



Land at Lundhill Road, Wombwell For Persimmon Homes West Yorkshire

Report no: 2409/1

Date: September 2016



LUNDHILL ROAD, WOMBWELL SUMMARY OF GEOENVIRONMENTAL ISSUES

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

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

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

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

Lithos' investigation included an inspection of historical and geological maps and information provided by the BGS, Landmark, the Coal Authority and the Environment Agency. In addition a site inspection has been carried out.

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

Issue	Remarks
Former uses	No former uses of the site are shown on historical OS plans other than open fields, with recent known grazing and stabling of horses.
Published Geology	The site is shown to be underlain by Coal Measures strata dipping around 4° to the north-east, with a geological fault trending north-east to south-west roughly through the centre of the site.
Hazardous gas	The site underlain by recorded coal workings (from around 50m depth) and lies within 250m of a former landfill site. Hazardous gas monitoring will be required and it is recommended that allowance be made for provision of protection measures in accordance with at least Amber 1 conditions.
Mining & quarrying	Eastern fault block: Swinton Pottery Coal outcrops in far north of eastern field and dips to the north-east. Underlain by Newhill coal at around 35m below the Swinton Pottery Coal. Western Fault Block: Newhill coal outcrops on the southern boundary and dips towards the north-east. There are no known quarries at or adjacent to the site.
Flooding & drainage	The far south-east of the site lies within Flood Zone 2. Soakaways are unlikely to provide a suitable drainage solution for surface water run-off.
Anticipated ground conditions	Likely residual soils (gravelly clays) from the weathering of bedrock overlying Coal Measures strata (sandstone, mudstone and siltstone) at relatively shallow depth.
Anticipated contamination	No significant contamination is anticipated.
Anticipated foundation solutions	Weathered Coal Measures should provide sufficient bearing capacity to enable the adoption of strip footings for two to three storey housing. If shallow mineworkings underlie the site, and require treatment, NHBC typically require foundations to be strengthened. Footings will probably need to be at least 300mm thick, and reinforced top and bottom with a layer of mesh.
Recommendations for ground investigation	Trial pitting with associated chemical and geotechnical laboratory testing of selected samples to determine shallow ground conditions. Rotary probing to check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings and to install monitoring wells to monitor for hazardous gas.

At this stage, anticipated significant abnormalities relating to geoenvironmental issues at the site are:

- Possible requirement for the treatment of shallow underground coal workings

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01	Environmental setting
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Appendix B – Drawings

Drawing	Title
2409/1	Site location plan
2409/2	Proposed layout
2409/3	Site features
2409/4	Site photographs
2409/5	Published Geology
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Appendix C - Commission

Appendix D – Historical OS plans*

Appendix E – Search responses*

From	Date	Content
Landmark	23 rd August 2016	Envirocheck report
Coal Authority	24 th August 2016	Coal Mining Report

* Some of this data is not included within the paper copy of this report; most is included in the PDF copy and all is included on the CD

FOREWORD (preliminary geoenvironmental investigation report)

This report has been prepared for the sole use and reliance of the Client named on page 1 and cannot be relied upon by any other parties without the express written authorisation of Lithos Consulting Limited (Lithos). Any unauthorized third party relies on this report at their own risk and the authors owe them no duty of care.

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 within the "electronic", PDF Report on the accompanying CD.

The findings and opinions conveyed in any Desk Study section of the report (including review of any third party reports) are based on information obtained from the sources listed, which Lithos understands are reliable. All reasonable skill, care and diligence has been applied in examining the information obtained. However, Lithos accept no responsibility for inaccuracies in the data supplied or for opinions based on any such inaccurate data.

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.

