

DEWSBURY RIVERSIDE (RAVENSTHORPE ROAD), SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2336	Site area/ha	13.4 ha (33 acres)
Client:	Miller Homes	NGR:	SE 230 197
Site:	Dewsbury Riverside – Ravensthorpe Road	Nearest postcode:	WF12 9EG

Lithos were commissioned by Miller Homes to provide a preliminary geoenvironmental appraisal (Report 2336/1A, dated April 2016) of a wider site (256 ha) which is to be redeveloped with a residential-led scheme. Lithos' investigation included review of a 3rd party report, the site's history and environmental setting. This summary of salient geoenvironmental issues has been prepared for sub-parcel off Ravensthorpe Road to support a planning application.

The area of current interest is located off Ravensthorpe Road, approximately 2km south-west of Dewsbury town centre, and currently comprises open farmland which falls to the north at gradients of between 1 in 7 and 1 in 25. Access is also available via gaps in the housing along Ravensthorpe Road. There is a boggy hollow, about 1.5m deep, with a broken land drain carrying ochreous water. Overhead electricity lines and a regional high pressure gas main cross the site, both running north-south.

Issue	Remarks
Made ground	Deep made ground is likely within the Power Station landfill (west of this sub-parcel), with a veneer of made ground anticipated around backfilled shafts.
Natural ground	Coal Measures bedrock, overlain by Glaciolacustrine Deposits in the north-east.
Coal	The shallowest seams to underlie the sub-parcel off Ravensthorpe Road are the Green Lane coal (about 0.3m to 0.7m thick) and the New Hards coal (about 0.2m to 0.4m thick, and about 35m below the Green Lane). The Green Lane coal only underlies the southern half of this sub-parcel, but the New Hards underlies the entire area. There is also an un-named coal which lies between the New Hards and the Green Lane.
Mining	The sub-parcel off Ravensthorpe Road lies within a Coal Authority High Risk Area, and there are 2 shafts recorded in the north-east. The boggy hollow may be a collapsed bell pit or shaft. A BGS Technical Report notes that the New Hards has been extensively worked around Dewsbury. There are abandonment plans showing mineworkings in both the New Hards and the Green Lane coals.
Landfill	An area of landfill is shown to extend beneath the western end of the sub-parcel off Ravensthorpe Road. This landfill is associated with the nearby (now demolished) Thornhill Power Station, and is thought to have accepted inert wastes derived from the power station's own processes.
Hazardous gas	The site is shown in an area where 1-3% of properties are above the radon action level. Given the presence of a landfill in the west of the site and shallow mineworkings, a robust gas risk assessment will be required. Protective gas measures are likely to be required for new buildings.
Contamination	Given the essentially undeveloped nature of much of the site, no significant contamination is anticipated. Contaminated mine water (ochreous water) will require further consideration.
Anticipated foundation solutions	If grouting is preferred, shallow footings will need to be at least 300mm thick, and reinforced top and bottom with a layer of mesh. If extraction of coal is undertaken, rafts would likely provide the most appropriate foundation solution, after consideration of potential high wall issues.
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. Soakaways are unlikely to provide a suitable means of disposal for the disposal of surface water at the site. Consequently, it may be necessary to consider alternative sustainable drainage systems (SUDS).

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

- Shallow mineworkings
- The presence of 2 known mine entries and likely further un-recorded mine entries
- An area of landfill and ochreous water
- Given existing topography, significant earthworks regrade is anticipated, with the need for underbuild and retaining walls

This brief summary should not be assumed to represent a complete account of all the potential geo-environmental issues that may exist at the site. As such it is strongly recommended that Report 2336/1A be read in its entirety.

The title card features a background image of a riverbank with green grass and a cross-section of soil and rocks. The text "Preliminary Geoenvironmental Investigation" is overlaid in white.

Preliminary Geoenvironmental Investigation

Land at Dewsbury Riverside For Miller Homes

Report no: 2336/1A

Date: April 2016



DEWSBURY RIVERSIDE SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2336	Site area/ha	156 ha (385 acres)
Client:	Miller Homes	NGR:	SE 232 192
Site:	Dewsbury Riverside	Nearest postcode:	WF12 9EG

The site is located to the south of Ravensthorpe Road and Lees Hall Road, approximately 2.5 km south-west of Dewsbury Town centre (NGR SE 232 192). The site is currently occupied by arable and pastoral farmland, woodlands and isolated farmhouses.

Lithos were commissioned by Miller Homes to provide a preliminary geoenvironmental appraisal. It is understood that the site is to be redeveloped as part of a sustainable urban extension to Dewsbury, which will see the construction of approximately 4,000 houses, as well as 3 new schools, community and retail facilities. A draft masterplan has been prepared by Spawforths.

Lithos' investigation included review of a third party report; a site walkover and inspection; an assessment of the land use history; determination of the site's environmental setting; a mining risk assessment; assessment of anticipated ground conditions; assessment of anticipated foundation and engineering issues associated with redevelopment for a mixed residential and educational end-use and the provision of recommendations for an appropriate ground investigation.

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

Issue	Remarks
Former uses	The site is largely undeveloped. However a former railway ran across the east of the site and several backfilled coal pits and quarries exist on the site.
Hazardous gas	Given the presence of a landfill in the north-west of the site, on- and off-site made ground, a robust gas risk assessment will be required. Protective gas measures are likely to be required for new buildings.
Mining & quarrying	The site is underlain by 10 coal seams at shallow depth, and there are known workings in 8 seams of coal at shallow to 300m depth. Consequently, the majority of this site is located within a Coal Mining Development High Risk Area, with remaining parts lying in Low Risk Areas. Abandonment plans show mineworkings beneath around 50% of the site. The most extensively worked seam are the New Hards and the Wheatley Lime. There are 51 known mine entries on or within 20m of the site. Coal is likely to have been mined by pillar & stall methods, and there may also have been earlier, unrecorded mineworkings via bell pits and/or pillar and stall methods. If old mineworkings 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 In addition to mineworkings, there are areas of opencast workings associated with Lady Wood Colliery in both the New Hards and Green Lane seams in the west.
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. Given anticipated ground conditions, soakaways are considered unlikely to provide a viable solution for the disposal of surface water.
Anticipated ground conditions	Locally, a veneer of made ground associated with existing buildings, hardstand and former railway is anticipated. Deeper made ground associated with a former landfill and backfilled coal pits/ quarries is also anticipated. Geological maps suggest the majority of the site will be underlain by residual soils over Coal Measures bedrock. Approximately 15ha in the north of the site is underlain by Glaciofluvial deposits.
Anticipated contamination	Historical and present use of the site as farmland is considered unlikely to have produced significant contamination. However, historical processes on/near site have included: mining, quarrying and landfilling, and all these have the potential to give rise to significant contamination. Ochreous water was noted during site walkover.
Anticipated foundation solutions	If grouting is preferred, shallow footings will need to be at least 300mm thick, and reinforced top and bottom with a layer of mesh. If extraction of coal is undertaken, rafts would likely provide the most appropriate foundation solution, after consideration of potential high wall issues. Alternative foundation solutions will be required in areas of deep made ground, and possibly in the north on Glaciofluvial deposits.

