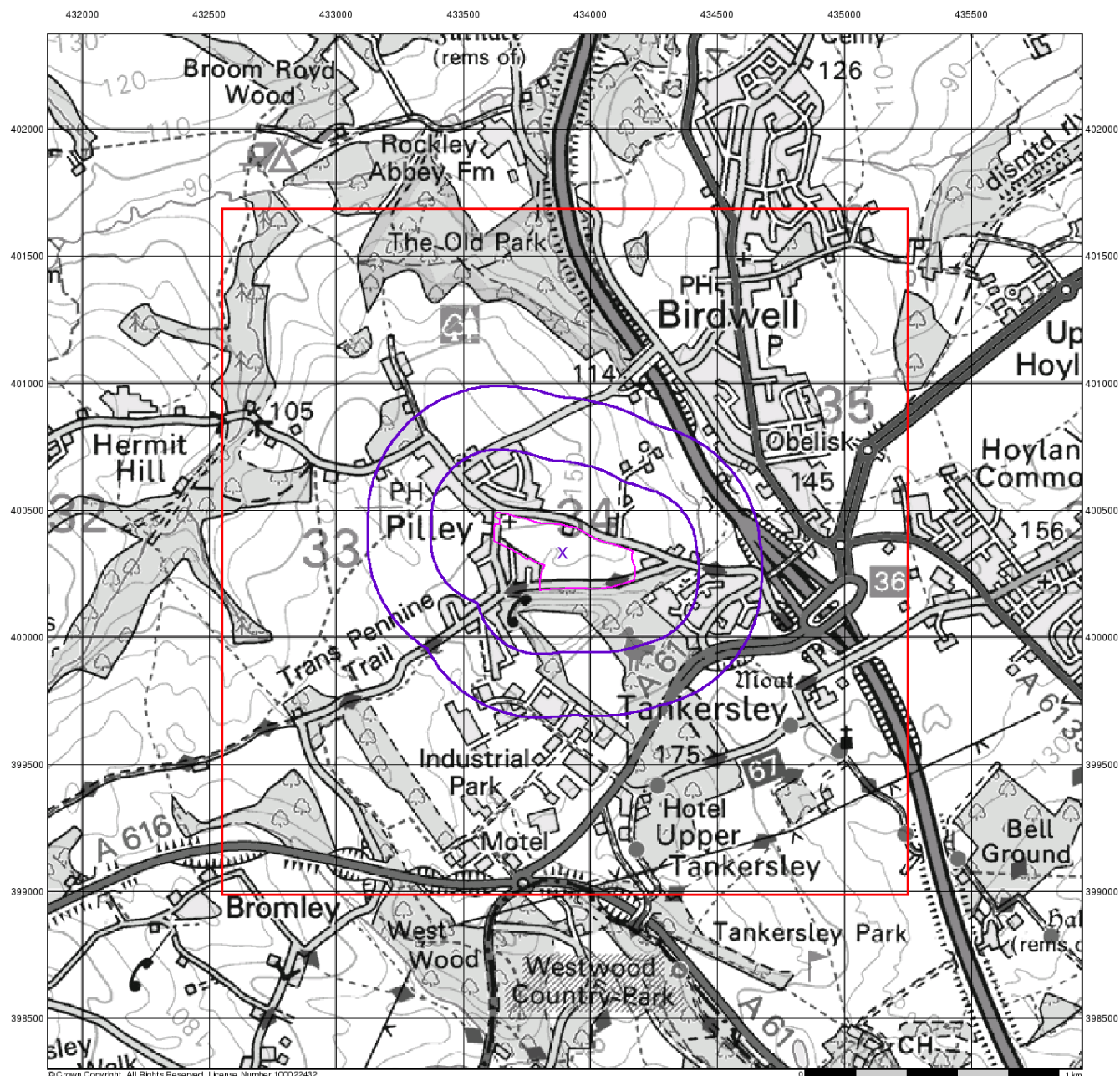
Order Number: 72903369_1_1
 Customer Ref: 2222
 National Grid Reference: 433890, 400330
 Slice: A
 Site Area (Ha): 10.09
 Search Buffer (m): 500

Site Details

84 Lidgett Lane, Tankersley, BARNSELY, South Yorkshire, S75 3AG



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



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Source Protection Zones

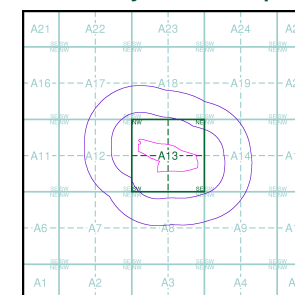
General

- 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

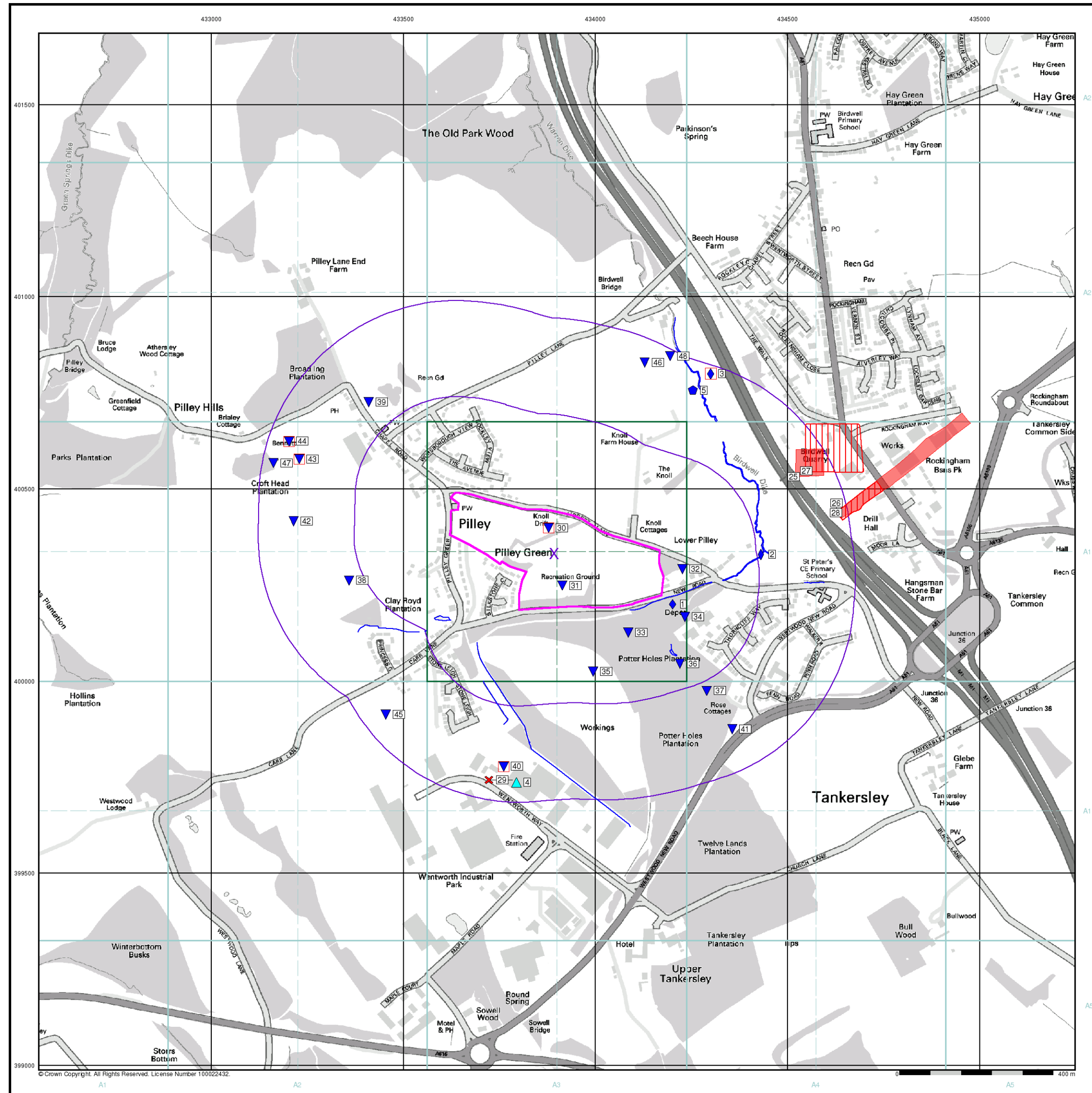
Order Number: 72903369_1_1
 Customer Ref: 2222
 National Grid Reference: 433890, 400330
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 Site Area (Ha): 10.09
 Search Buffer (m): 500

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- General**

 - Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point
 - Map ID
 - Several of Type at Location
- Agency and Hydrological**

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

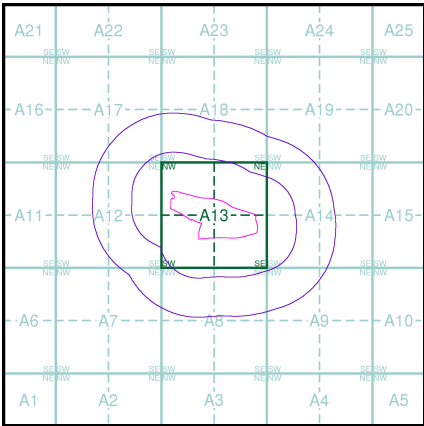
 - BGS Recorded Landfill Site (Location)
 - BGS Recorded Landfill Site
 - EA Historic Landfill (Buffered Point)
 - EA Historic Landfill (Polygon)
 - Integrated Pollution Control Registered Waste Site
 - Licensed Waste Management Facility (Landfill Boundary)
 - Licensed Waste Management Facility (Location)
 - Local Authority Recorded Landfill Site (Location)
 - Local Authority Recorded Landfill Site
 - Registered Landfill Site
 - Prosecution Relating to Authorised Processes
 - 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
- Geological**

 - BGS Recorded Mineral Site
- Industrial Land Use**

 - Contemporary Trade Directory Entry
 - Fuel Station Entry

Site Sensitivity Map - Slice A



Order Details

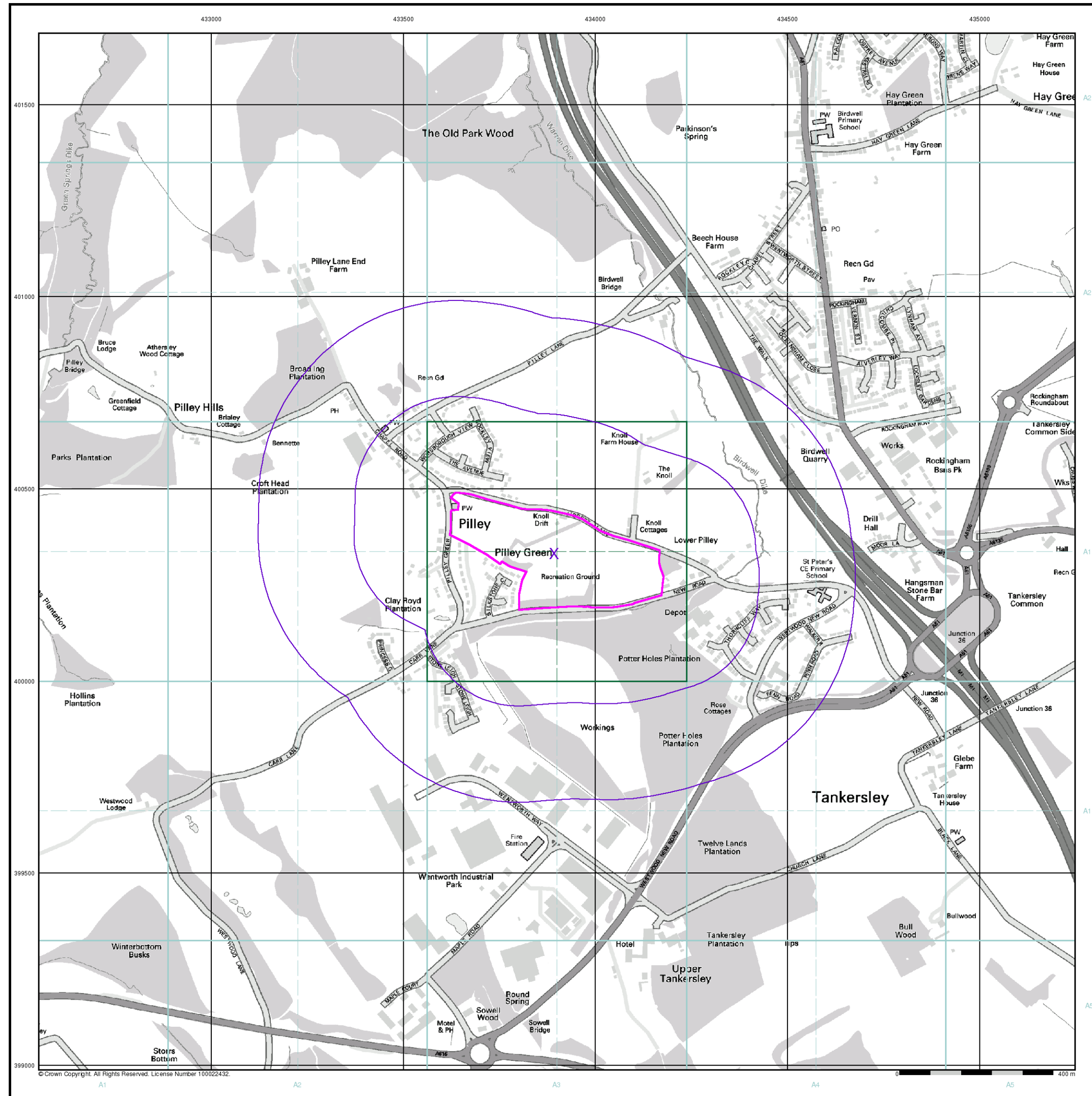
Order Number: 72903369_1_1
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Slice: A
Site Area (Ha): 10.09
Search Buffer (m): 500

Site Details

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Information Group

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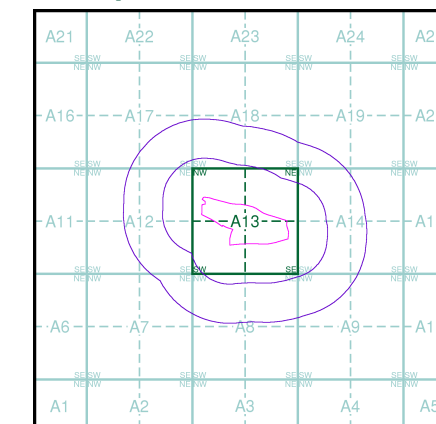
General