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

**PRELIMINARY
GEOENVIRONMENTAL INVESTIGATION
OF LAND AT
LUNDHILL ROAD, WOMBWELL**

1 INTRODUCTION

1.1 The commission and brief

- 1.1.1 Lithos Consulting were commissioned by Persimmon Homes West Yorkshire to carry out a preliminary investigation of land at Lundhill Road, Wombwell.
- 1.1.2 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:
- A site walkover and inspection
 - An assessment of the land use history
 - Determination of the site's environmental setting
 - A mining risk assessment in accordance with Coal Authority guidance.
 - Assessment of anticipated ground conditions, including potential contaminants
 - Assessment of anticipated foundation and engineering issues associated with redevelopment for a residential end-use
 - Provision of recommendations for an appropriate ground investigation
- 1.1.3 This Preliminary Investigation comprised an inspection of historical and geological maps and information provided by the British Geological Survey, and the Landmark Information Group, the Coal Authority and the Environment Agency. In addition a site inspection has been carried out by Lithos.
- 1.1.4 Primary aims of this investigation were to identify salient geoenvironmental issues affecting the site to enable design and costing of an appropriate intrusive investigation, and to support the submission of a planning application.

1.2 The proposed development

- 1.2.1 It is understood that consideration is being given to redevelopment of the site with 2 to 3 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A site layout has been provided by Persimmon (Drawing reference Lundhill Road Illustrative Layout, dated June 16) which is reproduced as Drawing 2409/2 in Appendix B to this report.

1.3 Report format and limitations

- 1.3.1 Standard definitions, procedures and guidance are contained within Appendix A, which includes background, generic information on assessment of the site's environmental setting.
- 1.3.2 General notes and limitations relevant to all Lithos preliminary investigations are described in the Foreword and should be read in conjunction with this report. The text of the report draws specific attention to any modification to these procedures and to any other special techniques employed.

2 SITE DESCRIPTION

2.1 General

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

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

2.2 Site features

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

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

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

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

2.2.4 The site typically comprises two overgrown fields (west and east) with areas of dense vegetation (bushes, brambles etc) predominantly in the western field.

2.2.5 Access is from Lundhill Road in the west, with timber gates in the north-west and south-west corners of the western field. A separate access track runs along the southern boundary of the site providing access to a single storey residential dwelling (appeared vacant) farm buildings and the eastern field (along an overgrown track).

2.2.6 Trees are typically located around the site boundaries with a row of mature poplars (12m to 14m high) on the southern boundary of the western field, adjacent to the overgrown track.

Western Field

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

Eastern Field

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

2.3 Site operations

- 2.3.1 The fields at the site are typically overgrown, however, horses are kept in the east with paddocks and rudimentary shelters fashioned from timber, corrugated steel sheeting and plastic sheeting.

3 SITE HISTORY

3.1 In order to investigate the development history and previous land uses at the site and immediate surrounding land, site centred extracts from Ordnance Survey (OS) plans dating back to 1854 have been examined. 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 with respect to the proposed end use. It is not the intention of this report to describe in detail all the changes that have occurred on or adjacent to the site. Significant former uses/operations are highlighted in bold text for ease of reference.

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

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

4 ENVIRONMENTAL SETTING

4.1 General

4.1.1 Notes describing how the site's environmental setting has been assessed are included in Appendix A to this report. The responses received from the Environment Agency, the Coal Authority, the BGS and extracts from the Landmark Report are presented in Appendix E.

Issue	Data reviewed	
Geology	1:50,000 BGS map (Sheet 87) 1:10,000 BGS map (Sheet SE 40 SW)	Drift – none. Solid – Middle Coal Measures (mudstone, siltstone and sandstone strata) with sandstone units in north (western field) and south (eastern field). Faults – running north-east to south-west with downthrow to south-east, roughly along the boundary between the western and eastern fields. Shallowest coal seam – Eastern fault block : Swinton Pottery Coal (0.3m to 1.2m thick) outcrops in far north of eastern field and dips to the north-east. Underlain by Newhill coal (1.0m to 3.0m thick) at around 35m below the Swinton Pottery Coal. Both seams shown to include relatively thick argillaceous partings. Western Fault Block : Newhill coal outcrops on the southern boundary and dips towards the north-east. Strata Dip – around 4 degrees to north-east (southern fault block).
Mining	Coal Authority BGS maps	This site is located within a Coal Mining Development Low Risk Area, but with localised areas of High Risk associated with the outcrops of the Newhill and Swinton Pottery Coals. Further information is provided in Section 4.3 below.
Quarrying	Historical OS plans	There are no known quarries at or adjacent to the site.
Radon	Public Health England	The site lies in an area where between 1% and 3% of homes are estimated to be above the action level.
Hydrogeology	Environment Agency	Source Protection Zone? No. Aquifer : Secondary A (Solid). Groundwater abstractions? None within 1km of the site. Soil leaching potential - Low. Pollution incidents? None at or affecting the site.
Hydrology	Envirocheck	Nearest watercourse(s) – Elsecar canal on southern boundary. Water quality - E. Pollution incidents? Nearest 80m to south-west involving discharge of landfill leachate to streams. Abstractions? Nearest 125m to south-east, licence revoked. Discharge consents? Nearest 140m to south for the discharge of sewage.
Flood risk	Environment Agency Envirocheck	The far south-east adjacent to the canal lies in Flood Zone 2, land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding. In accordance with Chapter 10 of the National Planning Policy Framework, a site-specific flood risk assessment is required for proposals of 1 hectare or where new development lies within Flood Zones 2 and 3.