DEWSBURY RIVERSIDE SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2336	Site area/ha	156 ha (385 acres)
Client:	Miller Homes	NGR:	SE 232 192
Site:	Dewsbury Riverside	Nearest postcode:	WF12 9EG

Issue	Remarks
Potential development constraints	Given existing topography, some significant site regrade is anticipated, with the need for underbuild and retaining walls. Careful consideration will need to be given to earthworks design, and implications for slope stability, retaining walls, foundations, highway gradients and drainage. In addition to concerns associated with topography, shallow mineworkings, mine entries, and gas there may be issues associated with: • The on-site landfill and its potential to be classified as Contaminated Land under Part IIA • Geotechnical issues (if development over opencast backfill or landfilled ground were considered), including the potential for settlement of land around piled dwellings • Overhead and underground utilities

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

- Extensive intrusive site investigation works will be required
- Shallow mineworkings is likely to affect surface stability across the majority of the site
- The presence of about 50 known mine entries
- An area of landfill exists in the north-west
- Several areas of made ground associated with backfilled quarries and former opencast
- Ochreous water
- Steep slopes may require assessment in parts of the site
- Significant utilities cross the site

1	INTRODUCTION.....	1
1.1	THE COMMISSION AND BRIEF	1
1.2	THE PROPOSED DEVELOPMENT	1
1.3	REPORT FORMAT AND LIMITATIONS.....	1
2	SITE DESCRIPTION	2
2.1	GENERAL.....	2
2.2	SITE FEATURES	2
3	SITE HISTORY	7
4	ENVIRONMENTAL SETTING	9
4.1	GENERAL.....	9
4.2	LANDFILLS	10
4.3	COAL & MINING.....	12
4.4	RECORDED MINEWORKINGS.....	14
4.5	UNRECORDED MINEWORKINGS	15
4.6	MINING RISKS	16
4.7	COAL EXTRACTION.....	17
4.8	DRILLING & GROUTING.....	18
4.9	MINERAL SAFEGUARDED AREAS.....	18
4.10	OTHER ISSUES	19
5	LAND CONTAMINATION - PART IIA & PLANNING	20
6	PREVIOUS INVESTIGATION FINDINGS.....	21
6.1	GENERAL.....	21
6.2	LITHOS COMMENTS	21
7	GROUND INVESTIGATION DESIGN	21
7.1	ANTICIPATED GROUND CONDITIONS & POTENTIAL ISSUES	21
7.2	PRELIMINARY CONCEPTUAL SITE MODEL	22
7.3	GROUND INVESTIGATION DESIGN & STRATEGY	23
8	CONCLUSIONS & RECOMMENDATIONS	25
8.1	GENERAL.....	25
8.2	MINING AND QUARRYING.....	25
8.3	HAZARDOUS GAS	26
8.4	SITE REGRADE & SLOPE STABILITY.....	26
8.5	FOUNDATIONS	27
8.6	HIGHWAY AND DRAINAGE.....	27
8.7	CONTAMINATION.....	28
8.8	POTENTIAL DEVELOPMENT CONSTRAINTS	29
8.9	FURTHER INVESTIGATION	29

APPENDICES

Appendix A – General notes

01	Environmental setting
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Appendix B – Drawings

Drawing	Title
2336/1	Site location plan
2336/2	Site layout
2336/3E	Site features & Land Use (East)
2336/3W	Site features & Land Use (West)
2336/4	Geological plan
2336/5	Preliminary conceptual site model (Mining)
2336/6	Preliminary conceptual site model (Contamination)
2336/7A	Abandonment Plan - New Hard Seam, Lady Wood Colliery
2336/7B	Abandonment Plan - Silkstone (New Hards) Seam, Calder Colliery
2336/7C	Abandonment Plan - Middleton Main (New Hards) Seam
2336/7D	Abandonment Plan – Ingham Colliery Silkstone (New Hards) Seam
2336/7E	Abandonment Plan – Ingham Colliery Wheatley Lime Seam
2336/7F	Abandonment Plan - Middleton Main (New Hards) Seam - East
2336/7G	Abandonment Plan - Silkstone (New Hards) Seam - South
2336/7H	Abandonment Plan - Silkstone (New Hards) Seam - Central
2336/7I	Abandonment Plan – Green Lane Seam, Lady Wood Colliery
2336/7J	Abandonment Plan – Old Hards, Lady Wood Colliery
2336/8	Site Constraints

Appendix C - Commission

Appendix D – Historical OS plans*

Appendix E – Search responses*

From	Date	Content
Groundsure	23 Dec 2015	Envirocheck report
Kirklees Council	8 Feb 2016	Environmental search data
Environment Agency	Awaited	Environmental search data

Appendix F – Site photos

* 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
DEWSBURY RIVERSIDE**

1 INTRODUCTION

1.1 The commission and brief

- 1.1.1 Lithos Consulting were commissioned by Miller Homes to carry out a preliminary investigation of land to the south of Ravensthorpe Road, Thornhill Lees, Dewsbury.
- 1.1.2 This document is a revision of the Geoenvironmental Appraisal (Report 2336/1) issued by Lithos in February 2016; Report 2336/1 is now superseded. This document now includes the EA search data, with the only significant revisions to 2336/1 having been made in Sections 4.2, 4.10, 7.3 & 8.8.
- 1.1.3 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:
- 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 mixed residential and educational end-use
 - Provision of recommendations for an appropriate ground investigation
- 1.1.4 This Preliminary Investigation comprised an inspection of historical and geological maps and information provided by the British Geological Survey, and Groundsure, Kirklees Council, the Coal Authority and the Environment Agency. In addition a site inspection has been carried out by Lithos.
- 1.1.5 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 approximately 4,000 two and three storey domestic dwellings, associated gardens, POS and adoptable roads and sewers, as well as 3 schools. A Consultation Draft Masterplan has been provided by Spawforths (from Dewsbury Riverside Vision document, undated) which is reproduced as Drawing No. 2336/2 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 2336/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	2.5 km south-west of Dewsbury town centre
NGR	SE 232 192
Area	156 ha (385 acres)
Known services	Overhead electric. Culverted watercourses High pressure underground gas

2.2 Site features

- 2.2.1 Lithos completed a walkover survey of the site on 18th and 19th of January 2016. This section should be read in conjunction with Drawings 2336/3E & W (Site Features and Land Use – East & West).

General

- 2.2.2 The site comprises a single parcel of land to the south of the River Calder, bounded to the north, south, east and west by Thornhill Lees village, farmland, Ingham Road and Sands Lane respectively.
- 2.2.3 The majority of the site is occupied by pastoral farmland/paddocks and arable farmland, with areas of woodland in the west (Lady Wood) and south (Long Plantation, Priest Royd Wood and Shragg Wood).
- 2.2.4 Smaller areas of rough grassland, allotments, farmyards, and a new-build development (Olympia Gardens) make up the remainder of the site area.

Access

- 2.2.5 The site can be accessed at a number of points off Sands Lane to the west; including at Sands House and Calder Farm. Sands Lane is blocked by a series of boulders in the south-west, just past the entrance to Woodlands Nursing Home (SE 2202 1906).
- 2.2.6 Access is also available via gaps in the housing along Ravensthorpe Road, albeit only suitable for farm vehicles/4x4s.
- 2.2.7 Ouzelwell Lane leads into the site from the adjacent housing estate to the north and splits into a series of tarmac roads and gravelled tracks which lead through the centre of the site, generally running southwards. In addition, Ings Lane crosses the site running north-south leading from Lees Hall Road/King Edward Street to the north. The majority of these roads are suitable for vehicular access.
- 2.2.8 Moor Farm in the east can be accessed off Lees Hall Road, as can the housing estate in the far east (Olympia Gardens).
- 2.2.9 Footpaths/tracks also run through Lady Wood from north to south.
- 2.2.10 The majority of the tracks and roads on site are marked as public footpaths on OS plans.