- 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

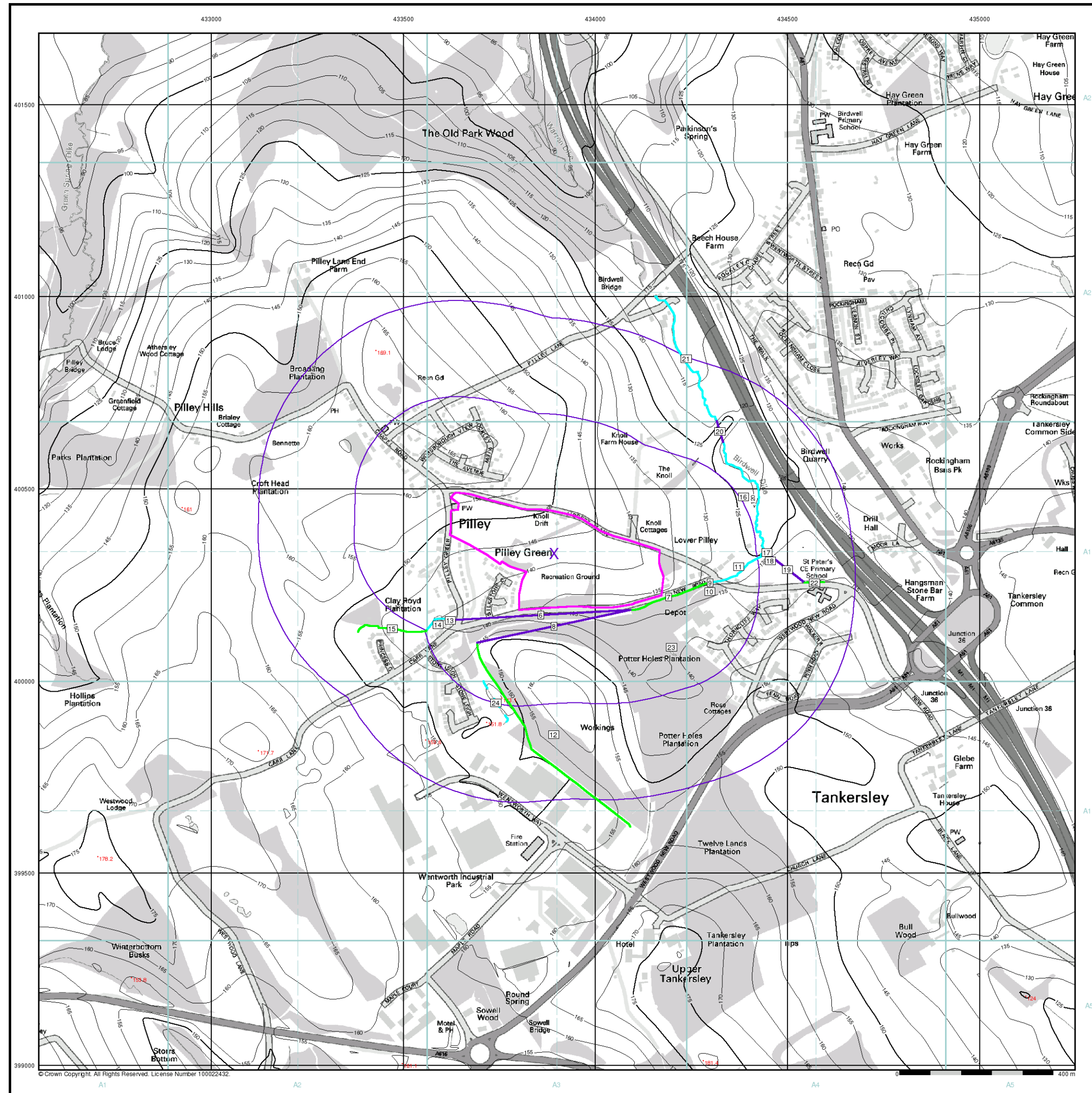
Order Number: 72903369_1_1
Customer Ref: 2222
National Grid Reference: 433890, 400330
Slice: A
Site Area (Ha): 10.09
Search Buffer (m): 500

Site Details

84 Lidgett Lane, Tankersley, BARNSELY, South Yorkshire, S75 3AG



Tel: 0844 844 9952
Fax: 0844 844 9951
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General

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

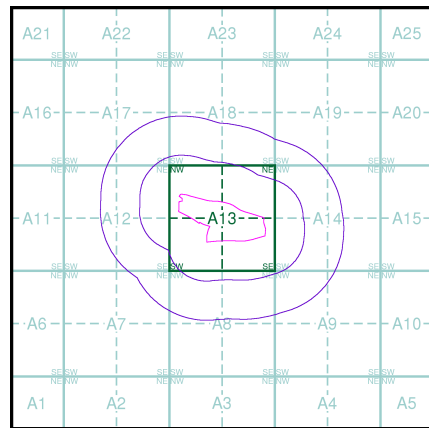
Detailed River Network Data

- 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

EAN/RW Detailed River Network Map - Slice A



Order Details

Order Number: 72903369_1_1
Customer Ref: 2222
National Grid Reference: 433890, 400330
Slice: A
Site Area (Ha): 10.09
Search Buffer (m): 500

Site Details

84 Lidgett Lane, Tannersley, BARNSELY, South Yorkshire, S75 3AG



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



The Coal Authority

Issued by:

The Coal Authority, Property Search Services, 200 Lichfield Lane, Berry Hill, Mansfield, Nottinghamshire, NG18 4RG
Website: www.groundstability.com Phone: 0345 762 6848 DX 716176 MANSFIELD 5

**LANDMARK INFORMATION GROUP
LIMITED
SOWTON INDUSTRIAL ESTATE
ABBAY COURT
UNIT 5/7 EAGLE WAY
EXETER
DEVON
EX2 7HY**

Our reference: **51001006821001**
Your reference: **72903369_2|**
Date of your enquiry: **24 September 2015**
Date we received your enquiry: **24 September 2015**
Date of issue: **24 September 2015**

This report is for the property described in the address below and the attached plan.

Non-Residential Coal Authority Mining Report

84 LIDGETT LANE, TANKERSLEY BARNESLEY, SOUTH YORKSHIRE,

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.

Coal mining	See comments below
Brine Compensation District	No

Information from the Coal Authority

Underground coal mining

Past

The property is in the likely zone of influence from workings in 7 seams of coal at 50m to 290m depth, and last worked in 1954.

Any ground movement from these coal workings should have stopped by now.

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 Coal Authority Information section of the report.

Present

The property is not in the likely zone of influence of any present underground coal workings.

Future

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.

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

The property is not in an area that is likely to be affected at the surface from any planned future workings.

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

No notice of the risk of the land being affected by subsidence has been given under section 46 of the Coal Mining Subsidence Act 1991.

Mine entries

Within, or within 20 metres of, the boundary of the property there are 2 mine entries, the approximate positions of which are shown on the attached plan.

Our records disclose the following information:

433400-018. was found and subsequently filled and graded over by Barnsley MDC in 1987.

433400-002. a brick arch and stopping is visible at the surface.

Records may be incomplete. Consequently, there may exist in the local area mine entries of which the Coal Authority has no knowledge.

For an additional fee, the Coal Authority will provide a supplementary Mine Entry Interpretive Report. The report will provide a separate assessment for the mine entry (entries) referred to in this report. It will give details based on information in the Coal Authority's possession, together with an opinion on the likelihood of mining subsidence damage arising from ground movement as a consequence of the existence of the mine entry/entries. It will also give details of the remedies available for subsidence damage where the mine entry was sunk in connection with coal mining. Please note that it may not be possible to produce a report if the main building to the property cannot be identified from Coal Authority plans (ie. for development sites and new build).

For further advice on how to order this additional information visit www.groundstability.com or telephone 0345 7626 848.

Coal mining geology

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.

Opencast coal mining

Past

The property is within the boundary of an opencast site from which coal has been removed by opencast methods.

Present

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

Future

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.

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.

Coal mining subsidence

A damage notice or claim for alleged subsidence damage was made in October 2003 for ST PAULS CHURCH PILLEY GREEN, TANKERSLEY, BARNSELY, SOUTH YORKSHIRE, S75 3AE. However, the claim was rejected.

There is no current Stop Notice delaying the start of remedial works or repairs to the property. A damage notice or claim for alleged subsidence damage was made in July 1998 for 1 KNOLL DRIFT LIDGETT LANE, TANKERSLEY, BARNESLEY, SOUTH YORKSHIRE, S75 3BT. The claim was discharged by repairs to the value of £9,590.68.

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

The 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 in addition to that provided in this report, the Authority need to manually search their records. For further advice on how to order this additional information visit www.groundstability.com or telephone 0345 7626 848.

Mine gas

The property has been subject to remedial works, by or on behalf of the Authority, associated with a mine gas investigation.

Hazards related to coal mining

The property has been subject to remedial works, by or on behalf of the Authority, under its Emergency Surface Hazard Call Out procedures.

Withdrawal of support

The property is in an area for which a notice of entitlement to withdraw support was published in 1951.

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

Working facilities orders

The property is not in an area for which 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.

Payments to owners of former copyhold land

The property is not in an area for which a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

Comments on Coal Authority information

The attached plan shows the approximate location of the disused mine entry/entries referred to in this report. For reasons of clarity, mine entry symbols may not be drawn to the same scale as the plan.

Property owners have the benefit of statutory protection (under the Coal Mining Subsidence act 1991*). This contains provision for the making good, to the reasonable satisfaction of the owner, of physical damage from disused coal mine workings including disused coal mine entries. A leaflet setting out the rights and the obligations of either the Coal Authority or other responsible persons under the 1991 Act can be obtained by telephoning 0345 762 6848.

If you wish to discuss the relevance of any of the information contained in this report you should seek the advice of a qualified mining engineer or surveyor. If you or your adviser wish to examine the source plans from which the information has been taken these are normally available at our Mansfield office, free of charge, by prior appointment, telephone 01623 637225. Should you or your adviser wish to carry out any physical investigations that may enter, disturb or interfere with any disused mine entry the prior permission of the owner must be sought. For coal mine entries the owner will normally be the Coal Authority.

The Coal Authority, regardless of responsibility and in conjunction with other public bodies, provide an emergency call out facility in coalfield areas to assess the public safety implications of mining features (including disused mine entries). Our emergency telephone number at all times is 01623 646333.

*Note, this Act does not apply where coal was worked or gotten by virtue of the grant of a gale in the Forest of Dean, or any other part of the Hundred of St. Briavels in the county of Gloucester.

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.

Information from the Cheshire Brine Subsidence Compensation Board

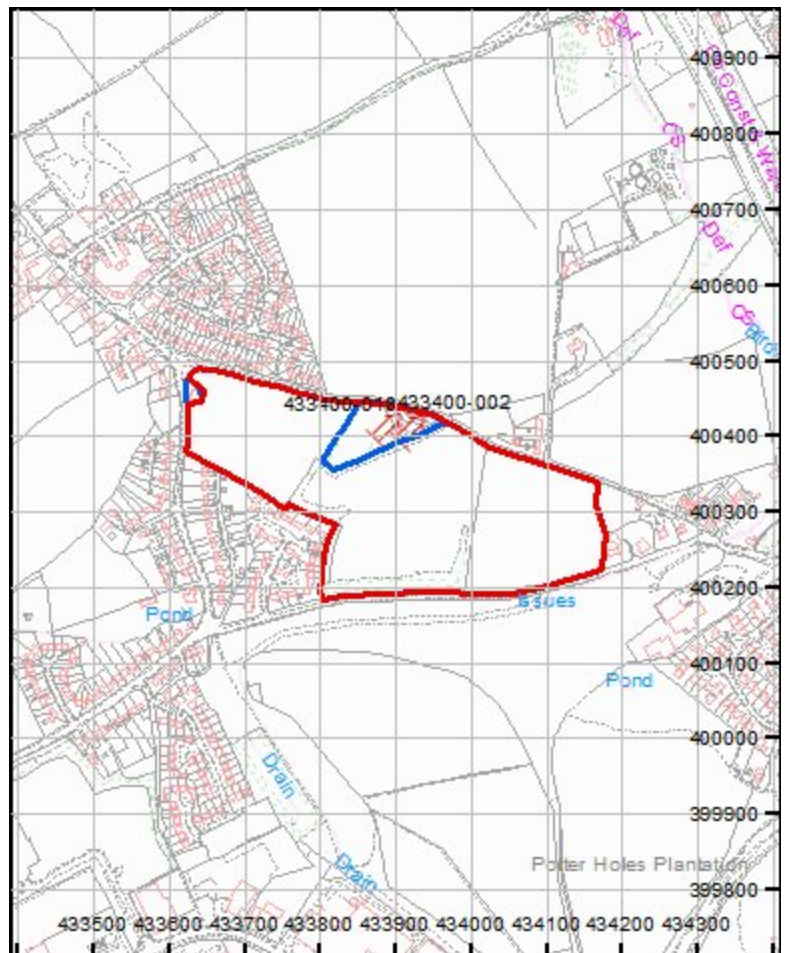
The property lies outside the Cheshire Brine Compensation District.

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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Key

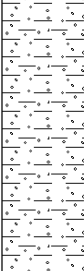
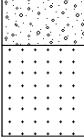


Appendix F

Trial Pit Logs

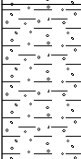
				Trial Pit Log				Trialpit No TP201 Sheet 1 of 1	
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433664.00 - 400476.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 2.60		Logged LEW	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)		
			HVP=55	0.70			Firm brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)		
	0.80	D					Firm orange mottled grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)		
			HVP=62				From 1.0m, clay is stiff.		
			HVP=85				From 1.2m, clay is gravelly.		
				1.60			Brown slightly sandy subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)		
				2.40			From 2.1m, locally gravelly clay.		
				2.60			Weak brown thinly laminated fine grained SANDSTONE recovered as slightly clayey sandy angular to subangular fine to coarse gravel. (COAL MEASURES - SANDSTONE)		
							Difficult to excavate beyond 2.6m. 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. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.									
Stability: 1. The sides of the trial pit remained stable during excavation.									