4.2 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 provides the necessary mining risk assessment required by the proposed planning application.
- 4.2.2 Geological maps suggest that two coal seams underlie the site at shallow depth. These are the:
- Swinton Pottery Coal, 0.3m to 1.2m thick, outcropping on the northern boundary of the eastern fault block (underlying approximately 800m² of the site), and
 - Newhill Coal, 1.0m to 3m thick, outcropping on the southern boundary of the western fault block (underlying around 25,200m²) and around 125m south of the site on the eastern fault block (underlying an area of around 23,100m²)
- 4.2.3 Approximate outcrops are shown on Drawing 2409/5 in Appendix B to this report.
- 4.2.4 Given its dip and topography, the Newhill seam is expected to the west of the site at shallow depth (<30m) and the east of the site from around 10m to 20m on the southern boundary. The next underlying significant coal seam is the Meltonfield Coal (0.5m to 1.6m thick) which underlies the Newhill Coal by around 30m.
- 4.2.5 It should be noted that seam outcrops plotted on geological maps have been known to be inaccurate by distances in excess of 100m.
- 4.2.6 The majority of the site lies within a Low Risk Area - within the defined coalfield, but no known defined risks have been recorded by the CA; there may still be unrecorded issues.
- 4.2.7 However, those areas of the site close to outcrop of both the Newhill and the Swinton Pottery coal seams are shown to lie within High Risk Areas - areas with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.
- 4.2.8 A CA mining report states that:
- *The property is in a surface area that could be affected by underground mining in 5 seams of coal at 50m (likely the Meltonfield Coal) to 570m depth, and last worked in 1962*
 - *Any movement due to coal mining activity should have stopped by now*
 - *In addition, the property is in an area where the Coal Authority believes there is coal at or close to the surface. This coal may have been worked at some time in the past. This comment probably relates to the Swinton Pottery and Newhill coals.*
 - *The property is not in the likely zone of influence of any present underground coal workings.*
 - *The property is not in an area for which the Coal Authority is determining whether to grant a licence to remove coal using underground methods.*
 - *There are no known mine entries within, or within 20 metres of, the boundary of the property.*
 - *The Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining. This confirms the absence of any known significant geological faults below the site.*
 - *The property is not within 800 metres of the boundary of an opencast site for which the Coal Authority is determining whether to grant a licence to remove coal by opencast methods.*
 - *There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property.*

4.2.9 A damage notice or claim for alleged subsidence damage was made in August 2002 for 8 Lundhill Grove located immediately north of the site, however, the claim was rejected.

4.3 Mineral safeguarded areas

4.3.1 The site is underlain by Newhill Coal, with the Swinton Pottery coal underlying the far north-east, and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).

4.3.2 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 Persimmon to consider the opportunity to recover (extract) the coal. Applicants submitting planning applications may need to demonstrate to the Local Authority that they will extract the coal, unless:

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

4.3.7 The viability of coal extraction at this site should be considered following an intrusive mining investigation to determine the thickness, depths and quality of underlying coal.

4.4 Barnsley Council Policy

4.4.1 Barnsley Council has to comply with national planning policy to extract coal where it is feasible in order to avoid sterilisation caused by building over it.