Topography

- 2.2.11 The site generally falls from south (c. 146mOD highest point) to north (c. 53mOD lowest point), towards the River Calder and Thornhill Lees Village. Locally however, the ground undulates, and there are small-scale valleys present associated with streams/surface waters; namely within Lady Wood, Long Plantation and Priest Royd Wood.
- 2.2.12 Areas of particularly steeply sloping land can be seen in the north-west (SE 2198 1935; gradients of up to 1 in 4), the south & central (SE 2261 1864 & SE 2305 1926; gradients of up to 1 in 3) and the south-east (SE 2352 1881; gradients of up to 1 in 2).
- 2.2.13 Land immediately north of the north-west boundary (north-east and south-west of Lady Wood) slopes very steeply down towards the adjacent railway and River Calder, at gradients of greater than 1 in 2.
- 2.2.14 In the field immediately east of Ings Lane (SE 2374 1933), the ground looks to have been excavated to create a square-shaped depression in the landscape, covering an area of around 8,000m². The maximum depth of the depression is around 3m below the surrounding ground level.

Watercourses

- 2.2.15 Two main streams are present on site. One issues in Lady Wood before flowing north-west where it spreads across a flat area in the north of woods, and then continues to flow northwards towards the River Calder.
- 2.2.16 The other flows to the north-east through Long Plantation, where it collects in a small pond before flowing north towards Priest Royd Wood through the south/centre of the site then out towards the housing estate north of the site (Ouzelwell Road & Ouzelwell Lane). Before reaching the estate it becomes culverted, just before crossing the tarmac access road leading down from Ravenshall School.
- 2.2.17 In addition, a drainage ditch, which was noted to contain water during the walkover, is present running east-west in the field north of Lineside Cottages (SE 2351 1921).
- 2.2.18 Water was also noted to be flowing in ditches at the side of Ouzelwell Lane running roughly north-east through the centre of the site. A number of culverts were also noted along this route.
- 2.2.19 Small-scale springs were also noted in Lady Wood, most of the water appears to flow towards the 'flat' area at around SE 2231 1950 where it spreads.
- 2.2.20 Known surface watercourses and culverts (according to the Groundsure report) are shown on Drawing 2336/3E & W. A summary of on-site and nearby watercourses can also be viewed in the Groundsure Report in Appendix E.
- 2.2.21 Ochreous water (indicative of acid mine drainage) was noted in an open excavation (c. 1.5m, deep) with broken land drain in its base. This is Feature 22 on Drawing 2236/3E.

Farmyards & residential dwellings

2.2.22 There are a number of farmyards and residential dwellings present throughout the site. Access within each farmyard was not available during the site walkover. However, some useful observations were made, and are summarised below:

- **The Beeches/Sands House – (SE 2187 1943):** Located in the far north-west comprising two main buildings (Sands House and The Beeches), both of sandstone brick construction. Access is via a tarmac road off Sands Lane. Buildings appear to predominantly be used as residential dwellings with paddocks in the surrounding land.
- **Calder Farm Livery & Stables (SE 2197 1924):** Located in the far west comprising a series of buildings leading into the site from the access point off Sands Lane. Structures include metal-clad warehouse structures with probable asbestos-cement roofs, stables and site cabins. There is associated hardcore surfacing and car park areas. A small site compound (around 600m²) can be seen in the south where stockpiles of soils/aggregate are kept. A bulldozer was operating in this area during the site walkover. A black-stained brick plinth was noted adjoining the southern-most building; likely the location of a former AST. To the east of the farmyard is an area of rough grassland where numerous vehicles, trailers and horse boxes are stored. A grassed and wooded mound is located in this field; this is marked as 'Made Ground' on the BGS geology plan.
- **Crow Royd (SE 2314 1934):** Located roughly in the centre of the site comprising a brick-built farm house with wooden outbuildings/stables and an open warehouse/barn structure in the west. The wooden stables were being used to store timber and stockpiles of brick rubble were noted in north-east garden area.
- **Wood Lea, Blare House & Lineside Cottages (SE 2335 1914):** Located in the centre-east predominantly comprising residential units of brick construction with associated garden areas and a tarmac access road off Ouzelwell Lane.
- **Moor Farm (SE 2406 1937):** Located in the north-east comprising a series of farm buildings including a farmhouse and barn of sandstone brick construction and a number of barns with probable asbestos-cement roofs. Horses and pigs were noted within the immediate vicinity of the farm, enclosed by electric fencing. A number of vehicles including cars, a caravan, a horse box and a boat were being stored in the farmyard. A large pile of hay bales are stored in the field immediately south of the farm.
- **Olympia Gardens (SE 2438 1932):** Located in the far east comprising a recent development of around 20 two-storey residential units with associated car parking and gardens, accessed off Lees Hall Road to the north.

2.2.23 It is recommended that, at some stage, each farmyard be inspected in more detail to ascertain the details of any site operations at each location, and potential sources of contamination (eg any ASTs, machinery, storage compounds etc).

Allotments

2.2.24 One of the eastern fields, accessed off Lees Hall Road, is currently in use as allotments (SE 2381 1935). The allotments comprise a series of plots with associated structures such as wooden sheds, greenhouses and an arch-shaped brick structure in the north.

2.2.25 Anthropogenic materials noted here included brick, wooden pallets, plastic storage drums and timber.

2.2.26 It is understood that the eastern-most parcel of land (SE 2444 1930) was also formerly allotments. This area is now heavily vegetated with undergrowth and young to mature trees. However, evidence of its former use was noted in the form of old brick walls, timber, wooden structures and asbestos cement-sheeting, in and amongst the vegetation. Foot access is difficult through this area, and there is no vehicular access.

Services

- 2.2.27 At this stage, a full set of statutory service information has not been requested, however some evidence of services at the site has been noted.
- 2.2.28 Three sets of overhead electricity lines cross the site, all running generally north-south. Two sets cross the centre-west and one crosses the centre-east. In addition, two sets of 'T' shaped electricity pylons cross the east of the site running roughly east-west, and close to the eastern boundary with Ingham Road.
- 2.2.29 A number of gas pipeline markers were noted through the site, thought to relate to a major underground gas main, the approximate route of which is shown on Drawing 2336/33E & W (according to Northern Gas Networks' online records).
- 2.2.30 A fenced-off compound with gas pipeline markers was noted roughly in the centre of the site (SE 2287 1934). The compound housed an 'L' shaped series of concrete pads around 400mm proud of ground level, constructed on top of breeze blocks with intermittent air bricks.
- 2.2.31 In the centre-north of the site (SE 2332 1940), a substation-type structure, was noted along with a series of square, metal manholes. A derelict caravan was also located here. Running water could be heard; these features are likely associated with some form of water storage/distribution or maybe a pump-house.
- 2.2.32 A number of culverts are shown on the Groundsure report, the approximate routes of which are marked on Drawings 2336/3E & W.