				Trial Pit Log			Trialpit No TP202 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433697.00 - 400466.00 Level:		Date 16/03/2018	
Location:				Dimensions (m):		2.5		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West				Depth 1.90				Logged LEW	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.40	D	HVP=84	0.30			TOPSOIL: Dark brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)		
	0.90	D	HVP=85				Stiff orangish brown slightly gravelly CLAY with rare subangular cobbles. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)		
	1.50	T		1.40			From 1.2m, clay is gravelly. No hand vane shear tests could be undertaken as no blocks of clay were recovered.		
				1.60			Light brown slightly clayey sandy angular to subangular fine to coarse GRAVEL of sandstone with occasional subangular cobbles. (GRANULAR RESIDUAL SOIL)		
				1.90			Strong light brown thinly bedded fine grained SANDSTONE recovered as sandy angular tabular fine to coarse gravel with occasional cobbles. (COAL MEASURES - SANDSTONE) End of pit at 1.90 m		
1 2 3 4 5									
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.									
Stability: 1. The sides of the trial pit remained stable during excavation.									



				Trial Pit Log			Trialpit No TP204 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433794.00 - 400437.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 2.40		Logged LEW	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T					TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)	
			HVP=65	0.30			Firm brown CLAY. (COHESIVE RESIDUAL SOIL)	
	0.60	D	HVP=65	0.50			Firm orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of mudstone. (COHESIVE RESIDUAL SOIL)	
			HVP=85				At 0.5m, terracotta land drain.	
							From 0.9m, clay is stiff.	
	1.10	D		1.00			Firm dark grey very gravelly CLAY. Gravel is subangular fine to medium of carbonaceous mudstone. (COHESIVE RESIDUAL SOIL)	1
				1.20			Stiff brown mottled grey slightly gravelly CLAY. Gravel is subangular fine to coarse of SANDSTONE. (COHESIVE RESIDUAL SOIL)	
							No hand vane shear tests could be undertaken as no blocks of clay were recovered.	
				1.80			Greyish brown slightly clayey sandy subangular fine to medium GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)	2
				2.10			Weak light brown thinly laminated fine grained SANDSTONE recovered as sandy angular tabular fine to coarse gravel with rare cobbles. (COAL MEASURES - SANDSTONE)	
				2.40			Difficult to excavate beyond 2.4m. End of pit at 2.40 m	

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

				Trial Pit Log			Trialpit No TP205 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433759.00 - 400423.00 Level:		Date 16/03/2018	
Location:				Dimensions (m):		2.5 		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West				Depth 1.70		0.6 		Logged LEW	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
▼				0.30			TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)	1
	0.50	D	HVP=65				Firm orangish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of sandstone. (COHESIVE RESIDUAL SOIL)	
	0.90	D	HVP=70				<i>From 0.9m, clay is stiff and gravelly.</i>	
	1.10						Light brown slightly clayey sandy angular to subangular tabular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)	
	1.30	T					Weak light brown thinly laminated fine grained SANDSTONE recovered as sandy angular tabular fine to coarse gravel with many cobbles. (COAL MEASURES - SANDSTONE)	
				1.50			At 1.5m, groundwater seepage. Difficult to excavate beyond 1.7m.	2
			1.70			End of pit at 1.70 m		
								3
								4
								5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 1.5m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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



				Trial Pit Log			Trialpit No TP206 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433774.00 - 400384.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 3.20		Logged LEW	

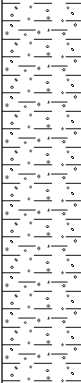
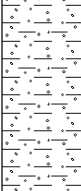
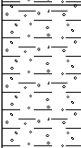
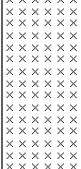
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
▼	0.10	J&T		0.20			TOPSOIL: Dark brown CLAY with occasional rootlets. (TOPSOIL)	1
	0.60	D	HVP=65				Firm brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL) <i>From 0.5m, clay is mottled grey.</i>	
	1.10	D	HVP=75	0.90			Stiff grey gravelly CLAY. Gravel is subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL) <i>No hand vane shear tests could be undertaken due to gravel content of clay.</i>	
				1.40			Grey slightly clayey sandy angular tabular fine to coarse GRAVEL of mudstone and occasional ironstone nodules. (GRANULAR RESIDUAL SOIL)	2
	2.60	T		2.00			Very weak dark grey thinly laminated MUDSTONE recovered as sandy angular tabular fine to coarse gravel with occasional cobbles. (COAL MEASURES - MUDSTONE)	
							<i>At 2.7m, 10cm band of ironstone nodules.</i>	
			3.20			<i>At 3.0m, groundwater seepage.</i>	3	
						End of pit at 3.20 m	4	
								5

Remarks:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 3.0m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.	
Stability:	1. The sides of the trial pit remained stable during excavation.	

				Trial Pit Log				Trialpit No TP208 Sheet 1 of 1	
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433739.00 - 400359.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 3.00		Logged LEW	

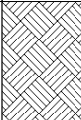
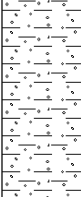
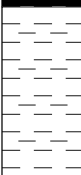
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)	
	0.60	D	HVP=65	0.90			Firm orangish brown mottled grey slightly gravelly CLAY. Gravel is subangular fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)	
	1.30	T	HVP=82	1.10			Stiff brown mottled grey gravelly CLAY. Gravel is subangular fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)	1
				1.40			Grey clayey sandy angular to subangular fine to coarse GRAVEL of mudstone. (GRANULAR RESIDUAL SOIL)	
				1.70			Weak dark grey thinly laminated MUDSTONE recovered as slightly clayey sandy tabular fine to coarse gravel. (COAL MEASURES - MUDSTONE)	
	2.50	T		3.00			Weak brown thinly laminated SILTSTONE with occasional ironstone nodules recovered as sandy angular tabular fine to coarse gravel with many cobbles. (COAL MEASURES - SILTSTONE)	2
							Unable to excavate beyond 3.0m. End of pit at 3.00 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. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.	
Stability: 1. The sides of the trial pit remained stable during excavation.	

				Trial Pit Log			Trialpit No TP209 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433748.00 - 400335.00 Level:		Date 16/03/2018	
Location:				Dimensions (m):		3		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West				Depth 3.40				Logged LEW	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
			HVP=58	0.30			TOPSOIL: Greyish brown gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)		
							Firm brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)		
				1.60			Stiff orangish brown mottled grey slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)		
				2.30			Stiff greyish brown gravelly CLAY. Gravel is angular to subangular fine to medium of siltstone. (COHESIVE RESIDUAL SOIL) <i>No hand vane shear tests could be undertaken as no blocks of clay were recovered.</i>		
				2.80			Weak light brown thinly laminated SILTSTONE recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES - SILTSTONE)		
				3.40		Unable to excavate beyond 3.4m. End of pit at 3.40 m			
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.									
Stability: 1. The sides of the trial pit remained stable during excavation.									



				Trial Pit Log			Trialpit No TP210 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433695.00 - 400362.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 2.50		Logged LEW	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
▼	0.10	J&T	HVP=82	0.40			TOPSOIL: Dark brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)	1
	0.70	D&B				Stiff orangish brown mottled grey slightly gravelly CLAY. Gravel is subangular fine to medium of sandstone. (COHESIVE RESIDUAL SOIL) <u>At 0.4m, groundwater seepage.</u>		
	1.20	T		1.10		Weak brittle black COAL recovered as slightly clayey sandy angular fine to medium gravel. (FLOCKTON THICK COAL)		
	1.30	T		1.40		Firm grey CLAY. (SEATEARTH)		
				2.00		Weak brown thinly laminated SILTSTONE recovered as sandy angular tabular fine to coarse gravel with many cobbles. (COAL MEASURES - SILTSTONE) <u>Unable to excavate beyond 2.4m.</u>		
			2.50			End of pit at 2.50 m		3
								4
								5

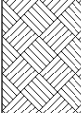
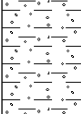
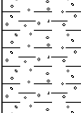
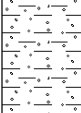
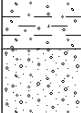
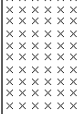
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 0.4m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.		
Stability: 1. The sides of the trial pit remained stable during excavation.		

				Trial Pit Log			Trialpit No TP211 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433657.00 - 400388.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 3.20		Logged LEW	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T	HVP=62				TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)	1
				0.30			Firm orangish brown mottled grey slightly gravelly CLAY. Gravel is subangular to subrounded fine of sandstone. (COHESIVE RESIDUAL SOIL)	
				0.80			Firm brown mottled grey gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)	
	1.10	D&B	HVP=94				No hand vane shear tests could be undertaken due to gravel content of clay.	2
				1.40			Stiff greyish brown gravelly CLAY. Gravel is subangular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)	
	1.60	D						
	2.40	T		2.10			Weak brittle black COAL recovered as slightly clayey sandy angular fine to medium gravel with occasional cobbles. (FLOCKTON THICK COAL)	3
	2.70	T		3.00			Firm grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)	
			3.20			End of pit at 3.20 m		
								4
								5

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

				Trial Pit Log				Trialpit No TP212 Sheet 1 of 1	
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433683.00 - 400411.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 3.20		Logged LEW	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T					TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)	
	0.70	D	HVP=67	0.40			Firm orangish brown mottled grey slightly gravelly CLAY. Gravel is subangular to subrounded fine of sandstone. (COHESIVE RESIDUAL SOIL)	1
				1.20			Stiff greyish brown gravelly CLAY. Gravel is angular to subangular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)	
			HVP=80	1.80			At 1.4m, 10cm band of clayey gravel of mudstone with occasional ironstone nodules.	
	2.00	B		2.10			Greyish brown clayey sandy angular to subangular fine to medium GRAVEL of mudstone. (GRANULAR RESIDUAL SOIL)	2
				2.40			Weak dark grey thinly laminated carbonaceous MUDSTONE recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES - MUDSTONE)	
	2.80	D&B					Weak dark brown thinly laminated SILTSTONE recovered as sandy angular tabular fine to medium gravel. (COAL MEASURES - SILTSTONE)	
				3.20			From 2.9m, occasional cobbles.	3
							End of pit at 3.20 m	4
								5

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

				Trial Pit Log			Trialpit No TP213 Sheet 1 of 1		
Project Name: New Road, Pilley				Project No. 2222		Co-ords: 433694.00 - 400438.00 Level:		Date 16/03/2018	
Location:						Dimensions (m):		Scale 1:25	
Client: Barratt & David Wilson Homes Yorkshire West						Depth 3.00		Logged LEW	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.30		 TOPSOIL: Dark greyish brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)		
			HVP=68			 Firm orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of sandstone. (COHESIVE RESIDUAL SOIL)		
	0.90	D		1.40		 From 0.9m, clay is stiff.	1	
			HVP=98			 Stiff greyish brown gravelly CLAY. Gravel is subangular fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)		
	2.40	D&B		2.00		 Greyish brown clayey sandy angular tabular fine to medium GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)	2	
				2.70		 Weak brown thinly laminated SILTSTONE recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES - SILTSTONE)		
				3.00		Difficult to excavate beyond 3.0m. End of pit at 3.00 m	3	
							4	
							5	

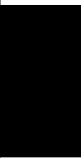
Remarks:	1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.
Stability:	1. The sides of the trial pit remained stable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



Appendix G

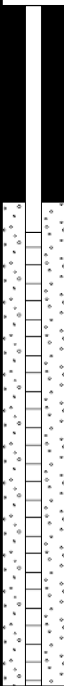
Probehole Logs



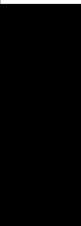
					Borehole Log			Borehole No. PH101 Sheet 2 of 4		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433718.00 - 400408.00		Hole Type PH	
Location:					Level: 147.35		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					11.00	136.35		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	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. 3. Full air returns.										

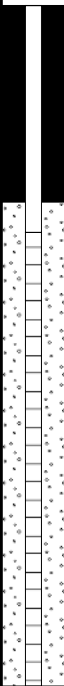
					Borehole Log			Borehole No. PH101 Sheet 3 of 4		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433718.00 - 400408.00		Hole Type PH	
Location:					Level: 147.35		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
Continued on next sheet									30	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.										

					Borehole Log			Borehole No. PH101 Sheet 4 of 4													
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433718.00 - 400408.00		Hole Type PH												
Location:					Level: 147.35		Scale 1:50		Logged By MAR												
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015																
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description													
		Depth (m)	Type	Results																	
					36.00	111.35				31											
										32											
										33											
										34											
										35											
										36											
										37											
										38											
										39											
										40											
										End of borehole at 36.00 m											
										Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.											

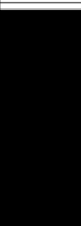
				Borehole Log			Borehole No. PH101A Sheet 1 of 1		
Project Name: Lidgett Lane and New Road, Pilley				Project No. 2222		Co-ords: -		Hole Type PH	
Location:						Level:		Scale 1:50	
Client: Redrow Homes Ltd						Dates: 22/09/2015 - 22/09/2015		Logged By MAR	
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								OVERBURDEN (WEATHERED COAL MEASURES)	1 2 3 4 5 6 7 8 9 10
					4.00			Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	
					4.50		End of borehole at 4.50 m		
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.									

					Borehole Log			Borehole No. PH102 Sheet 1 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433775.00 - 400388.00		Hole Type PH	
Location:					Level: 145.50		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	144.50		OVERBURDEN (WEATHERED COAL MEASURES)		
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	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. 3. Full air returns.										

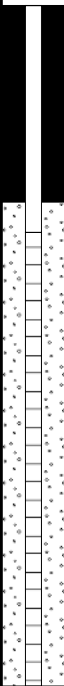
					Borehole Log			Borehole No. PH102 Sheet 2 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433775.00 - 400388.00		Hole Type PH	
Location:					Level: 145.50		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					11.70	133.80			11	
								COAL (FLOCKTON THICK SEAM)	12	
					13.20	132.30		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	13	
					15.00	130.50		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. 3. Full air returns.										

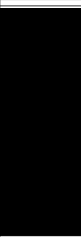
				Borehole Log				Borehole No. PH102A Sheet 1 of 1	
Project Name: Lidgett Lane and New Road, Pilley				Project No. 2222		Co-ords: -		Hole Type PH	
Location:						Level:		Scale 1:50	
Client: Redrow Homes Ltd						Dates: 22/09/2015 - 22/09/2015		Logged By MAR	
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00			OVERBURDEN (WEATHERED COAL MEASURES)	1
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	2
					4.50		End of borehole at 4.50 m		
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.									