4.4.2 The Council have a Local Development Framework (LDF) which consists of a series of documents intended to guide the use of land and new development throughout the district until 2033. The Core Strategy (adopted in September 2011) is the overarching document which brings together all the strategic elements of the LDF.

4.4.3 Barnsley Council's approach, in their Local Plan Publication Draft 2016, states that shallow coal extraction by opencast methods may occur before some other form of development takes place on a site, whether greenfield or during reclamation of a brownfield site.

- 4.4.4 Most former colliery sites have now been reclaimed in the Borough but shallow coal extraction can provide an opportunity to work other economic minerals such as fireclay and brick clay.
- 4.4.5 The Council also consider it important to avoid unnecessary sterilisation of coal and associated mineral resources by other forms of development where these can be extracted, within a reasonable timescale and in an environmentally friendly way or where local or community benefits clearly outweigh the likely impacts to justify the grant of planning permission.
- 4.4.6 Review of Barnsley Council's local development map shows the site to be allocated for residential development, although this does not necessarily mean that assessment of the viability of coal extraction will not be required prior to development.

4.5 Landfills

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

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

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

4.6 Hazardous gas

Methane & carbon dioxide

- 4.6.1 The site is believed to be affected by sources of hazardous gas generation as it is:
- located within 250m of known former landfill sites
 - is underlain by recorded underground mineworkings (from around 50m depth)
 - crossed by a geological fault which may act as a migration pathway for hazardous gas from underlying coal workings and/or nearby landfills

Radon

- 4.6.2 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%).

- 4.6.3 The Public Health England UK radon map and the Landmark report indicate that the site is in an area where between 1% and 3% of homes are estimated to be above the action level. Consequently, basic radon protection measures may not be required in new dwellings.
- 4.6.4 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.

4.7 Land contamination - Part IIA & planning

- 4.7.1 Local Authorities have responsibilities with respect to land contamination in the context both of Part IIA of the Environmental Protection Act 1990, and Planning.
- 4.7.2 The contaminated land regime in Part IIA was introduced specifically to address the historical legacy of land contamination. It applies where there is unacceptable risk, assessed on the basis of the current use and the relevant circumstances of the land. It is not directed to assessing risks in relation to a future use of the land that would require a specific grant of planning permission. This is primarily a task for the planning system, which aims to control development and land use in the future.

Planning

- 4.7.3 As of 27th March 2012, Planning Policy Statement (PPS23) was replaced by the National Planning Policy Framework (NPPF). The NPPF includes the following with respect to contamination and site investigation:
- 4.7.4 'Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.
- 4.7.5 Planning policies and decisions should ensure that:
- The site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses, and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;
 - After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the environmental protection act 1990; and
 - Adequate site investigation information, prepared by a competent person, is presented'.
- 4.7.6 Annex 2 of the NPPF states that 'all investigations of land potentially affected by contamination should be carried out in accordance with established procedures (such as BS10175 - 2011, Code of Practice for the Investigation of Potentially Contaminated Sites)'.

This site

- 4.7.7 The underlying Middle Coal Measures strata is classified as a Secondary A aquifer. The nearest surface watercourse is the Dearne & Dove Canal, which flows in an easterly direction, immediately beyond the site's southern boundary. Therefore, the site's environmental setting is considered to be of moderate sensitivity.
- 4.7.8 With respect to human health, the proposed end use (residential) is considered sensitive.
- 4.7.9 Current and former uses of the site are considered unlikely to have given rise to any significant ground and groundwater contamination.

- 4.7.10 It is therefore considered that the site should be suitable for the proposed use subject to implementation of appropriate intrusive investigation (see Section 5), and any subsequent preparatory works.