Surrounding land

- 2.2.33 The north-west of the site is bounded by a railway, with the River Calder and Huddersfield Road beyond.
- 2.2.34 Ravensthorpe Road and Lees Hall Road run adjacent to the site's northern boundary along with housing and shops (Thornhill Lees village). Ravenshall Primary School is located immediately north of the site, just off Ravensthorpe Road.
- 2.2.35 The east of the site is bounded by Ingham Road with housing (Leeds Hall Road) and woodland beyond.
- 2.2.36 Sands Lane marks the western site boundary, with Dewsbury District Golf Club beyond which is an 18-hole course.
- 2.2.37 Land to the south of the site is predominantly occupied by farmland; woodlands care home is located immediately to the south-west.

Evidence of mining

- 2.2.38 There are 49 mine entries shown on site on Coal Authority plans (see Section 4.3). Areas where mine entries were thought to be located were inspected during the site walkover; a summary of the features observed is included in the table on page 6, namely Features 11, 12, 19, 21 & 22.

Observations

- 2.2.39 In addition to the above, a number of observations were made during the site walkover, as summarised in the table below. The corresponding numbers for each feature are marked on Drawings 2336/3E & W. Where applicable, photo references are also cross-referenced; site photos are presented in Appendix F.

Summary of field observations

Map ref.	Grid Ref.	Feature	Remarks/description	Photo ref. (See Appendix F)
1	SE 24409 19362	Fly tipping	Materials tipped include plastic bottles, bin bags.	32
2	SE 24460 19330	Dense undergrowth	Difficult access on foot, no vehicular access possible.	31
3	SE 24414 19253	Anthropogenic materials	Includes timber, asbestos-cement sheeting, tyres, gas bottles.	-
4	SE 24023 19329	Running water	Surface water seen running to the south at the field boundary.	-
5	SE 23923 19466	Service markers	Gas pipeline marker and electricity substation.	-
6	SE 23924 19496	Garages	Collection of garages and surrounding areas of hardcore/tarmac.	25
7	SE 23886 19317	Asbestos cement sheeting	Noted within the allotments.	24
8	SE 23735 19325	Depression	Square shaped depression max. 3m deep, covering an area of c. 8,000m ² .	28
9	SE 23538 19350	Fly tipping within ditch running along site boundary	Materials tipped include plastic bags, cardboard, car tyre.	23
10	SE 23599 18961	Hummocky landscape	Within vicinity area also marked as 'made ground' on Groundsure report.	-
11	SE 23105 18790	Former Air Shaft	Lined with sandstone bricks, c. 2.5m diameter, noted to contained tipped materials incl. computer screens, plastic drums, timber, bin bags.	21
12	SE 25269 19148	Pile of stones & brambles	Close to location of a CA marked mine entry.	16
13	SE 22873 19339	Gas pipeline compound	See paragraph 2.2.30.	17
14	SE 22682 18912	Brick wall & outfall	Around 400mm diameter, outfall just above the pond.	15
15	SE 22343 19182	Wooded mound	Marked as 'made ground' on the BGS plan, two CA mine entries shown on the SE side.	11
16	SE 22254 19281	Wooded mound	Marked as 'made ground' on the BGS plan, one CA mine entry shown immediately east.	12
17	SE 22146 19290	Wooded mound	Marked as 'made ground' on the BGS plan.	8
18	SE 22320 19650	Pipes	Two metal pipes spanning a small valley in Lady Wood, thought to be water utilities.	5
19	SE 22288 19469	Circular feature & culvert/small adit	Possible bell pit or old mine entry with adjacent sandstone-lined culvert or small adit, with running water issuing from it.	6
20	SE 22476 19569	Saplings	Area of new planting and undergrowth with a footpath running through from east to west towards Lady Wood. Area was formerly a power station landfill.	3
21	SE 23117 19646	Boggy ground with orange surface water noted	Orange colour of water possible indication of acid mine drainage, in addition, surface vegetation appeared to be sparser here.	-
22	SE 23140 19622	Excavation (c. 1.5m, deep) with broken land drain at base	Bright orange water flowing through the land drain, indicative of acid mine drainage. Area around excavation appears very boggy, possible former bell pit.	26 & 27
23	SE 23323 19407	Metal manholes, brick structure & derelict caravan	Possible pumping station or water distribution (see paragraph 2.2.31)	19

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. Grid references are approximate.

Date	Site	Surrounding land
1854	Several wooded areas across the site, including Lady Wood in the north-west, Priest Royd Wood in the centre, Shragg Wood shown in the south of the site Sands House shown in the north-west Paradise (probable farm) shown in the centre of the site Crow Royd (probable farm) shown in the centre of the site Lees (probable farm) shown in east of site Green Hill (probable farm) shown in south-west of site Coal pit at 422350 419150 Coal pit at 422580, 419190 Well at 422580, 419140 to south of 'Paradise' farm Sandstone Quarry at 423170, 419540 'Cromwell Colliery Railway' (Mineral Railway) cuts across the east of the site ' Brick Field ' shown in east of site	Ouzelwell Hall to south of site Land south of site predominantly open fields and woodlands, with several isolated coal pits Railway shown along north-west site boundary A Glass Works and an Coke Ovens are shown about 200m north of the site
1892	Spring shown on site boundary at 422870, 418850 Spring shown at 423800, 419320 Excavation shown at 422150, 419300 Lees now shown as Moor Farm	Coke Ovens no longer shown; area now occupied by an Iron Works . Rifle Range shown 200m west of site
1893	2 shafts and 1 Old Shaft shown in Lady Wood Air Shaft shown at 423320, 419100 Well shown at 422330, 419440 in Lady Wood Well shown at 421960, 419460 Excavation shown at 422270, 419310 on western edge of Lady Wood Pond shown at Paradise Farm Spring shown at 423790, 419330	
1905	Air Shaft shown at 423130, 418780 2 'Old Shafts' shown in Lady Wood Spring at 423800, 419320 no longer shown Watch House shown west of Lady Wood	'Calder New Pit ' shown 100m north Gravel Pit shown 100m north of the site
1907	Possible pond/ excavation shown at 422880, 419770	Shaft shown 80m north-west of site at 422530, 419850 Excavation south of site now shown as 'Ingham's Pit (Coal)'
1922	Mineral Railway widened Spring at 423790, 419330 no longer shown	Gasometer shown at 423830, 419040, 150m south of the site
1931	Pylons shown crossing the site Allotment Gardens shown at 423880, 419400	Ingham's Pit shown 30m south of site at 424180, 419150
1933		Excavation shown 10m north of site at 422850, 419850 Ingham's Pit excavation extended to within 10-50m of the site boundary

Date	Site	Surrounding land
1937	Spring shown at 423080, 419640 Excavation shown at 422500, 419700, crossed by pylons	
1954	Issues shown in Lady Wood at 422320, 419470 Further excavations shown on western edge of Lady Wood Linear excavation shown at 423350, 419300 Issues shown at 423130, 419080 Sinks shown at 423340, 419440 Sinks shown at 423090, 419770	Slurry Beds shown 100m south of the site at Ingham's Pit Excavations at Ingham's Pit shown as close as 100m east of site boundary.
1955	Spring-sink- issues- sink sequence shown around 423080, 419700	
1963	Excavation shown at 422570, 419540 Excavation shown at 423330, 419410 ETL overheads shown crossing the site east-west	
1966		Housing shown along the majority of the site's northern boundary
1973	Excavations in the north-west of the site shown as Refuse Tip Slag Heap shown at 422550, 419520	
1979	Mineral Railway now dismantled	Ingham's Pit now shown as a ' Disused Colliery '
1981	Spring at 423080, 419640 no longer shown	
1982	Brick Field shown as a wooded area	
1988	Possible excavation shown at 423750, 419300	
1989	Sinks at 423090, 419770 no longer shown	
2002	Sinks shown at 423300, 419440	

- 3.3 The majority of the site has remained undeveloped.
- 3.4 It is unclear whether 'Brick Field' refers to production of bricks, extraction of raw materials for bricks (i.e. clay), both, or neither.
- 3.5 Various springs are shown sporadically on historical plans.
- 3.6 Features shown historically on the adjacent 'Ingham's Pit' site include more than 20 tanks, boilers, coke ovens, slurry beds, magazines and sub-stations.