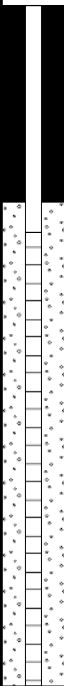
					Borehole Log			Borehole No. PH103 Sheet 1 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433756.00 - 400363.00		Hole Type PH	
Location:					Level: 143.45		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	142.45		OVERBURDEN	1	
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	2	
									3	
									4	
									5	
					5.90	137.55		COAL (FLOCKTON THICK SEAM)	6	
					7.40	136.05		Interbedded mudstone and sandstone (PENNINE LOWER 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. 3. Full air returns.										

					Borehole Log			Borehole No. PH103 Sheet 2 of 2			
Project Name: Lidgett Lane and New Road, Pilly					Project No. 2222		Co-ords: 433756.00 - 400363.00		Hole Type PH		
Location:					Level: 143.45		Scale 1:50		Logged By MAR		
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					12.00	131.45					
										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.											

				Borehole Log				Borehole No. PH103A Sheet 1 of 1	
Project Name: Lidgett Lane and New Road, Pilley				Project No. 2222		Co-ords: -		Hole Type PH	
Location:						Level:		Scale 1:50	
Client: Redrow Homes Ltd						Dates: 22/09/2015 - 22/09/2015		Logged By MAR	
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00			OVERBURDEN (WEATHERED COAL MEASURES)	1
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	2
					4.50		End of borehole at 4.50 m		
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.									
									

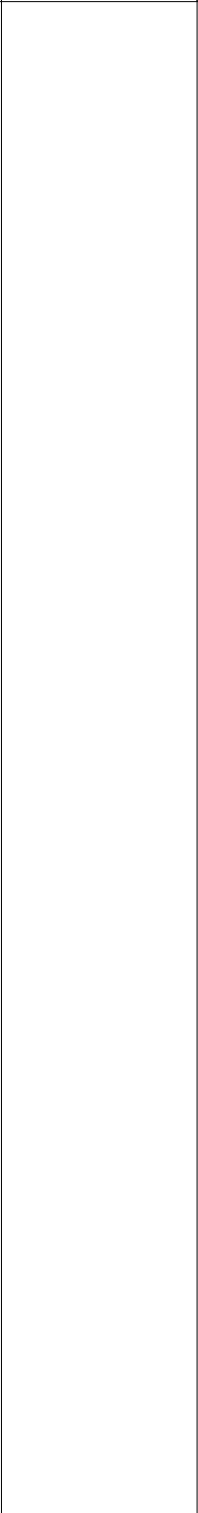
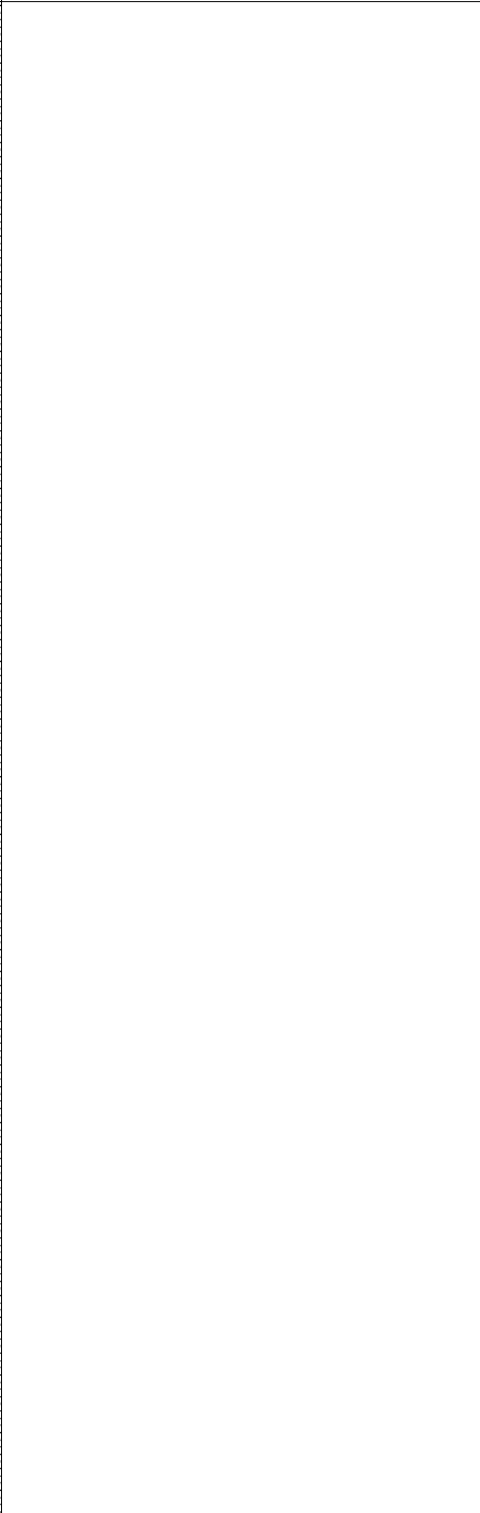
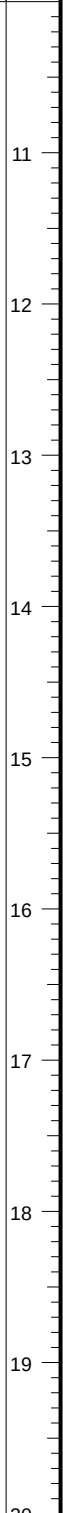
					Borehole Log			Borehole No. PH104 Sheet 1 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433704.00 - 400382.00		Hole Type PH	
Location:					Level: 145.05		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	144.05		OVERBURDEN (WEATHERED COAL MEASURES)		
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	1	
									2	
									3	
					4.10	140.95		COAL (FLOCKTON THICK SEAM)	4	
									5	
					5.60	139.45		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	6	
									7	
									8	
									9	
Continued on next sheet									10	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.										

					Borehole Log			Borehole No. PH104 Sheet 2 of 2			
Project Name: Lidgett Lane and New Road, Pilly					Project No. 2222		Co-ords: 433704.00 - 400382.00		Hole Type PH		
Location:					Level: 145.05		Scale 1:50		Logged By MAR		
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					12.00	133.05					
										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.											

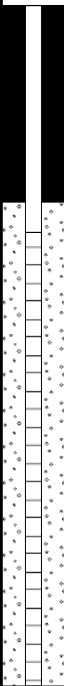
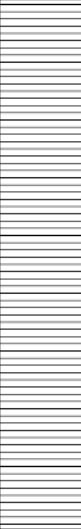
				Borehole Log				Borehole No. PH104A Sheet 1 of 1	
Project Name: Lidgett Lane and New Road, Pilley				Project No. 2222		Co-ords: -		Hole Type PH	
Location:						Level:		Scale 1:50	
Client: Redrow Homes Ltd						Dates: 22/09/2015 - 22/09/2015		Logged By MAR	
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00			OVERBURDEN (WEATHERED COAL MEASURES)	1
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	2
									3
									4
					4.10			COAL (FLOCKTON THICK SEAM)	
					4.50		End of borehole at 4.50 m		
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.									



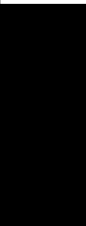
					Borehole Log			Borehole No. PH105 Sheet 1 of 3	
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433821.00 - 400441.00		Hole Type PH
Location:					Level: 150.25		Scale 1:50		
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00	149.25		OVERBURDEN (WEATHERED COAL MEASURES)	
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	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. 3. Full air returns.									

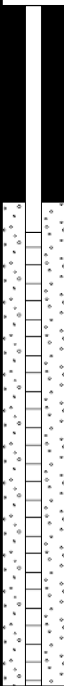
					Borehole Log			Borehole No. PH105 Sheet 2 of 3										
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433821.00 - 400441.00		Hole Type PH									
Location:					Level: 150.25		Scale 1:50		Logged By MAR									
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015													
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description										
		Depth (m)	Type	Results														
																		
										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. Full air returns.																		

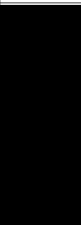


				Borehole Log				Borehole No. PH105A Sheet 1 of 1	
Project Name: Lidgett Lane and New Road, Pilley				Project No. 2222		Co-ords: -		Hole Type PH	
Location:						Level:		Scale 1:50	
Client: Redrow Homes Ltd						Dates: 22/09/2015 - 22/09/2015		Logged By MAR	
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00			OVERBURDEN (WEATHERED COAL MEASURES)	1
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	2
					4.50		End of borehole at 4.50 m		
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.									
									

					Borehole Log			Borehole No. PH106 Sheet 1 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433681.00 - 400436.00		Hole Type PH	
Location:					Level: 152.85		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	151.85		OVERBURDEN (WEATHERED COAL MEASURES)		
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	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. 3. Full air returns.										

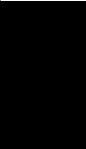
					Borehole Log			Borehole No. PH106 Sheet 2 of 2			
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433681.00 - 400436.00		Hole Type PH		
Location:					Level: 152.85		Scale 1:50		Logged By MAR		
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					11.50	141.35				11	
								COAL (FLOCKTON THICK SEAM)		12	
					13.00	139.85		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)		13	
					15.00	137.85		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. 3. Full air returns.											

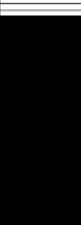
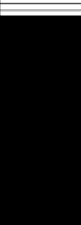
					Borehole Log			Borehole No. PH106A Sheet 1 of 1		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: -		Hole Type PH	
Location:					Level:			Scale 1:50		
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015			Logged By MAR		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00			OVERBURDEN (WEATHERED COAL MEASURES)		
					4.50			Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	1 2 3 4	
							End of borehole at 4.50 m		5 6 7 8 9 10	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.										

					Borehole Log			Borehole No. PH107 Sheet 1 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433684.00 - 400406.00		Hole Type PH	
Location:					Level: 148.85		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	147.85		OVERBURDEN (WEATHERED COAL MEASURES)		
									Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	1
										2
										3
					7.20	141.65		COAL (FLOCKTON THICK SEAM)	7	
					8.70	140.15		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	9	
Continued on next sheet									10	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.										

					Borehole Log			Borehole No. PH107 Sheet 2 of 2		
Project Name: Lidgett Lane and New Road, Pilly					Project No. 2222		Co-ords: 433684.00 - 400406.00		Hole Type PH	
Location:					Level: 148.85		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					12.00	136.85		End of borehole at 12.00 m	11	
									12	
									13	
									14	
									15	
									16	
									17	
									18	
									19	
									20	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.										

					Borehole Log			Borehole No. PH108 Sheet 1 of 2		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433781.00 - 400371.00		Hole Type PH	
Location:					Level: 143.95		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	142.95		OVERBURDEN (WEATHERED COAL MEASURES)		
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	1	
										2
									3	
									4	
									5	
									6	
									7	
									8	
									9	
					9.50	134.45		COAL (FLOCKTON THICK SEAM)	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. Full air returns.										

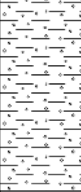
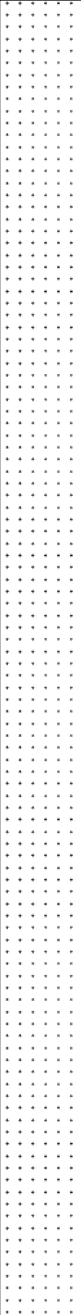
					Borehole Log			Borehole No. PH108 Sheet 2 of 2			
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433781.00 - 400371.00		Hole Type PH		
Location:					Level: 143.95		Scale 1:50		Logged By MAR		
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015						
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
					11.00	132.95		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)		11	
										12	
					15.00	128.95		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. Full air returns.											

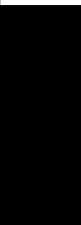
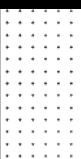
					Borehole Log			Borehole No. PH109 Sheet 1 of 1		
Project Name: Lidgett Lane and New Road, Pilley					Project No. 2222		Co-ords: 433730.00 - 400370.00		Hole Type PH	
Location:					Level: 143.95		Scale 1:50			
Client: Redrow Homes Ltd					Dates: 22/09/2015 - 22/09/2015		Logged By MAR			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00	142.95		OVERBURDEN (WEATHERED COAL MEASURES)		
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	1	
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	2	
								Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	3	
					4.60	139.35		COAL (FLOCKTON THICK SEAM)	4	
					6.10	137.85		Interbedded mudstone and sandstone (PENNINE LOWER COAL MEASURES)	5	
					9.00	134.95	End of borehole at 9.00 m			

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full air returns.



					Borehole Log			Borehole No. PH201 Sheet 1 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433709.00 - 400443.00		Hole Type PH
Location:					Level:		Scale 1:50		Logged By LEW
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.30			Overburden. (WEATHERED COAL MEASURES)	1
								Brown SANDSTONE and 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. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

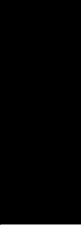
					Borehole Log			Borehole No. PH201 Sheet 2 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433709.00 - 400443.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
									11
									12
									13
									14
					17.50			Black COAL. (FLOCKTON THICK COAL)	18
					19.00			Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	19
							Continued on next sheet		20
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

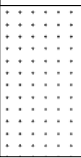
					Borehole Log			Borehole No. PH201	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433709.00 - 400443.00		Sheet 3 of 3
Location:					Level:		Hole Type PH		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Scale 1:50		
Logged By LEW									
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					21.00			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. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

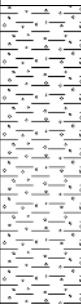
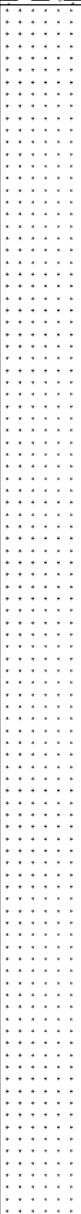
					Borehole Log			Borehole No. PH202 Sheet 1 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433751.00 - 400430.00		Hole Type PH
Location:					Level:		Scale 1:50		Logged By LEW
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018				

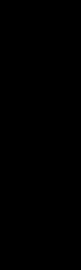
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00		Overburden. (WEATHERED COAL MEASURES)		
							Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	1	
								2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	
							Continued on next sheet	10	

Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.		
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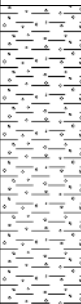
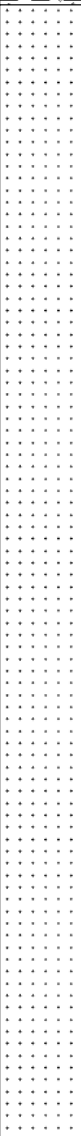
					Borehole Log			Borehole No. PH202 Sheet 2 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433751.00 - 400430.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					17.00				11
									12
									13
									14
					18.50			Black COAL. (FLOCKTON THICK COAL) <i>At 17.5m, 0.3m band of grey mudstone.</i>	15
									16
									17
									18
								Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	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. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

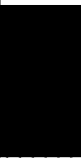
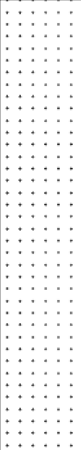
					Borehole Log			Borehole No. PH202 Sheet 3 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433751.00 - 400430.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					21.00			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. 3. Co-ordinates from hand held GPS, hole not surveyed in.