5 GROUND INVESTIGATION DESIGN

5.1 Anticipated ground conditions & potential issues

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

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

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

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

5.2 Preliminary conceptual site model

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

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

Agricultural activity	Potential contaminant
Sewage farming, slurry spreading	Methane, metals, nitrates, oxygen depletion
Crop & animal protection	Pesticides & herbicides
Soil conditioners	Metals, sulphates, PAH
Naturally occurring contaminants	Arsenic, metals

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

5.2.4 The most significant receptors include:

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

5.2.5 The most significant pathways include:

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

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

5.3 Ground investigation design & strategy

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

Exploratory holes	Purpose
About 30 Trial Pits	To determine the general nature of soils underlying the site, including the: <ul style="list-style-type: none"> • nature, distribution and thickness of shallow soils, including any made ground • suitability of the ground for founding structures and highways
About 10 probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings and to install monitoring wells across the site in order to monitor for hazardous gas

5.3.2 Proposed exploratory hole locations should be selected to provide a representative view of the strata beneath the site and to target potential areas of interest identified in Section 5.1 above. A nominal 50m grid spacing should be appropriate, with additional exploratory locations scheduled as necessary in light of the ground conditions actually encountered.

5.3.3 Representative soil samples of natural and any man-made ground should be taken during the works. The number of soil samples taken should be reflective of the geological complexity actually encountered, but in general about 3 samples should be taken from most exploratory holes.

5.3.4 The investigation should be undertaken in general accordance with:

- BS5930:2015 "Code of practice for site investigation"
- BS10175:2011+A1:2013 "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)

5.3.5 The in-situ shear strengths of any cohesive soils encountered should be determined by use of a hand-held shear vane.

5.3.6 The potential for soakaways should be reviewed in light of ground conditions actually encountered, and if considered likely, soakaway tests should be commissioned. Testing would also remove any ambiguity with respect to Yorkshire Water queries.

5.3.7 Routine geotechnical soils analysis (moisture content, Atterberg limits, pH, water soluble sulphate) should be scheduled on about 12 samples.

- 5.3.8 The site is essentially Greenfield, and therefore testing of potentially contaminated samples should only be required if made ground is encountered in the exploratory holes. However, analysis of around 9 samples of existing topsoil (for pH, metals, TOC, speciated PAH and asbestos ID) should be undertaken in order to confirm its suitability for re-use.
- 5.3.9 Ten probeholes should be sufficient to determine whether or not old mineworkings are present in the Newhill or Swinton Pottery coal seams. If present, 10 probeholes should also be suffice to determine whether or not mineworkings pose a significant risk to surface stability of the site (via assessment of seam depths, thicknesses and thicknesses of overlying competent bedrock) above across the site. However, if a potential risk is perceived to exist, further probeholes may be required to delineate the extent of workings in order to obtain fixed price quotations for the necessary consolidation works.
- 5.3.10 It will be necessary to submit an application (with the associated fee) to the Coal Authority (CA) for '*Permission to enter CA mining interests*'.
- 5.3.11 Given the proximity of surrounding housing (within 50m of the northern boundary), and in accordance with CA requirements it may be necessary to advance some probeholes using water as the flushing medium (as reinforced by recent CA guidance on managing the risk of hazardous gas).
- 5.3.12 The generation potential of potential gas sources (underground coal workings, nearby landfill) is considered likely to be Low. Therefore, in accordance with CIRIA Report C665, it would be prudent to initially allow for at least 9 visits over a 6 month period. A hazardous gas risk assessment should be issued on completion of monitoring.
- 5.3.13 On completion of the fieldwork and laboratory testing a comprehensive bound, factual and interpretative report should be issued. This should contain detailed engineering records, laboratory test results, copies of all relevant correspondence and drawings of the site. The report should also include qualitative risk assessment with respect to both controlled waters and human health.

6 CONCLUSIONS & RECOMMENDATIONS

6.1 General

- 6.1.1 It is understood that Persimmon are considering acquisition of the site with a view to redevelopment with housing.
- 6.1.2 The main issues considered in this report, and in particular in Sections 3 and 4 are based on a review of historical maps and available geological/environmental data. This report provides an assessment of geoenvironmental issues and implications associated with the proposed residential redevelopment of the site, together with any implications for current use of the site.