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, Kirklees Council and extracts from the Groundsure Report are presented in Appendix E.

Issue	Data reviewed	
Geology	1:50,000 BGS map (Sheet 77) 1:10,000 BGS map (Sheet SE21NW) BGS Technical Report WA/98/6	Drift – no drift deposits are shown across the vast majority of the site. Glaciofluvial Deposits are shown across 15ha in the east. Boreholes detailed in BGS Report WA/98/6 prove that drift deposits in the north of the site are known to be up to 8.9m thick. Solid – Predominantly Pennine Lower Coal Measures (undifferentiated mudstones, siltstones and sandstones. Other units include: the Birstall Rock (fine- medium grained sandstones) in the south-west and centre of the site; and the Lepton Edge sandstone is present in a band across the north. Strata Dip – not shown. Shallowest coal seam – 7 named seams and 3 unnamed seams crop out across the site; see Section 4.3. Faults – 5 unnamed faults cut the site.
Mining	Coal Authority BGS maps	The majority of the site is located within Coal Mining Development High Risk Areas, with the remainder within Low Risk Areas. Past and present workings – 8 areas of opencast are shown on BGS map. Mine entries – 49 shown on site, 2 within 20m of the site boundary. Further details in Section 4.3 below.
Quarrying	Historical OS plans	At least 11 former quarries/ opencasts on the site.
Radon	Public Health England	Maximum radon potential is 1-3% for the majority of the site, but significant areas in the south and east have maximum radon potential of 3-5%.
Hydrogeology	Environment Agency	Source Protection Zone? No. Aquifer Secondary A (Drift); Secondary A (Solid). Groundwater abstractions? None of significance. Soil leaching potential – Varies from low through to high. Pollution incidents? None of significance.
Hydrology	EnviroInsight Report	Nearest watercourse(s) – 17 individual unnamed watercourses (3 culverted) are identified on site. The nearest named watercourse is the River Calder, 54m North of the site. Water quality – C (Chemical); E (Biological). Pollution incidents? None of significance. Abstractions? None of significance. Discharge consents? There are 6 active discharge consents on site, of which 5 are for treated effluent and 1 is for process effluent.
Flood risk	Environment Agency EnviroInsight Report	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. The site area is greater than 1 hectare Flood Zone 1, therefore a Flood Risk Assessment, focused on the management of surface water run-off, will be required. Development that increases the amount of impermeable surfaces can result in an increase in surface water run-off, which in turn can result in increased flood risk both on site and elsewhere within the catchment.

4.2 Landfills

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

Location	NGR (proximity to site)	Remarks	Source of data
Thornhill Power Station	SE 226 196 (on site)	Inert and industrial waste. Associated with the now demolished Power Station, and thought to have accepted inert wastes derived from the power station's own processes. There is no Waste License number stipulated (which would infer that tipping was completed prior to 1974, nor any mention of landfill gas monitoring having been carried out.	EA KC
Land at Ravensthorpe Road	SE 229 198 (40m north of site)	Inert and commercial wastes	EA
C R Longley Ltd	SE 230 198 (50m north of site)	Inert, industrial and special wastes	EA
Forge Lane	SE 238 196 (100m north of site)	Inert, industrial and commercial wastes	EA
Unnamed landfill	SE 239 196 (85m north of site)	From historical plans	OS plans
Unnamed landfill	SE 235 198 (200m north of site)		

4.2.2 Given the waste types accepted at the above landfills, significant volumes of landfill gas are not anticipated.

4.2.3 The Thornhill Power Station landfill is located in the north-west of the site. Waste types accepted here are known to have included inert and industrial wastes.

4.2.4 BGS map SE21NW identifies 8 areas of infilled ground and 3 areas of made ground on the site in addition to recorded landfills.

4.2.5 The EA have only been able to provide limited information regarding the Thornhill Power Station landfill. The first input is recorded as being in 1923, and is believed to include general factory waste.

Planning & development

4.2.6 Current Environment Agency guidance on the management of landfill gas (LFTGN 03, 2004) which provides an update to Waste Management Paper 27.

4.2.7 The Town and Country Planning (General Development Procedure) Order 1995 (GDPO) (as amended) requires planning authorities to consult with the Environment Agency (EA) before granting planning permission for development within 250 metres of land which is being used for the deposit of waste (or has been at any time in the previous 30 years).

4.2.8 The EA has developed 'standing advice' to enable LPAs to make decisions on planning applications for hard development within 250 metres of a 'licensed' or 'permitted' landfill without consulting the EA. The standing advice should be a material consideration in determining the planning application, as would advice received from the EA under Article 10(5) of the GDPO.

- 4.2.9 For landfill sites that are no longer licensed or permitted, the EA holds information that it can provide to local authorities to aid decision-making on relevant planning applications. However, local authority records for landfill sites that closed prior to the requirements of waste management licensing regime are likely to be more complete than those held by the EA (but apparently not in this case; see response from Kirklees Council in Appendix E).
- 4.2.10 Given the presence of shallow mineworkings, landfilled ground in the north-west, and proximity to on- and off-site made ground and landfills, a robust ground gas investigation will be required. Such investigation should be undertaken in accordance with current UK guidance, most notably:
- 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
 - BS8576:2013 Guidance on investigations for ground gas – permanent gases and volatile organic compounds
 - 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
 - Wilson, Card & Haines (CIEH, 2008) The Local Authority Guide to Ground Gas
- 4.2.11 In addition to concerns associated with landfill gas there may be issues associated with:
- The potential for the north-west of the site to be classified as Contaminated Land under Part IIA of the Environmental Protection Act 1990
 - Geotechnical issues (if development over landfilled ground were considered), including:
 - potential for settlement of land around piled dwellings
 - damage to underground services, especially drainage caused by uneven settlement

The Control of Pollution Act 1974

- 4.2.12 Landfilling in the north-west of the site pre-dates the Control of Pollution Act 1974. Prior to 1974 legislation on waste disposal had focussed on public health with no concern for wider environmental issues related to leachate and landfill gas. There was no classification of waste and no control over what types of waste were deposited in landfill sites. There are numerous stories of dead cows, chemical drums, etc. being deposited in such landfill sites.
- 4.2.13 Sites were usually capped off with a layer of soil to cover the waste without consideration of controlling gas emissions or rainfall infiltration. The Control of Pollution Act 1974 was the first major legislation to control the operation of landfill sites with an emphasis on environmental protection. It led to the creation of Waste Collection Authorities and introduced licensing for waste disposal facilities. The Act led to the introduction of waste classification and the first controls on what type of waste landfill sites could accept.
- 4.2.14 The act also required consideration of the wider environmental effects of waste disposal due to leachate generation.
- 4.2.15 At this time, “dilute and disperse” was still an accepted practice, most landfills were not lined and large volumes of degradable waste were placed in unlined pits in permeable soils (the worst conditions for landfill gas and leachate generation and migration). Co-disposal of hazardous waste with other types was also an accepted practice and so some domestic refuse sites from this time contain a wide range of hazardous materials.