					Borehole Log			Borehole No. PH203 Sheet 1 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433790.00 - 400404.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.00			Overburden. (WEATHERED COAL MEASURES)	1
								Brown SANDSTONE and 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. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

					Borehole Log			Borehole No. PH203 Sheet 2 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433790.00 - 400404.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					16.50				11
									12
									13
									14
					18.30			Black COAL. (FLOCKTON THICK COAL) <i>At 17.0m, 0.3m band of grey mudstone.</i>	15
									16
									17
									18
								Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	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. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

					Borehole Log			Borehole No. PH203	
							Sheet 3 of 3		
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433790.00 - 400404.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					21.00			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. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

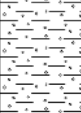
					Borehole Log			Borehole No. PH204 Sheet 1 of 2		
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433719.00 - 400391.00		Hole Type PH	
Location:					Level:		Scale 1:50			
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					2.00			Overburden. (WEATHERED COAL MEASURES)	1	
								Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	2	
					9.50				4	
										5
										6
					9.50				7	
										8
										9
					9.50			Black COAL. (FLOCKTON THICK COAL)	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. Co-ordinates from hand held GPS, hole not surveyed in.										

					Borehole Log			Borehole No. PH204 Sheet 2 of 2	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433719.00 - 400391.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.00			At 10.0m, 0.3m band of grey mudstone.	
					14.00			Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	11 12 13 14 15 16 17 18 19 20
End of borehole at 14.00 m									
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.									
									

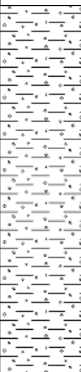
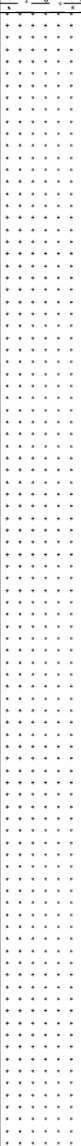
					Borehole Log			Borehole No. PH205 Sheet 1 of 1	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433668.00 - 400402.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.70		Overburden. (WEATHERED COAL MEASURES)	1	
							Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	2	
								3	
								4	
					6.50		Black COAL. (FLOCKTON THICK COAL) <i>At 6.8m, 0.3m band of grey mudstone.</i>	7	
							Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	8	
								9	
								10	
					9.50		End of borehole at 9.50 m		

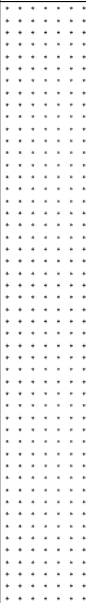
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.								
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					Borehole Log			Borehole No. PH206 Sheet 1 of 1	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433715.00 - 400355.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.80			Overburden. (WEATHERED COAL MEASURES)	
								Brown SANDSTONE and grey MUDSTONE. (COAL MEASURES)	1
									2
									3
									4
									5
									6
									7
									8
					9.00			End of borehole at 9.00 m	9
									10
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.									



					Borehole Log			Borehole No. PH208 Sheet 1 of 3	
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433658.00 - 400450.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					2.50			Overburden. (WEATHERED COAL MEASURES)	1
							Brown SANDSTONE and 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 encountered at 18.0m during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

					Borehole Log			Borehole No. PH208 Sheet 2 of 3		
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433658.00 - 400450.00		Hole Type PH	
Location:					Level:		Scale 1:50		Logged By LEW	
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018					
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
								From 15.0m to 15.5m, driller reported traces of coal.	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 18.0m during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.										

					Borehole Log			Borehole No. PH208	
							Sheet 3 of 3		
Project Name: New Road, Pilley					Project No. 2222		Co-ords: 433658.00 - 400450.00		Hole Type PH
Location:					Level:		Scale 1:50		
Client: Barratt & David Wilson Homes Yorkshire West					Dates: 04/04/2018 - 04/04/2018		Logged By LEW		
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					24.00				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 encountered at 18.0m during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in.									

Appendix H

Chemical Test Results



Certificate of Analysis

Certificate Number 18-06563

27-Mar-18

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 18-06563

Client Reference 2222

Order No PO12789/2222

Contract Title New Road, Pilley

Description 15 Soil samples.

Date Received 21-Mar-18

Date Started 21-Mar-18

Date Completed 27-Mar-18

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager



Summary of Chemical Analysis

Soil Samples

Our Ref 18-06563

Client Ref 2222

Contract Title New Road, Pilley

Lab No	1313705	1313706	1313707	1313708	1313709	1313710
Sample ID	TP201	TP203	TP204	TP207	TP208	TP211
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	16/03/18	16/03/18	16/03/18	16/03/18	16/03/18	16/03/18
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	18	14	16	12	14	15
Boron, Water Soluble	DETSC 2123#	0.2	mg/kg	1.2	1.5	1.3	1.3	1.7	1.6
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.3	0.3	0.3	0.3	0.3
Chromium	DETSC 2301#	0.15	mg/kg	18	18	18	19	21	21
Chromium III	DETSC 2301*	0.15	mg/kg	18	18	18	19	21	21
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	40	30	32	36	29	30
Lead	DETSC 2301#	0.3	mg/kg	65	41	47	53	50	53
Mercury	DETSC 2325#	0.05	mg/kg	0.13	0.06	0.07	0.1	0.06	0.08
Nickel	DETSC 2301#	1	mg/kg	20	19	19	31	21	19
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	0.7	0.7	< 0.5
Zinc	DETSC 2301#	1	mg/kg	84	79	350	100	92	93
Inorganics									
pH	DETSC 2008#			6.8	6.9	6.6	6.9	7.3	7.1
Calorific Value	DETSC 5008	1	MJ/kg						
Total Organic Carbon	DETSC 2084#	0.5	%	4.7	4.7	4.4	5.3	3.9	4.9
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l						
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.04	< 0.03	0.09	< 0.03	< 0.03	0.03
Pyrene	DETSC 3303#	0.03	mg/kg	0.03	< 0.03	0.08	< 0.03	< 0.03	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10	< 0.10	0.34	< 0.10	< 0.10	< 0.10

Summary of Chemical Analysis

Soil Samples

Our Ref 18-06563

Client Ref 2222

Contract Title New Road, Pilley

Lab No	1313711	1313712	1313713	1313714	1313715	1313716
Sample ID	TP210	TP210	TP211	TP211	TP203	TP205
Depth	1.20	1.30	2.40	2.70	1.20	1.30
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	16/03/18	16/03/18	16/03/18	16/03/18	16/03/18	16/03/18
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						
Boron, Water Soluble	DETSC 2123#	0.2	mg/kg						
Cadmium	DETSC 2301#	0.1	mg/kg						
Chromium	DETSC 2301#	0.15	mg/kg						
Chromium III	DETSC 2301*	0.15	mg/kg						
Chromium, Hexavalent	DETSC 2204*	1	mg/kg						
Copper	DETSC 2301#	0.2	mg/kg						
Lead	DETSC 2301#	0.3	mg/kg						
Mercury	DETSC 2325#	0.05	mg/kg						
Nickel	DETSC 2301#	1	mg/kg						
Selenium	DETSC 2301#	0.5	mg/kg						
Zinc	DETSC 2301#	1	mg/kg						
Inorganics									
pH	DETSC 2008#			6.1	6.1	5.6	5.5	6.6	7.1
Calorific Value	DETSC 5008	1	MJ/kg	18.5	17.6	4.5	28.3		
Total Organic Carbon	DETSC 2084#	0.5	%						
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	19	18	27	50	15	12
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg						
Acenaphthylene	DETSC 3303#	0.03	mg/kg						
Acenaphthene	DETSC 3303#	0.03	mg/kg						
Fluorene	DETSC 3303	0.03	mg/kg						
Phenanthrene	DETSC 3303#	0.03	mg/kg						
Anthracene	DETSC 3303	0.03	mg/kg						
Fluoranthene	DETSC 3303#	0.03	mg/kg						
Pyrene	DETSC 3303#	0.03	mg/kg						
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg						
Chrysene	DETSC 3303	0.03	mg/kg						
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg						
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg						
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg						
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg						
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg						
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg						
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg						

Summary of Chemical Analysis

Soil Samples

Our Ref 18-06563

Client Ref 2222

Contract Title New Road, Pilley

Lab No	1313717	1313718	1313719
Sample ID	TP208	TP202	TP207
Depth	1.30	1.50	2.40
Other ID			
Sample Type	SOIL	SOIL	SOIL
Sampling Date	16/03/18	16/03/18	16/03/18
Sampling Time	n/s	n/s	n/s

Test	Method	LOD	Units			
Metals						
Arsenic	DETSC 2301#	0.2	mg/kg			
Boron, Water Soluble	DETSC 2123#	0.2	mg/kg			
Cadmium	DETSC 2301#	0.1	mg/kg			
Chromium	DETSC 2301#	0.15	mg/kg			
Chromium III	DETSC 2301*	0.15	mg/kg			
Chromium, Hexavalent	DETSC 2204*	1	mg/kg			
Copper	DETSC 2301#	0.2	mg/kg			
Lead	DETSC 2301#	0.3	mg/kg			
Mercury	DETSC 2325#	0.05	mg/kg			
Nickel	DETSC 2301#	1	mg/kg			
Selenium	DETSC 2301#	0.5	mg/kg			
Zinc	DETSC 2301#	1	mg/kg			
Inorganics						
pH	DETSC 2008#			6.3	7.3	7.5
Calorific Value	DETSC 5008	1	MJ/kg			
Total Organic Carbon	DETSC 2084#	0.5	%			
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	16	16	17
PAHs						
Naphthalene	DETSC 3303#	0.03	mg/kg			
Acenaphthylene	DETSC 3303#	0.03	mg/kg			
Acenaphthene	DETSC 3303#	0.03	mg/kg			
Fluorene	DETSC 3303	0.03	mg/kg			
Phenanthrene	DETSC 3303#	0.03	mg/kg			
Anthracene	DETSC 3303	0.03	mg/kg			
Fluoranthene	DETSC 3303#	0.03	mg/kg			
Pyrene	DETSC 3303#	0.03	mg/kg			
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg			
Chrysene	DETSC 3303	0.03	mg/kg			
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg			
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg			
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg			
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg			
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg			
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg			
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg			

Summary of Asbestos Analysis

Soil Samples

Our Ref 18-06563

Client Ref 2222

Contract Title New Road, Pilley

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1313705	TP201 0.10	SOIL	NAD	none	A Christodoulou
1313706	TP203 0.10	SOIL	NAD	none	A Christodoulou
1313707	TP204 0.10	SOIL	NAD	none	A Christodoulou
1313708	TP207 0.10	SOIL	NAD	none	A Christodoulou
1313709	TP208 0.10	SOIL	NAD	none	A Christodoulou
1313710	TP211 0.10	SOIL	NAD	none	A Christodoulou

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 18-06563
 Client Ref 2222
 Contract New Road, Pilley

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1313705	TP201 0.10 SOIL	16/03/18	GJ 250ml, PT 1L x2		
1313706	TP203 0.10 SOIL	16/03/18	GJ 250ml, PT 1L x2		
1313707	TP204 0.10 SOIL	16/03/18	GJ 250ml, PT 1L x2		
1313708	TP207 0.10 SOIL	16/03/18	GJ 250ml, PT 1L x2		
1313709	TP208 0.10 SOIL	16/03/18	GJ 250ml, PT 1L x2		
1313710	TP211 0.10 SOIL	16/03/18	GJ 250ml, PT 1L x2		
1313711	TP210 1.20 SOIL	16/03/18	PT 1L		
1313712	TP210 1.30 SOIL	16/03/18	PT 1L		
1313713	TP211 2.40 SOIL	16/03/18	PT 1L		
1313714	TP211 2.70 SOIL	16/03/18	PT 1L		
1313715	TP203 1.20 SOIL	16/03/18	PT 1L		
1313716	TP205 1.30 SOIL	16/03/18	PT 1L		
1313717	TP208 1.30 SOIL	16/03/18	PT 1L		
1313718	TP202 1.50 SOIL	16/03/18	PT 1L		
1313719	TP207 2.40 SOIL	16/03/18	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



4043

Contract Number: PSL18/1313

Report Date: 13 April 2018
Client's Reference: 2222
Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Lewis Whiteley/Matt Thompson

Contract Title: New Road, Pilley
Date Received: 21/3/2018
Date Commenced: 21/3/2018
Date Completed: 13/4/2018

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

R Berriman
(Quality Manager)

L Knight
(Senior Technician)

C Marshall
(Laboratory Manager)

A Fry
(Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

PSL
Professional Soils Laboratory

New Road, Pilley

Contract No:**PSL18/1313****Client Ref:**

2222

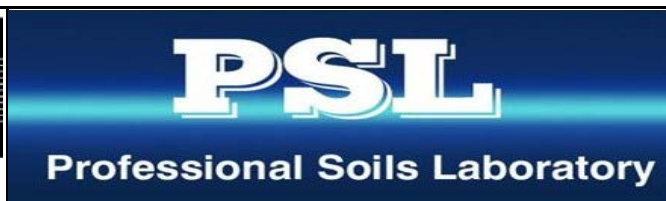
SUMMARY OF SOIL CLASSIFICATION TESTS

(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
TP205	1	D	0.50		21			42	22	20	88	Intermediate plasticity CI.
TP208	2	D	0.60		29			64	26	38	100	High plasticity CH.
TP203	2	D	0.70		19			53	22	31	96	High plasticity CH.
TP202	2	D	0.90		19			52	24	28	97	High plasticity CH.
TP213	2	D	0.90		21			48	23	25	99	Intermediate plasticity CI.
TP211	3	D	1.60		18			54	24	30	99	High plasticity CH.
TP210	2	D&B	0.70		27			48	24	24	99	Intermediate plasticity CI.
TP211	2	D&B	1.10		22			42	20	22	93	Intermediate plasticity CI.