6.2 Mining and quarrying

- 6.2.1 The majority of the site lies within a Low Risk Area, but areas close to outcrop of both the Newhill and the Swinton Pottery coal seams are shown to lie within High Risk Areas. Consequently, an intrusive mining investigation (via rotary probeholes) will be required.
- 6.2.2 If old mineworkings are present in the Newhill or Swinton Pottery coal seams, and are considered to pose a significant risk to surface stability, mitigation of the risks posed will be required; this could be achieved in one of two ways:
- Extraction of the remaining coal
 - Consolidation, via drilling & grouting

6.3 Hazardous gas

- 6.3.1 The site is underlain by known coal workings (from around 50m depth, likely in the Meltonfield Coal), and lies within 250m of a former landfill site.
- 6.3.2 A geological fault crosses the site which may act as a migration pathway for hazardous gas from underlying coal workings and/or nearby landfills
- 6.3.3 The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level.
- 6.3.4 As such, hazardous gas monitoring will be required and it is recommended that an allowance be made for provision of protection measures in accordance with at least Amber 1 conditions.

6.4 Foundations

- 6.4.1 At present, no geotechnical ground investigation data is available and consequently it is only possible to estimate ground conditions. Before firm foundation recommendations can be given, it will be necessary to undertake an appropriate ground investigation. However, tentative recommendations are provided below.
- 6.4.2 Made ground is not generally considered a suitable founding material and foundations should be taken through it, into underlying natural in-situ strata of adequate bearing capacity.
- 6.4.3 The published geological data suggests that the site is underlain by Coal Measures strata, likely to comprise gravelly clays (residual soils) over sandstone/mudstone at relatively shallow depth.
- 6.4.4 Weathered Coal Measures should provide sufficient bearing capacity to enable the adoption of strip footings for two to three storey housing. Reinforcement, as a precaution against differential settlement, is recommended only where foundation excavations encounter significant lateral and vertical variations in strata.
- 6.4.5 If shallow mineworkings underlie the site, and require treatment, NHBC typically require foundations to be strengthened. Footings will probably need to be at least 300mm thick, and reinforced top and bottom with a layer of mesh. For a standard 600mm wide, a suitable reinforcement would be B385 mesh
- 6.4.6 If rock is encountered at shallow depth, foundations should be placed entirely on rock and not partially on rock and partially on residual soil. This may, depending on surface gradient, necessitate significant over deepening of foundations.

6.5 Highway, drainage and external works issues

- 6.5.1 Highways at the site are likely to be constructed in natural soils (gravelly clays) which should have a CBR value of at least 2%. This value should be confirmed through in-situ testing prior to or during redevelopment.
- 6.5.2 Given anticipated ground conditions and topography, soakaways are considered unlikely to provide a viable solution for the disposal of surface water.
- 6.5.3 Whilst the site may not lend itself to the adoption of discrete soakaways, ground may 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.

6.5.4 Alternative SUDS options (see CIRIA C697:2007 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.

6.5.5 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.

6.5.6 Given the sloping nature of the site, there may be a need for re-grading and/or retaining walls, most notably on the south-west boundary.

6.6 Contamination

6.6.1 The site's environmental setting is considered to be of moderate sensitivity. With respect to human health, the proposed end use (residential) is considered sensitive.

6.6.2 The site is essentially greenfield and no significant contamination is anticipated. Nonetheless, activities such as the discharge of chemicals to ground and burning of waste may have occurred.

6.6.3 Consequently, a ground investigation is recommended in order to assess the degree and extent of any ground contamination and to determine the suitability for re-use of existing soils.

6.7 Potential development constraints

6.7.1 A geological fault crosses the centre of the site roughly north-east to south-west with a downthrow to the south-east.

6.7.2 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.

6.7.3 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.

6.7.4 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

6.7.5 The existing overhead power lines present a potential development constraint unless they can be relocated or the proposed layout is modified to take account of their position. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required by the service undertaker if they remain in-situ.

6.7.6 The far south-east of the site is recorded as lying in Flood Zone 2 although the current Illustrative Layout appears to take account of this with the area shown as POS. It is recommended that no development takes place in this area without inclusion of appropriate flood mitigation measures.

6.8 Further investigation

6.8.1 Whilst the site is considered suitable for its current and proposed use, the proposed change in use will require intrusive investigation.