- 4.2.16 In 1980, the Control of Pollution (Special Waste) Regulations were implemented under the Control of Pollution Act 1974. These defined hazardous waste through toxicity criteria and concentration of chemicals or substances. They retained the need (from the Deposit of Poisonous Waste Act 1972) to pre-notify the waste regulation authorities before moving special waste to pre-determined disposal sites.
- 4.2.17 In 1989, the first edition of Waste Management Paper 27 was published by the Department of the Environment. Updated in 1991, and now superseded by the Environment Agency's guidance on the management of landfill gas (LFTGN 03, 2004), this provided the first guidance on managing landfill gas emissions from landfill sites.

4.3 Coal & mining

- 4.3.1 In July 2011 the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology relating to coal mining development areas. This Section provides the necessary mining risk assessment required by the proposed planning application.
- 4.3.2 The majority of this site is located within a Coal Mining Development High Risk Area - an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc). Remaining parts of the site are located within Low Risk Areas - within the defined coalfield, but no known defined risks have been recorded by the Coal Authority; there may still be unrecorded issues.
- 4.3.3 Geological maps and BGS Technical Report (WA/98/6) suggest that 10 coal seams underlie the site at shallow depth. These are the:
- Flockton Thick (about 0.4-1.1m thick) outcropping south of the site
 - Flockton Thin (about 0.5-0.8m thick) outcropping in the far south of the site
 - An unnamed coal seam (about 0.0-0.9m thick) outcropping in the south of the site
 - First Brown Metal (about 0.3-0.7m thick), outcropping in the south and east of the site
 - Second Brown Metal/ Old Hards Coal (about 0.3-0.7m thick)
 - Third Brown Metal/ Stone Coal (about 0.2-0.6m thick)
 - Green Lane/ Middleton Little Coal (about 0.3-0.7m thick)
 - New Hards/ Middleton Main Coal (about 0.2-0.4m thick)
 - An unnamed Coal seam (no thickness given on BGS map)
 - Wheatley Lime Coal (about 0.7-1.2m thick)
- 4.3.4 Approximate outcrops are shown on Drawing 2336/4.
- 4.3.5 The BGS Technical Report notes that all of the named seams have been worked in the area, with the Second Brown Metal, New Hards and Wheatley Lime described as extensively worked.
- 4.3.6 The Flockton Thin, First Brown Metal and Third Brown Metal seams are described as having been worked by opencast methods only. Drilling supervised by Lithos on nearby sites has found the Flockton Thin seam to have been worked by deep mining, suggesting this is inaccurate.
- 4.3.7 Given dip and topography, the entire site is expected to be underlain by shallow coal in several seams. The stratigraphically lowest coal seam (the Wheatley Lime) on the site is underlain by the Middleton Eleven Yards coal in the wider area of BGS map SE21NW, however the BGS map suggests it is not present beneath this site.
- 4.3.8 Assuming this is correct, the Wheatley Lime coal is expected to be underlain by at least 30m of Coal Measure strata, within which there are no further significant coal seams.

4.3.9 A CA mining report states that:

- *The property is in the likely zone of influence from workings in 8 seams of coal at shallow to 300m depth, and last worked in 1944. This means there are known shallow mineworkings.*
- *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.*
- *Within, or within 20 metres of, the boundary of the property there are 51 mine entries.*
- *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.*
- *The property is in an area for which notices of entitlement to withdraw support were published in 1944 and 1947.*

4.3.10 Of the 49 known mine entries on site, the CA only have mine entry data for only one – Shaft Ref. 423418-004, of unknown depth. This shaft is located in the far south of the site, and was found filled with rubble and secured by a post and wire fence by the Coal Authority in 2010.

4.3.11 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 further mineworkings beneath the site for which the Coal Authority have no records.

4.3.12 It is also worth noting that CA shaft positions are often only approximate, and in some cases the same shaft has been recorded in multiple locations, or some other feature such as a chimney has erroneously been recorded as a shaft. For example in Lady Wood at SE 223 194, a feature is mapped as a well very close to a recorded shaft.

4.4 Recorded mineworkings

4.4.1 Abandonment plans have been obtained from the Coal Authority and are reproduced in Drawings 2336/7A to 2336/7J in Appendix B to this report. These plans show workings within the New Hards, Wheatley Lime, Old Hards and Green Lane coal seams.

4.4.2 A summary of the information given on the various abandonment plans is presented in the table below:

Drawing ref.	Location	Colliery	Seam	Mine entries	Remarks
2336/7A	North-west (Lady Wood)	Lady Wood Colliery	New Hards	Numerous adits at outcrop in the north-west.	Dip of seam recorded as c. 4° to the south-east. Coal recorded as 1.1m thick with 0.1m dirt parting. Likely Pillar & Stall workings due to shallow depth.
2336/7B	Far west (Calder Farm/Sands Lane)	Calder Colliery	New Hards	Numerous 'pits' labelled throughout.	Plan shows a number of faults along with a series of suspected tunnels with shaded areas in between, assumed to be areas worked.
2336/7C	Far west (Calder Farm/Sands Lane)	Unknown, likely Calder	New Hards	Numerous 'pits' labelled throughout.	3 shaded areas, assumed to be workings, numerous pits shown which tie in with those shown on the above plan, likely also associated with Calder Colliery.
2336/7D	Far south	Ingham Combs Colliery	New Hards	None shown	Thickness of New Hards shown as 1.1m. 'Old workings' labelled to the west, which could underlie the site. Shaded areas indicate location of workings.
2336/7E	East	Ingham Combs Colliery	Wheatley Lime	None shown	Workings shown as a series of tunnels and shaded areas. Based on current levels and those on the plans, workings range from around 35m to 80m depth. Thickness of seam shown as 0.8m. Dip of seam shown as c. 9° to the south-east. 'Old Workings' shown to the south-west.
2336/7F	Far East	Unknown	New Hards	None shown	Map shows a series of tunnels and shaded (worked) areas.
2336/7G	South	Unknown	New Hards	Numerous shafts shown	Old workings' shown to the west which underlie the site. Map shows a series of tunnels and shaded (worked) areas.
2336/7H	Central	Unknown	New Hards	Numerous shafts shown	Old workings' shown to the west which underlie the site. Map shows a series of tunnels and shaded (worked) areas.
2336/7I	North-east (Lady Wood)	Lady Wood Colliery	Green Lane	Numerous adits at outcrop in the north-west.	Dip of seam recorded as c. 4° to the south-east. Coal recorded as 0.6m thick with 0.2m fireclay beneath. Two areas of opencast in the north-east and one in the far west at outcrop. Most of workings likely Pillar & Stall workings due to shallow depth. 'Old Road' leading to the south indicating old, unrecorded mineworkings.
2336/7J	North-east (Lady Wood)	Lady Wood Colliery	Old Hards	One adit in the central-north	Predominantly opencast workings. Dip of seam recorded as c. 4° to the south-east. Coal recorded as 0.5m thick.