SYMBOLS : NP : Non Plastic

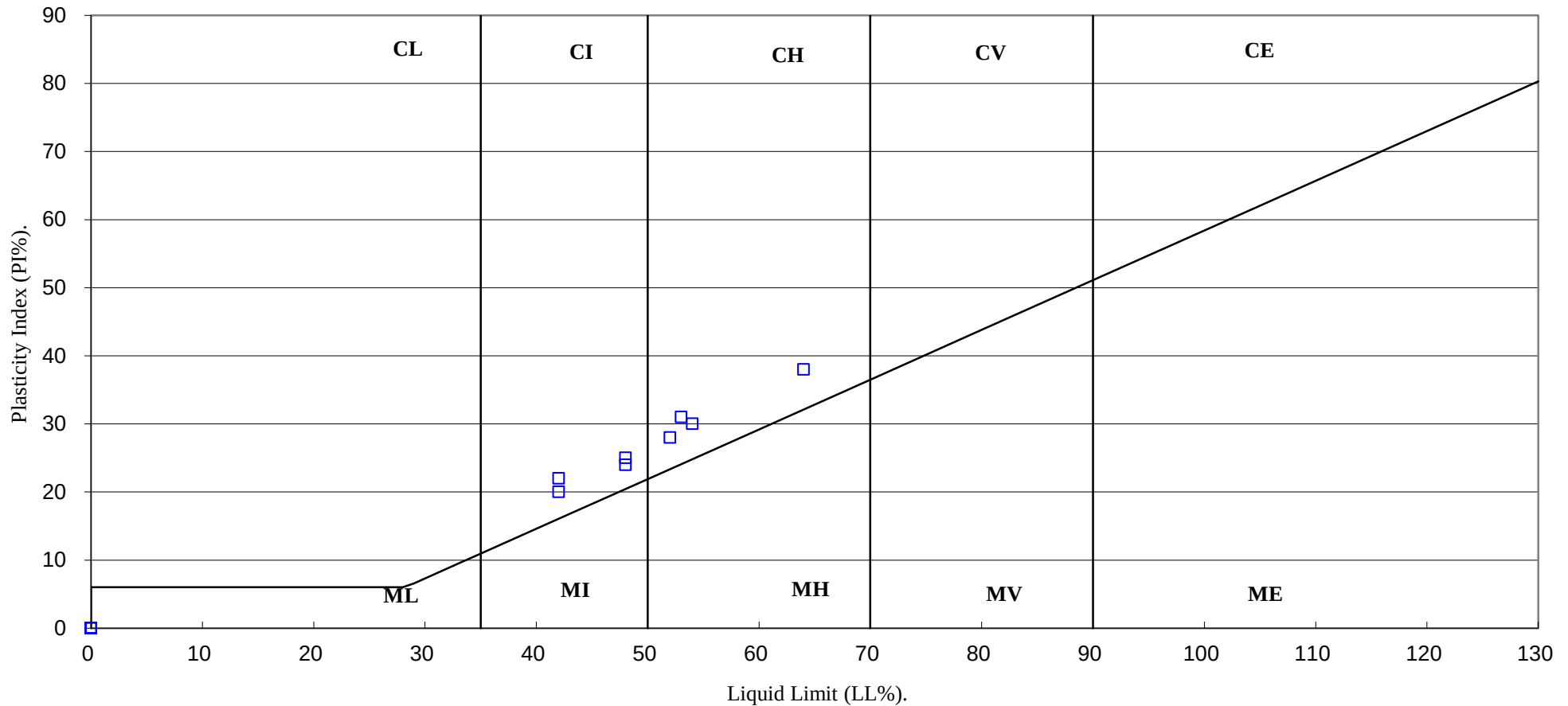
* : Liquid Limit and Plastic Limit Wet Sieved.



New Road, Pilley

Contract No:
PSL18/1313
Client Ref:
2222

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



4043

PSL
Professional Soils Laboratory

New Road, Pilley

Contract No:

PSL18/1313

Client Ref:

2222

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : 1990

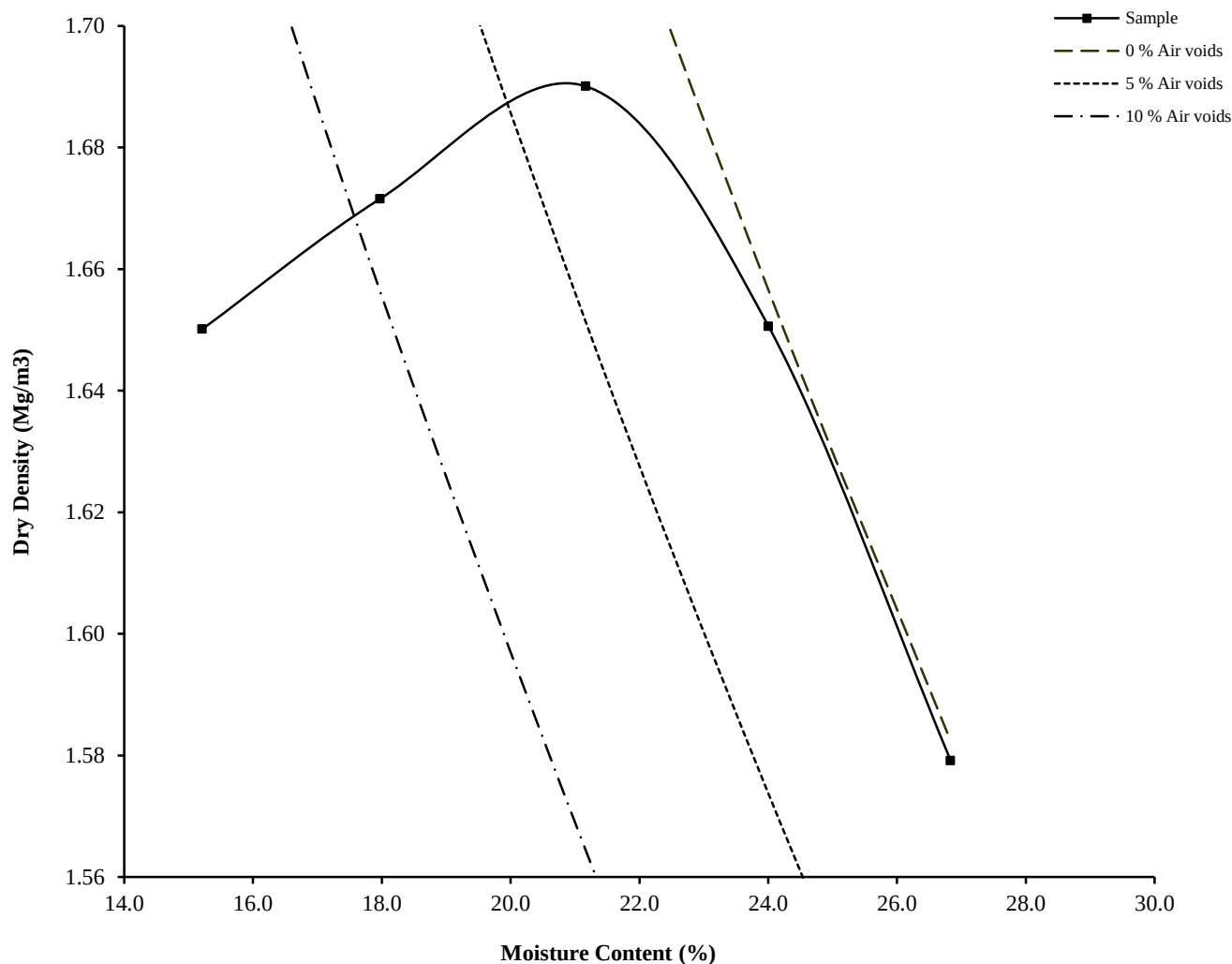
Hole Number: TP210

Top Depth (m) : 0.70

Sample Number: 2

Base Depth (m) :

Sample Type: D&B



Initial Moisture Content:	30	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m ³):	2.75	Assumed	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m ³):	1.69		Material Retained on 20.0 mm Test Sieve (%):	0
Optimum Moisture Content (%):	21			
Remarks				
See summary of soil descriptions.				



PSL
Professional Soils Laboratory

New Road, Pilley

Contract
PSL18/1313
Client Ref
2222

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : 1990

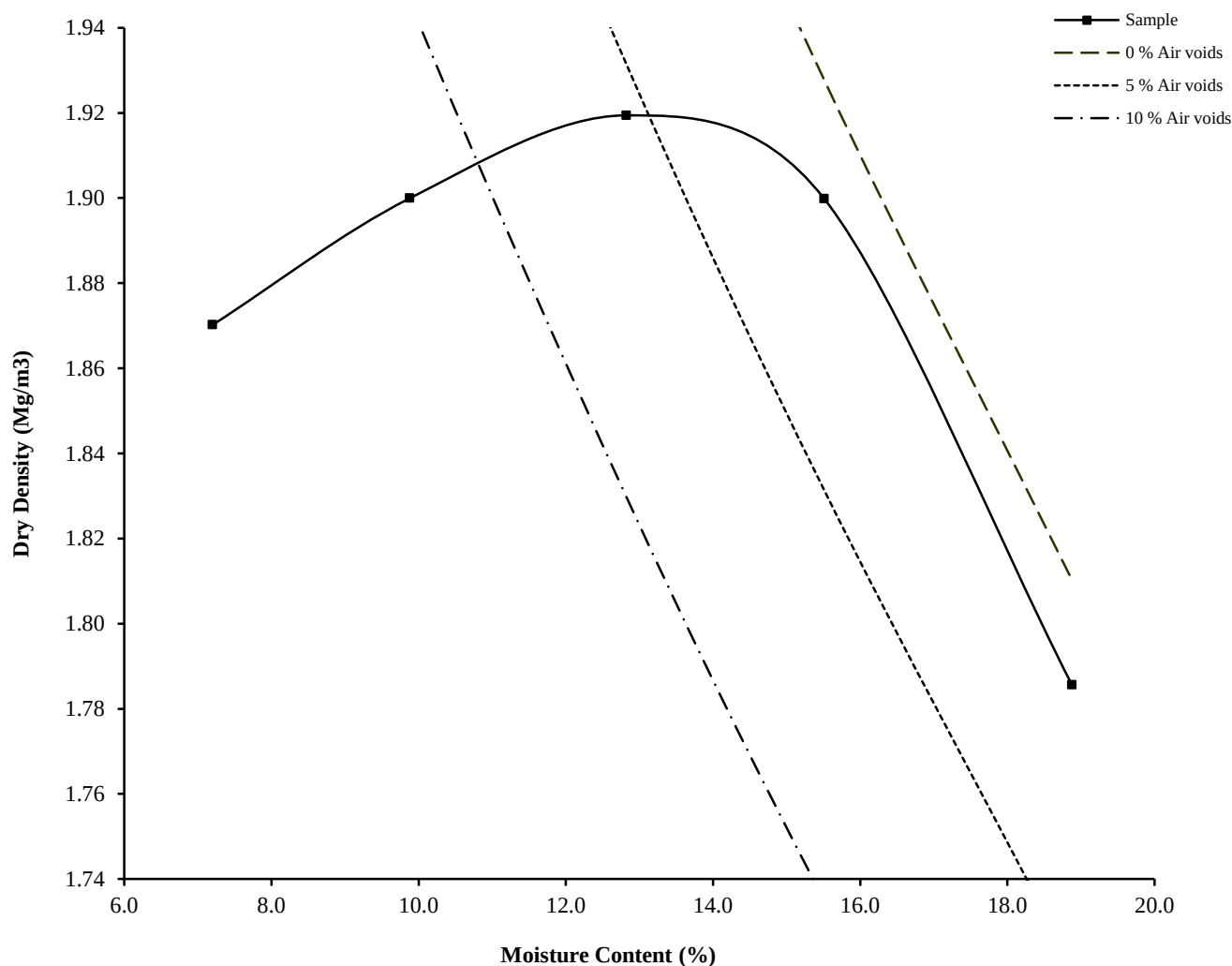
Hole Number: TP211

Top Depth (m) : 1.10

Sample Number: 2

Base Depth (m) :

Sample Type: D&B



Initial Moisture Content:	21	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m ³):	2.75	Assumed	Material Retained on 37.5 mm Test Sieve (%):	4
Maximum Dry Density (Mg/m ³):	1.92		Material Retained on 20.0 mm Test Sieve (%):	4
Optimum Moisture Content (%):	14			
Remarks				
See summary of soil descriptions.				

		New Road, Pilley	Contract
			PSL18/1313
			Client Ref
			2222

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : 1990

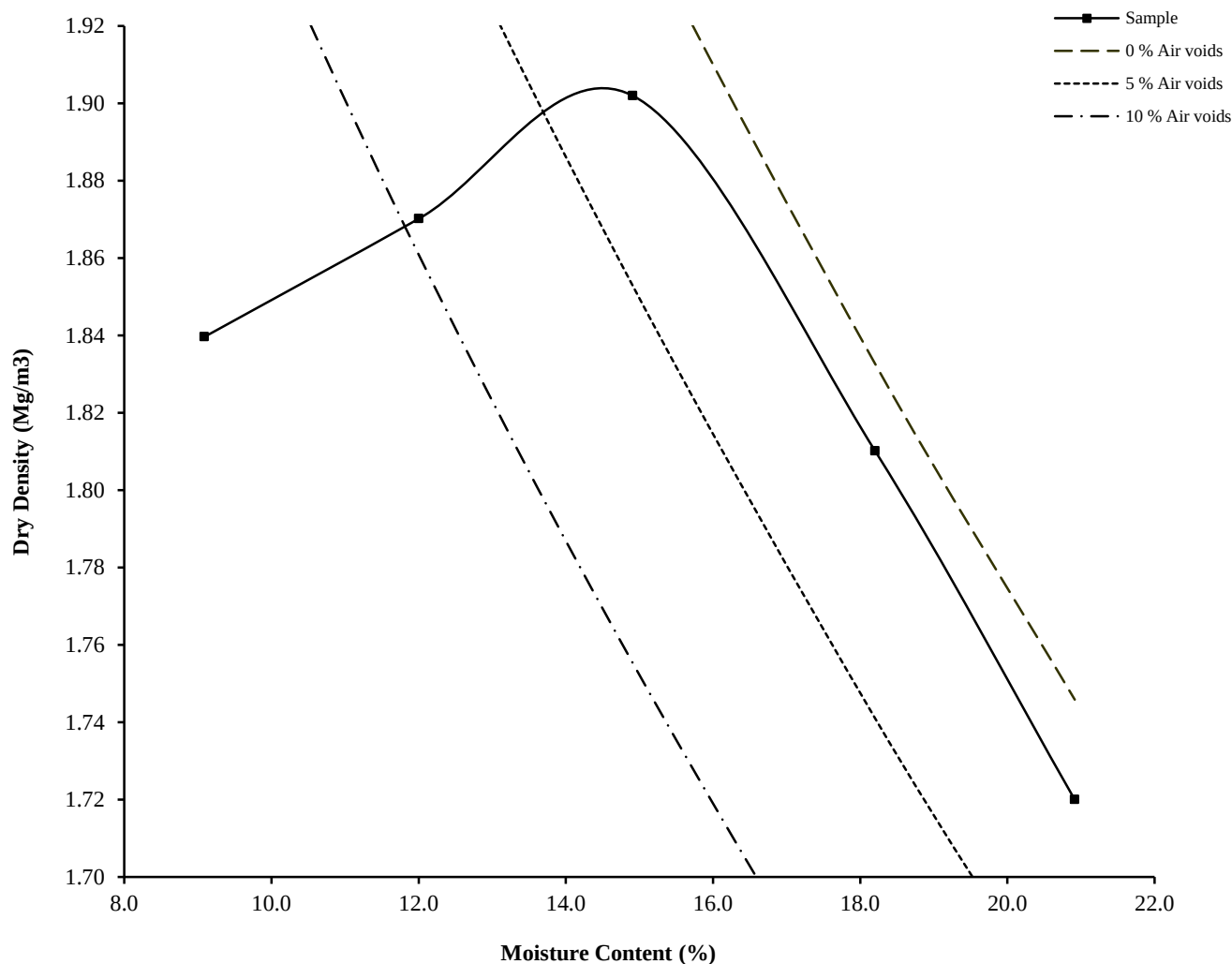
Hole Number: TP212

Top Depth (m) : 2.00

Sample Number: 3

Base Depth (m) :

Sample Type: B



Initial Moisture Content:	18	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m ³):	2.75	Assumed	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m ³):	1.90		Material Retained on 20.0 mm Test Sieve (%):	0
Optimum Moisture Content (%):	15			
Remarks				
See summary of soil descriptions.				