6.8.2 This would include:

- Machine-excavated trial pits to determine near surface ground conditions including depth to bedrock, nature of overlying residual soils, groundwater and stability
- Geotechnical soils analysis to enable foundation recommendations
- Chemical testing on soil and if necessary groundwater, samples to assess the significance of any contamination, if any
- Rotary probeholes to confirm depths and thicknesses of shallow coal seams in order to assess risks associated with possible old mineworkings and surface stability
- Gas monitoring and risk assessment

6.8.3 An appropriate ground investigation strategy is presented in Section 5.3.

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 from the Local Authority and by reference to current and historical OS plans. A coal mining report is obtained from the Coal Authority (CA).

In July 2011, the 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 areas of higher risk (known as the Coal Mining Development Referral Area) and lower risk (known as the Standing Advice Area). The Coal Mining Development Referral Areas contain a range of specific mining legacy risks to the surface, including mine entries; shallow coal workings; workable coal seam outcrops; mine gas; geological features; and previous surface mining sites. The Standing Advice Area is the remainder of the defined coalfield. In this area no known defined risks have been recorded; although there may still be unrecorded issues.

Landfills

Lithos obtain data from the Landmark Information Group, the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site. Reference is also made to historical OS plans, which are 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 BR211, 2007: "Radon: guidance on protective measures for new buildings", and to information from the BGS / HPA (Health Protection Agency) radon potential dataset provided by the Landmark Information Group. The level of protection needed is site-specific and is determined by reference to the maps contained in Annex A of BR211. These maps are derived from the Radon Atlas of England and Wales (2007), and indicate 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 (average annual radon concentration of 200 Bq.m-3), as follows:

- Unshaded grid squares where less than 3% of homes are estimated to be above the Action Level, and no radon protection is required in new dwellings
- Light grey shaded grid squares where between 3% & 10% of homes are estimated to be above the Action Level, and basic radon protection is required in new dwellings
- Dark grey shaded grid squares where greater than 10% of homes are estimated to be above the Action Level, and full radon protection is required
- Sites where either basic or full radon protective measures are required (i.e. Where greater than 3% of homes are estimated to be above the Action Level) are referred to as Radon Affected Areas

BR211 provides a preliminary indication of the measures required for a particular site, as the Annex A maps indicate the highest geological radon potential within each 1km grid square, but in many cases the radon potential varies considerably within the grid square. The Landmark information is more site-specific and therefore may allow the adoption of a lower level of protection than that indicated in the Annex A maps. Alternatively, a BR211 Radon Report can be obtained from the BGS in order to provide more site-specific information.

It should be noted that in July 2010 the Health Protection Agency (HPA) published new advice (Document RCE-15: "Limitation of Human Exposure to Radon"), in which they recommend that all new buildings, extensions, conversions & refurbished buildings in the UK include (at least) basic radon protective measures. The HPA also widened the definition of Radon Affected Areas to include areas where greater than 1% of homes are estimated to be above the Action Level.

Hydrogeology

Lithos obtain information from the Environment Agency (EA) and the Landmark Information Group 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 type 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 drift 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 drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two 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 - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type

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

Note: The maps are only display the principal and secondary aquifers as coloured areas. All uncoloured areas on the bedrock designation 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 drift is present. To do this, it is necessary to consult the published geological survey maps.

For the purposes of our 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 drift overlies principal bedrock, an overall designation of principal is assumed)

The EA have also designated 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 the Landmark Information Group with respect to:

- surface water quality
- recorded pollution incidents
- licensed abstractions (groundwater & surface waters)
- licensed discharge consents
- site susceptibility to flooding

Generic notes – geoenvironmental Investigations

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 six 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 provide 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 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 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

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 (or 1 in 200 year as appropriate), 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 consultant who can advise on appropriate mitigating measures; ie raising slab levels, provision of storage etc.

COMAH & explosive sites

Lithos obtain information from the Landmark Information Group with respect to COMAH or explosive sites within 1km of the proposed development site. Lithos's 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 ground 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 targets.

Potential pollutant linkages are shown on a preliminary conceptual site model, presented as a Drawing in an Appendix to this Geoenvironmental Report. The preliminary model is revised in light of data arising from the subsequent ground investigation.