4.4.3 The plans show that the mineworkings are recorded at shallow depth beneath around 50% of the site; mostly associated with the Lady Wood Colliery (north-west), Calder Colliery (off-site), and Ingham Combs Colliery (east).

4.4.4 The most extensively worked seam is the New Hards seam, with recorded workings covering around 45% of the site's area; the Wheatley Lime seam is also extensively worked in the south and east.

4.4.5 It should be noted that, whilst the BGS plan states a thickness for the New Hards seam of 0.2m to 0.4m, information on the abandonment plans indicate it is up to 1.1m thick at Ingham Combs and Lady Wood Colliery.

- 4.4.6 A number of mine entries are shown on the various abandonment plans, including dayholes, shafts and adits. The highest concentration of adits is associated with workings in 3 seams at Lady Wood Colliery in the north-west. Shafts and pits are also common in the south-west.
- 4.4.7 In addition to the workings shown on the abandonment plans, a number of plans also label areas of 'Old Workings' beyond the recorded mines which indicates that large portions of the site are also likely to be underlain by older, unrecorded mineworkings (see below).

4.5 Unrecorded mineworkings

- 4.5.1 Coal has been mined in Yorkshire for centuries, and there are also likely to be unrecorded mineworkings which pre-date the requirement for abandonment plans (Coal Mines Regulation Act of 1872). 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).
- 4.5.2 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). Consequently, bell pits are often closely spaced; the most intensive concentration of shafts recorded to date (66 per acre) was at the Middleton Broom Opencast site.
- 4.5.3 As coal was removed during bell pitting, the unsupported strata above assumed an inverted slope of stability, generating a bee-hive shape around the base of the shaft which forms the characteristic vertical section. 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.
- 4.5.4 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; but rarely exceeded one quarter of a mile (400m) shaft to shaft, due to problems with ventilation and underground haulage. It was customary to view the life expectancy of an individual pit as about three to five years and at any one time several new pits would be sinking to replace those currently operating.
- 4.5.5 Up until the last decades of the eighteenth century, coal mining almost always represented a short-term interruption to ongoing use of land for agricultural. The right to sink shafts and extract coal was usually conditional upon restoration of the surface after coal extraction was complete. This not only involved filling the shaft, but also required that any subsequent settlement of shaft fill material did not result in depressions in the field surface. Consequently, it was usual to fill the shaft and heap excess arisings into a dome over the shaft eye. Over subsequent years, the dome supplied material to compensate for settlement of the shaft fill. In the normal course of events, at the conclusion of the recovery period, any remaining spoil accumulations above ground level would have been planed-off to leave a relatively stable, level surface where the shaft had been.
- 4.5.6 Bell pits may be present across the whole of the site near coal outcrops (see Drawing 2336/4). Given the absence of loose superficial deposits across the majority of the site, it is considered unlikely that any shallow mine entries at Dewsbury Riverside would have been lined.

- 4.5.7 Faults are believed to present beneath the land at Dewsbury Riverside. Faults 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).

4.6 Mining risks

- 4.6.1 Risks associated with shallow mineworkings include:

- Mines gas
- Combustion
- Collapse, with consequent subsidence affecting surface stability
- Recorded, and unrecorded, mine entries

Mining risks – gas

- 4.6.2 Gas monitoring and a hazardous gas risk assessment will be required; see Sections 4.2 & 8.3.

Mining risks – combustion

- 4.6.3 Where coal is exposed during any site preparatory earthworks, or within excavations, care should be taken to avoid the potential for spontaneous coal combustion.
- 4.6.4 If any foundation excavation comes into contact with coal, the foundation should be taken through the coal seam, into underlying natural in-situ strata of adequate bearing. The full thickness of coal should then be sealed with mass concrete fill placed as soon as possible after exposing the seam to prevent the ingress of air.
- 4.6.5 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. Miller 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).
- 4.6.6 Any ground investigation and/or drilling for grouting purposes should be carried out to HSE and Coal Authority guidelines to minimise the risk of coal combustion and potential for migration of mine gases into neighbouring properties.

Mining risks – mine entries

- 4.6.7 The Coal Authority hold records of 49 known mine entries on the site, all of which are believed to remain uncapped. It is possible that in addition to these known entries several unrecorded mine entries, possibly including bell pits exist.
- 4.6.8 The Coal Authority discourage development over or adjacent to shafts. However, such features are typically of less concern where they only extend to relatively shallow seams. The recommended no build zone around deep shafts is usually defined by a line drawn up at 45° from the top of the shaft, where it intercepts rock head.
- 4.6.9 Once located, each shaft should be accurately located by grid co-ordinates, proved to its base, pressure grouted and then be capped off at rockhead level. A shaft cap is generally required to be twice the shaft diameter and designed to support the depth of fill above plus any surcharge loads. Detailed cap design is beyond the scope of this report but should also include gas venting measures.

Mining risks – surface stability

- 4.6.10 Mineworkings which could affect surface stability are probably present beneath the majority of the site. Coal is likely to have been extracted by pillar & stall methods.
- 4.6.11 In addition there may also have been earlier, unrecorded mineworkings via bell pits and/or pillar and stall methods, and if present these could result in unpredictable subsidence. Individual pillars may collapse at any time, leading to settlement in the overlying strata. As the mine roof degrades and collapse the void migrates upwards, sometimes causing a surface collapse or crown hole.
- 4.6.12 The vertical distance through which a void can migrate is difficult to assess. Made ground and superficial deposits are considered to have no inherent strength and the assumption is generally made that if a void reaches the base of these formations, it will reach the surface.
- 4.6.13 CIRIA ('Construction over abandoned mine workings', 1989) suggest a thickness of solid rock through which a void can migrate as $7h$ to $10h$ above the roof of the workings, where h is the height of the workings (generally assumed to be similar to the seam thickness; i.e. about 1m). The succession here is likely to comprise a mixed sequence of siltstones and mudstones and it is therefore considered appropriate to assume a figure of $10h$ (i.e. about 10m of bedrock, plus any overlying residual soil and made ground) for void migration calculations at this stage. However, the Birstall Rock and Lepton Edge sandstones may be suitable strata for adoption of a figure of $7h$.
- 4.6.14 Mitigation of the risks posed by the shallow mineworkings will be required, and this could be achieved in one of two ways:
- Extraction of the remaining coal
 - Consolidation, via drilling & grouting

4.7 Coal extraction

- 4.7.1 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.
- 4.7.2 The Extraction Contractor would pay the landowner a disturbance allowance for the coal. Consequently, there could be a significant financial benefit to this approach, since in essence any proposed earthworks (i.e. regrading) would be undertaken and there would be a considerable saving because grouting would not be required.
- 4.7.3 Coal extraction could be completed within about 12 months, and would include redistribution of the excavated materials to an engineered specification as required by the final earthworks model.
- 4.7.4 In order to pursue this option, it will be necessary to obtain a statutory licence from the Coal Authority.
- 4.7.5 In addition to commercial and planning considerations, advantages of coal extraction over grouting include the removal of development constraints associated with known mine entries. Traffic movements (associated with coal export) are expected to be no greater than those associated with grouting (import of PFA and cement).