		New Road, Pilley	Contract
			PSL18/1313
			Client Ref
			2222

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : 1990

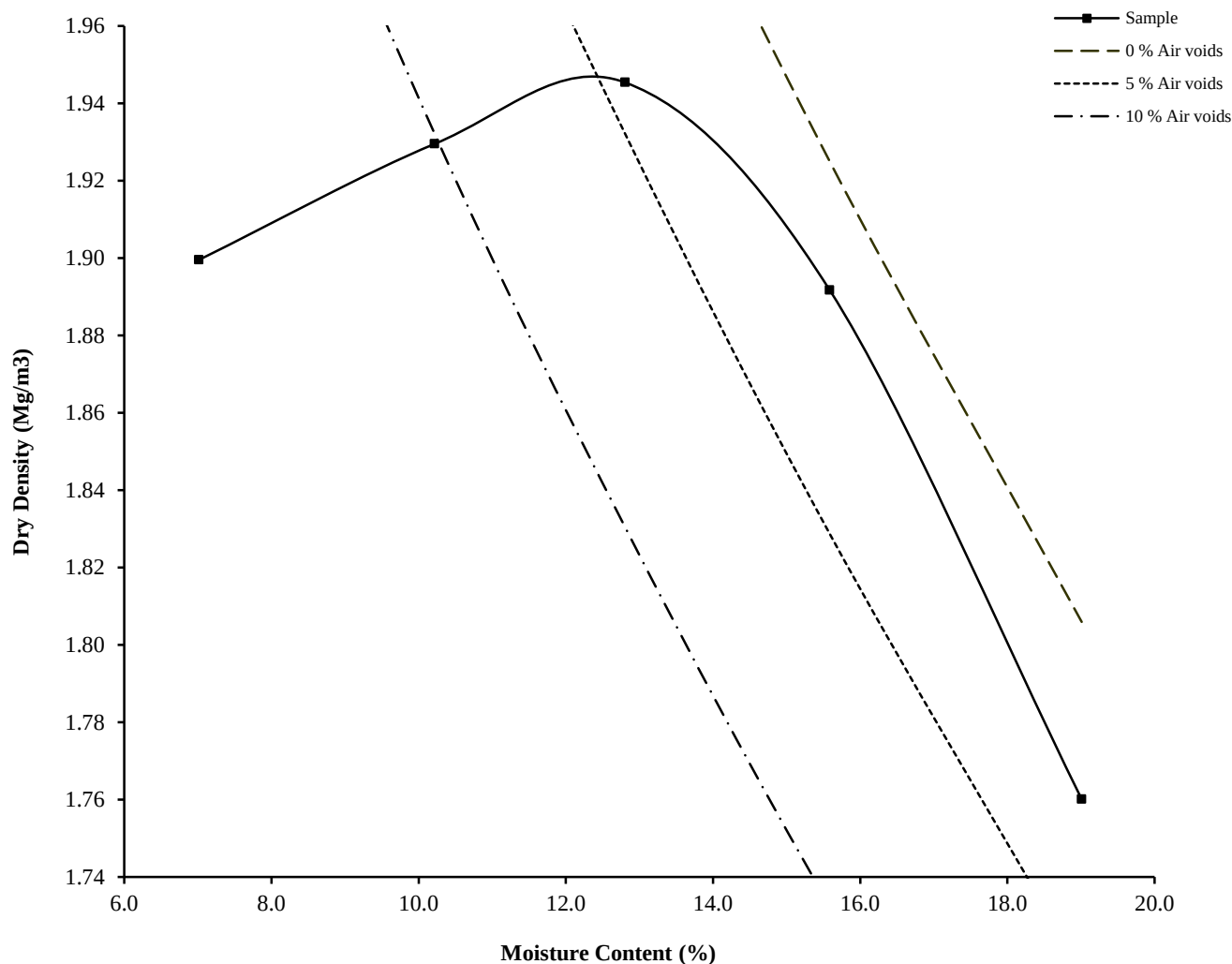
Hole Number: TP213

Top Depth (m) : 2.40

Sample Number: 3

Base Depth (m) :

Sample Type: D&B



Initial Moisture Content:	16	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m ³):	2.75	Assumed	Material Retained on 37.5 mm Test Sieve (%):	0
Maximum Dry Density (Mg/m ³):	1.95		Material Retained on 20.0 mm Test Sieve (%):	0
Optimum Moisture Content (%):	12			
Remarks				
See summary of soil descriptions.				

		New Road, Pilley	Contract
			PSL18/1313
			Client Ref
			2222



Certificate of Analysis

Certificate Number 18-06879

28-Mar-18

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

Our Reference 18-06879

Client Reference PSL18/1313

Order No (not supplied)

Contract Title New Road, Pilley

Description 6 Soil samples.

Date Received 23-Mar-18

Date Started 23-Mar-18

Date Completed 28-Mar-18

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager



Summary of Chemical Analysis

Soil Samples

Our Ref 18-06879

Client Ref PSL18/1313

Contract Title New Road, Pilley

Lab No	1315434	1315435	1315436	1315437	1315438	1315439
Sample ID	TP205	TP208	TP203	TP202	TP213	TP211
Depth	0.50	0.60	0.70	0.90	0.90	1.10
Other ID	1	2	2	2	2	2
Sample Type	D	D	D	D	D	D
Sampling Date	16/03/18	16/03/18	16/03/18	16/03/18	16/03/18	16/03/18
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Inorganics									
pH	DETSC 2008#			7.0	6.8	6.9	7.1	7.2	6.4
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	11	32	18	14	21	38

Information in Support of the Analytical Results

Our Ref 18-06879
 Client Ref PSL18/1313
 Contract New Road, Pilley

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1315434	TP205 0.50 SOIL	16/03/18	PT 500ml		
1315435	TP208 0.60 SOIL	16/03/18	PT 500ml		
1315436	TP203 0.70 SOIL	16/03/18	PT 500ml		
1315437	TP202 0.90 SOIL	16/03/18	PT 500ml		
1315438	TP213 0.90 SOIL	16/03/18	PT 500ml		
1315439	TP211 1.10 SOIL	16/03/18	PT 1L		

Key: P-Plastic T-Tub

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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:
Pilleys				2222
Client:				Sheet :
Redrow Homes				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
08/10/2015	12:20	13:30	J Jones	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.4
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Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂					
		(m) bgl	% v/v	(%)	% v/v	(%)	litre/hr	litre/hr	secs	m	
PH101	ND	ND	1.9	ND	1.9	16.8	ND	ND	ND	4.25	
PH102	ND	ND	1.0	ND	1.0	19.7	ND	ND	ND	4.23	
PH103	ND	ND	0.8	ND	0.8	19.4	ND	ND	ND	4.25	
PH104	ND	ND	0.8	ND	0.8	19.0	ND	ND	ND	4.25	
PH105	3.74	ND	4.1	ND	4.1	15.1	ND	ND	ND	4.33	
PH106	ND	ND	1.5	ND	1.5	19.6	ND	ND	ND	4.23	

Notes

Equipment Used:				Next Calibration Date				Key			
Gas Data GFM430 Infrared Gas Analyser				29/07/2016				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 (Birdwell Barnsley Station)							
		Temp (°C):		15		Barometric Pressure Trend:				Rising	
Time:		12:21 12:54 13:27		00:00 04:30 08:15		13:00 17:15 21:45		Trigger level 1		1.0 5.0 16.0	
Pressure (mb):		1002 1001 1000		1012.1 1014.4 1016.1		1018.2 1018.8 1019.9		Trigger level 2		5.0 10.0 10.0	
		Weather Conditions:		Cloudy							
		Surface Ground Conditions:		Dry							

Remarks:	
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Job Title:				Job No:
Pitiley				2222
Client:				Sheet :
Redrow Homes				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
26/10/2015	13:25	14:30	J Jones	

Gas Monitoring Results:						
Ambient Concentration (% Volume):		CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :
					20.1	

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	(%)					
PH101	ND	ND	2.7	ND	2.7	11.6	ND	ND	ND	4.24	H2S 2ppm
PH102	ND	ND	2.2	ND	2.2	16.2	ND	ND	ND	4.24	
PH103	ND	ND	2.2	ND	2.2	11.3	ND	ND	ND	4.30	
PH104	ND	ND	4.3	ND	4.3	3.7	ND	ND	ND	4.27	CO 28ppm. H2S 1ppm. Vandalised.
PH105	3.76	ND	2.3	ND	2.3	16.9	ND	ND	ND	4.33	
PH106	ND	ND	2.3	ND	2.3	17.4	ND	ND	ND	4.25	

Notes														
Equipment Used:						Next Calibration Date				Key				
Gas Data GFM430 Infrared Gas Analyser						29/07/2016				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 (Birdwell, Barnsley Station)								CH ₄	CO ₂	O ₂
		Temp (°C):	14	Barometric Pressure Trend:						Falling				
Time:	13:29	13:55	14:25	00:00	04:15	09:15	14:00	18:30	22:30	Trigger level 1	1.0	5.0	16.0	
Pressure (mb):	994	994	992	1016.8	1013.4	1012.4	1010	1009.7	1009.7	Trigger level 2	5.0	10.0	10.0	
		Weather Conditions:		Sunny										
		Surface Ground Conditions:		Dry										
Remarks:														



Job Title:				Job No:
Pitiley				2222
Client:				Sheet :
Redrow Homes				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
26/11/2015	11:25	12:30	J Jones	

Gas Monitoring Results:						
Ambient Concentration (% Volume):		CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :
					20.1	

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	(%)					
PH101	2.39	ND	0.8	ND	0.8	18.4	ND	ND	ND	4.23	
PH102	3.17	ND	1.0	ND	0.9	19.6	ND	ND	ND	4.24	CO2 to 0.9 in 31 seconds.
PH103	4.29	ND	1.9	ND	1.9	14.5	ND	ND	ND	4.32	
PH104	ND	ND	0.6	ND	0.6	20.3	ND	ND	ND	4.25	
PH105	2.32	ND	1.2	ND	1.2	19.8	ND	ND	ND	4.31	
PH106	4.09	ND	2.3	ND	2.3	13.3	ND	ND	ND	4.27	

Notes													
Equipment Used:						Next Calibration Date				Key			
Gas Data GFM430 Infrared Gas Analyser						29/07/2016				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 (Birdwell, Barnsley Station)								
		Temp (°C):			Barometric Pressure Trend:					Fluctuating			
Time:	11:31	12:00	12:22	00:00	04:15	08:30	12:00	16:15	20:30	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1001	998	999	1012.8	1013.4	1015.1	1015.8	1014.8	1013.8	Trigger level 2	5.0	10.0	10.0
		Weather Conditions:			Sunny								
		Surface Ground Conditions:			Damp								

Remarks:													
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Job Title:				Job No:
Pitiley				2222
Client:				Sheet :
Redrow Homes				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
09/12/2015	13:40	14:30	J Jones	

Gas Monitoring Results:						
Ambient Concentration (% Volume):		CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :
					20.3	

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	(%)					
PH101	3.09	ND	1.0	ND	1.0	15.1	ND	ND	ND	4.24	
PH102	2.82	ND	0.9	ND	0.9	19.7	ND	ND	ND	4.24	
PH103	ND	ND	2.7	ND	2.7	10.7	ND	ND	ND	4.25	
PH104	ND	ND	1.5	ND	1.5	17.5	2.6	0.6	12.0	4.23	
PH105	2.32	ND	1.6	ND	1.6	19.2	-0.6	0.0	17.0	4.32	
PH106	ND	ND	3.4	ND	3.4	11.5	ND	ND	ND	4.26	

Notes											
Equipment Used:						Next Calibration Date			Key		
Gas Data GFM430 Infrared Gas Analyser						26/07/2016			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 (Birdwell, Barnsley Station)						
		Temp (°C):	10	Barometric Pressure Trend:			Fluctuating				
Time:	13:42	14:02	14:25	00:00	04:14	09:45	14:00	16:00	21:15	Trigger level 1	1.0 5.0 16.0
Pressure (mb):	1007	1006	1004	1022.2	1024.3	1024.3	1021.9	1019.9	1017.8	Trigger level 2	5.0 10.0 10.0
		Weather Conditions:		Cloudy							
		Surface Ground Conditions:		Damp							
Remarks:											



Job Title:				Job No:	
Pitiley				2222	
Client:				Sheet :	
Redrow Homes				1 of 1	
Date:	Arrival Time:	Depart Time:	Operator:		
06/01/2016	11:30	12:20	J Jones		

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.5
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Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH101	1.96	ND	0.4	ND	0.4	17.5	ND	ND	ND	4.25	
PH102	1.29	ND	0.5	ND	0.5	19.4	ND	ND	ND	4.27	
PH103	4.25	ND	2.2	ND	2.2	12.0	ND	ND	ND	4.27	
PH104	4.22	ND	0.1	ND	0.1	20.5	ND	ND	ND	4.25	
PH105	1.73	ND	0.8	ND	0.8	19.9	ND	ND	ND	4.31	
PH106	3.53	ND	3.3	ND	3.3	9.0	-3.6	3.0	28.0	4.26	

Notes

Equipment Used:				Next Calibration Date				Key					
Gas Data GFM436 Infrared Gas Analyser				09/06/2016				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 (Birdwell, Barnsley Station)									
		Temp (°C):	7	Barometric Pressure Trend:			Fluctuating						
Time:	11:33	11:58	12:16	00:00	04:14	08:00	12:15	16:45	20:15	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	980	978	976	987.4	989.4	991.8	992.8	991.4	988.7	Trigger level 2	5.0	10.0	10.0
		Weather Conditions:		Cloudy/Still									
		Surface Ground Conditions:		Wet									

Remarks:	
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Job Title:				Job No:	
Pitiley				2222	
Client:				Sheet :	
Redrow Homes				1 of 1	
Date:	Arrival Time:	Depart Time:	Operator:		
14/01/2016	11:10	12:35	J Jones		

Gas Monitoring Results:						
Ambient Concentration (% Volume):	CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.3

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂					
		(m) bgl	% v/v	(%)	% v/v	(%)	litre/hr	litre/hr	secs		
PH101	2.46	ND	0.9	ND	0.9	17.7	ND	ND	ND	4.26	
PH102	2.14	ND	0.8	ND	0.8	19.7	ND	ND	ND	4.25	
PH103	ND	ND	1.9	ND	1.9	15.2	ND	ND	ND	4.26	
PH104	ND	ND	0.3	ND	0.3	19.7	-8.5	-5.8	23.0	4.22	
PH105	2.06	ND	0.9	ND	0.9	19.8	ND	ND	ND	0.32	
PH106	3.74	ND	3.5	ND	3.5	9.6	-5.5	-3.0	29.0	4.27	

Notes

Equipment Used:

Gas Data GFM436 Infrared Gas Analyser
Geotechnical Instruments Dipmeter

Next Calibration Date

09/06/2016

Key

ND None Detected
NR Not Recorded
1.0 Recorded value does not breach trigger levels
5.0 Recorded value breaches trigger level 1
10.0 Recorded value breaches trigger level 2

	Site Data:			Weather Station Data (Birdwell, Barnsley Station)							CH ₄	CO ₂	O ₂
	Temp (°C):	3		Barometric Pressure Trend:			Fluctuating						
Time:	11:15	11:49	12:15	00:00	04:15	12:00	16:15	20:00	22:45	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	986	983	984	998.2	996.2	1001.2	1005	1008	1009	Trigger level 2	5.0	10.0	10.0

Weather Conditions:

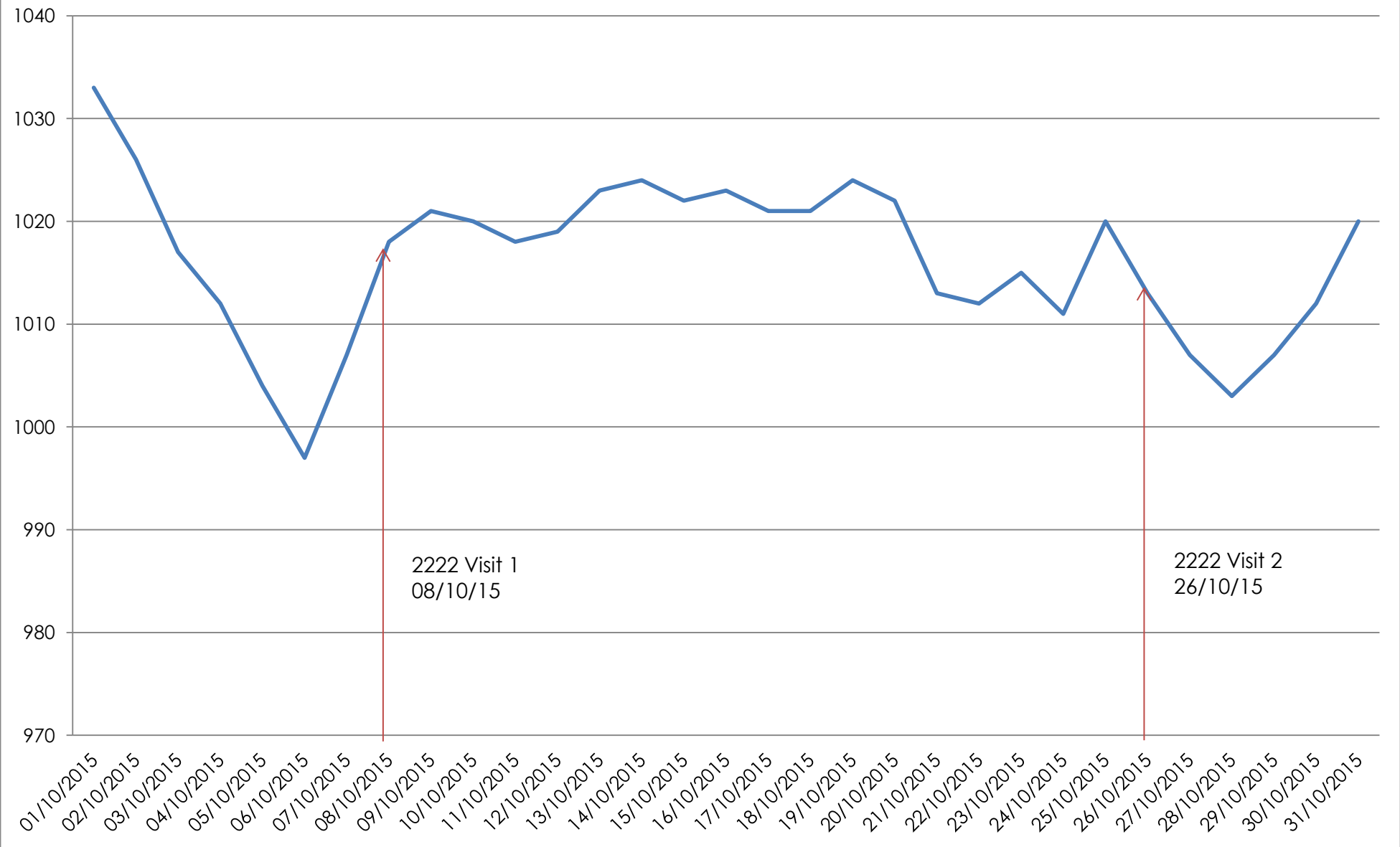
Windy/snow

Surface Ground Conditions:

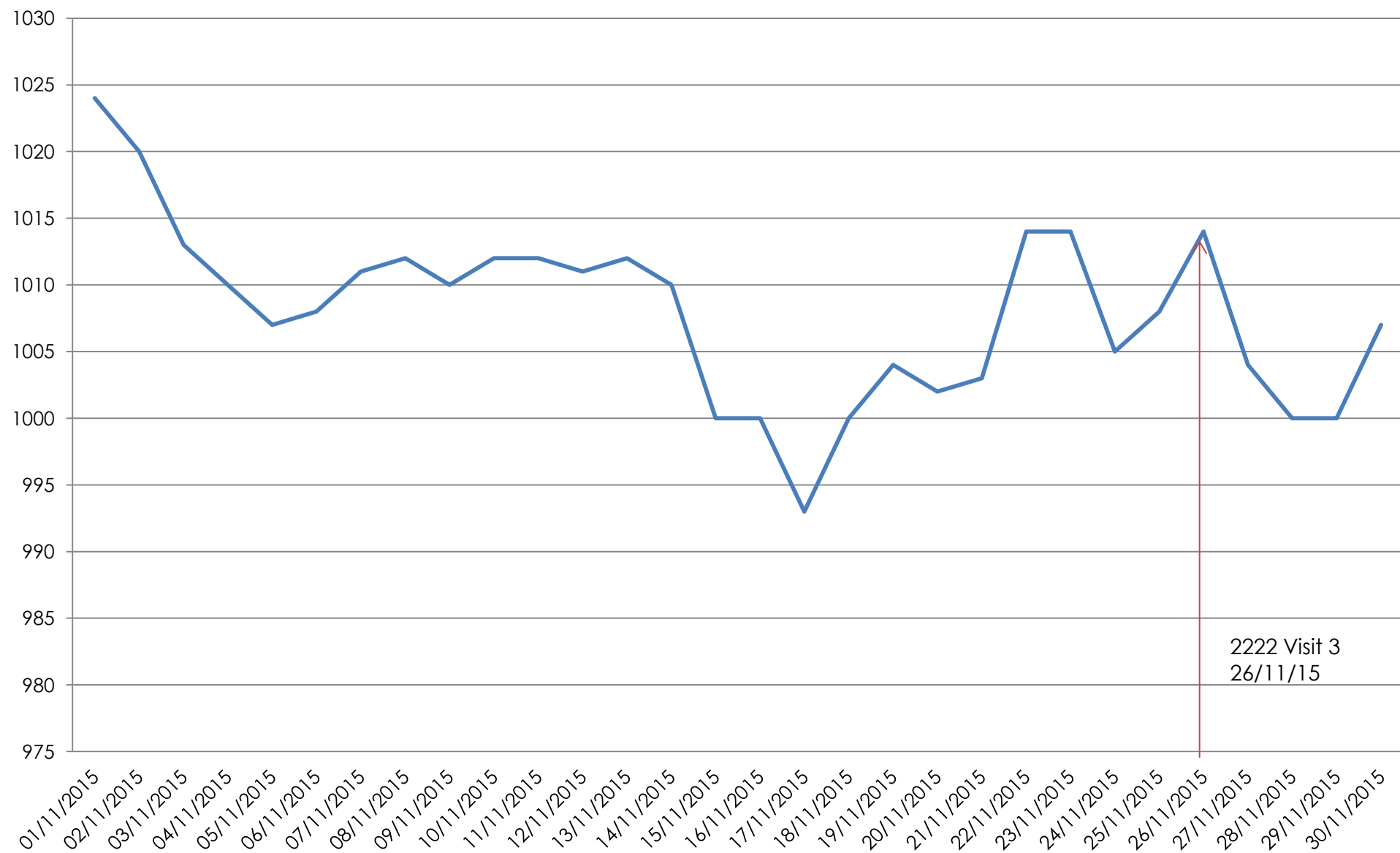
Wet

Remarks:

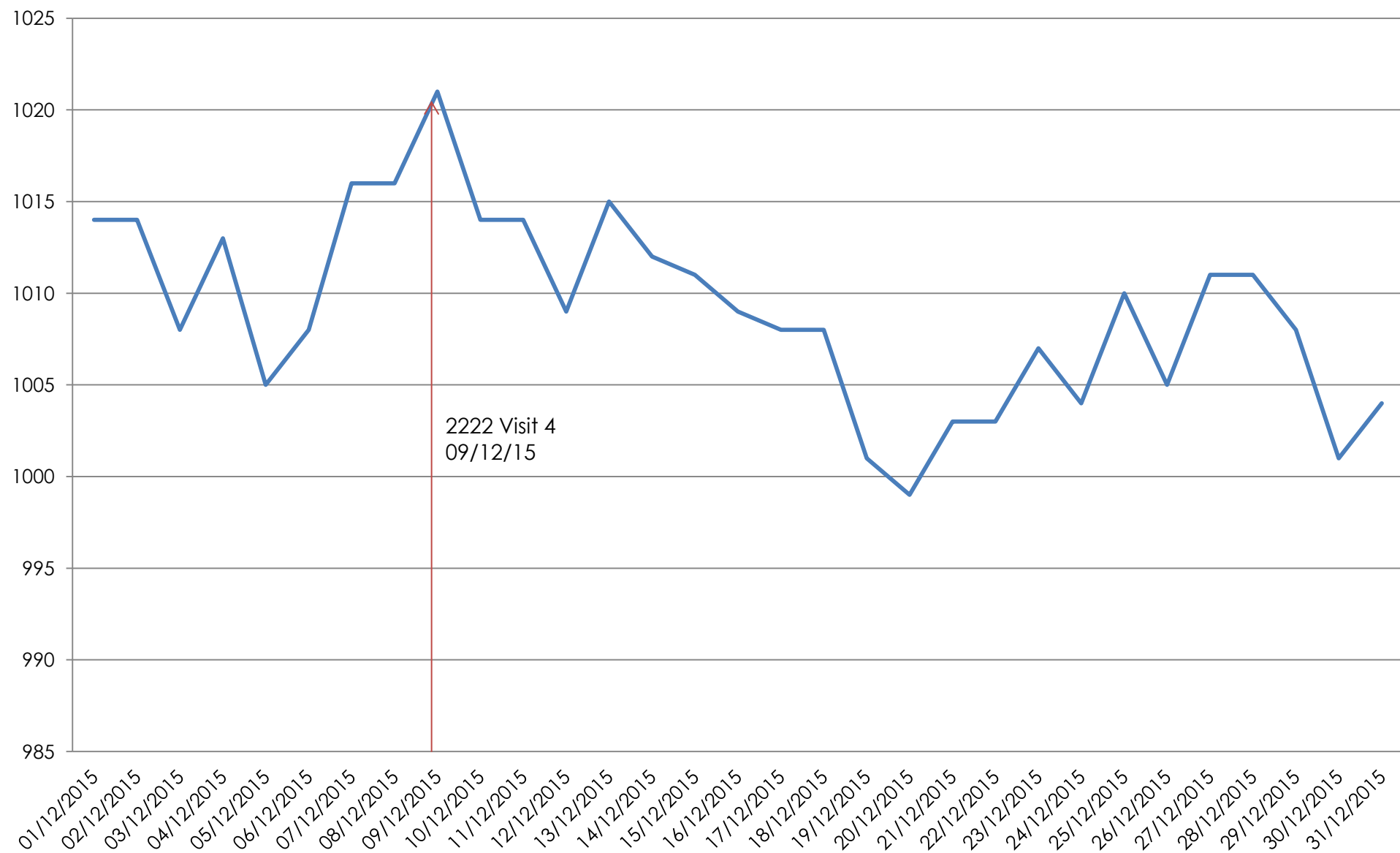
Barnsley October 15



Barnsley November 15



Barnsley December 15



Barnsley January 16