4.8 Drilling & grouting

- 4.8.1 If shallow coal seams are not entirely removed by prior extraction, then it may be necessary to consolidate the mineworkings by drilling and grouting.
- 4.8.2 The necessary consolidation should be achieved by drilling holes on an appropriate grid (likely 3m to 5m spacings). A viscous grout composed of appropriate proportions of OPC, PFA, sand or pea gravel would then be injected into the workings via these holes.
- 4.8.3 Drilling and grouting operations should be carried out with engineering supervision, and be undertaken in accordance with a revision of Lithos' "General Specification for the Treatment of Shallow Mineworkings" tailored to the site-specifics associated with this site.
- 4.8.4 Proposals to treat the mineworkings and shafts will need to be discussed with both Kirklees Council (most notably Highways), and the Coal Authority well in advance of starting works on site.

4.9 Mineral safeguarded areas

NPPF

- 4.9.1 The site is underlain by 10 seams of coal at shallow depth and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).
- 4.9.2 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.
- 4.9.3 Specialist guidance on Mineral Safeguarding "A Guide to Mineral Safeguarding in England" has been produced by The Coal Authority and the British Geological Survey.
- 4.9.4 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.
- 4.9.5 NPPF Paragraph 144 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.
- 4.9.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require Miller 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

Kirklees Council Policy

- 4.9.7 The Council have a Unitary Development Plan (UDP), adopted in 1999 with some revision in 2007. Section 6.10 (Minerals) of the UDP notes that: *"In West Yorkshire opencast coal mining is concentrated in Leeds and Wakefield Districts. There has not been an operational opencast coal mine in Kirklees since 1984 perhaps because the local geology is more difficult and because of the extent of previous extraction in the exposed coalfield within Kirklees during the 1950's and 1960's. Unlike aggregates there is no national or regional guidance on the level of production required or where it should be met; MPG3 leaves that to market forces. For these reasons no allocations for opencast coal mining are considered necessary."*
- 4.9.8 However, Kirklees 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. In essence Section 6.10 is concerned with coal extraction where no subsequent development is proposed; this is quite different to the NPPF scenario with its emphasis on avoiding sterilisation of coal reserves.
- 4.9.9 Kirklees Council have also issued a Draft Local Plan (Strategy & Policies) in November 2015. Map 5 suggests the site (referred to as H2089) does not lie within a Mineral Safeguarded Area.

4.10 Other issues

- 4.10.1 Underground high pressure gas mains and overhead electric pylons cross the site. These are likely to require either substantial development easements or diversion at significant cost.
- 4.10.2 Where proposed highways cross quarry highwalls, significant precautions must be taken to avoid unacceptable settlement.
- 4.10.3 There are 3 recorded pollution incidents on site. Two of these incidents involved household waste and are classified as category 3 (minor) towards water and land, category 4 (no impact) towards air. One further incident involved asbestos pollutants and was assessed as category 3 (minor) towards land, category 4 (no impact) towards air and water.
- 4.10.4 The EA have provided 3 years of water quality results from the closest monitored upstream/downstream locations to the site. In order to offer more upstream/downstream comparison they have also included data from the site further above at Battysford - this has a more extensive suite, in line with the downstream Dewsbury point. The immediate upstream point at Mitchell Cotts only carries more basic analyses. This EA data (Microsoft excel format) is not included within Appendix E, but is included on the CD issued with this Report.
- 4.10.5 The EA have no concerns regarding surface/groundwater passing through the site.

5 LAND CONTAMINATION - PART IIA & PLANNING

- 5.1.1 Local Authorities have responsibilities with respect to land contamination in the context both of Part IIA of the Environmental Protection Act 1990, and Planning.
- 5.1.2 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

- 5.1.3 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:
- 5.1.4 'Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.
- 5.1.5 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'.
- 5.1.6 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

- 5.1.7 The underlying bedrocks are classified as Secondary A aquifers. Furthermore, several watercourses have been identified on the site, flowing towards the River Calder, which flows east, approximately 50m beyond the site's northern boundary. Therefore, the site's environmental setting is considered to be of moderate to high sensitivity.
- 5.1.8 With respect to human health, the proposed end use (predominantly residential) is also sensitive.
- 5.1.9 Whilst current agricultural use of the site is considered unlikely to have given rise to any significant ground and groundwater contamination, former usage associated with mining and landfilling may have.
- 5.1.10 However, it is considered that the site should be suitable for the proposed use subject to implementation of appropriate preparatory works.

6 PREVIOUS INVESTIGATION FINDINGS

6.1 General

- 6.1.1 Miller have provided Lithos with a copy of the following report: Preliminary Geoenvironmental Investigation of land at Ravensthorpe Road, Dewsbury (Ref. 9517/1), issued by Encia Consulting in June 2008.
- 6.1.2 The report includes a desk-based study and site visit concerned with a 13 hectare parcel of land in the north of the current site.

6.2 Lithos comments

- 6.2.1 The report does not contain any intrusive investigation data. Consequently, its content is similar to that reported here, although less detailed.

7 GROUND INVESTIGATION DESIGN

7.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	Likely to only occur in significant volumes in backfilled shafts, pits and quarries. Landfill waste known in the north-west of the site. Veneer likely associated with existing buildings and hardstand.
Natural soils	Topsoil over majority of the site. Predominantly residual soils of weathered bedrock, with cohesive Glaciofluvial deposits across approximately 15ha in the north of the site
Bedrock	Coal Measures sandstone, siltstones and mudstones (predominantly undifferentiated) from 1mBGL to 9mBGL
Mineworkings	Likely to underlie the entire site at shallow depth, 51 known mine entries on or within 20m of the site
Groundwater	Likely at shallow depth within bedrock Artesian water is likely to be present at the site

- 7.1.2 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. Landfill 2. Backfilled coal pits & quarries 3. Rail sidings 4. Shallow mineworkings 5. Material storage	1. Landfill known to have accepted power station waste, a source of dioxins 4. Hazardous gas & acid mine drainage 5. Materials stored on farms include fuels, oils, pesticides
Potential off-site contamination sources	1. Landfill 2. Backfilled coal pits & quarries 3. Shallow mineworkings	1. Migration of hazardous gas

Type of issue	Specific issue	Remarks
Potential geotechnical hazards	1. Deep Made Ground 2. Steep slopes 3. 'Soft spots' in Glaciofluvial deposits 4. Shallow workings 5. Mine entries	1. Associated with backfilled quarries & pits 2. Steep slopes in the south of the site may require stability assessment 3. May require alternative foundation solutions 4. Ground instability where workings are near the surface 5. Will require location and treatment. The CA will likely object to development directly above.
Other potential constraints	1. Culverts 2. Underground and overhead utilities	1. Will require easement or diversion 2. Likely to be prohibitively expensive to divert

7.2 Preliminary conceptual site model

7.2.1 Preliminary conceptual site models, presented as Drawing Nos 2336/5 (mining) and 2336/6 (contamination) in Appendix B, have been prepared after consideration of all the data presented in Sections 2 to 7.1 inclusive of this report.

7.2.2 An assessment of potential contaminants associated with the former uses has been undertaken with reference to CLR8 and the following DETR Industry Profiles: Railway Land; Power Stations; and Waste recycling, treatment and disposal sites. As a consequence of this assessment, anticipated potential contaminants, within soil and/or groundwater include:

- Railway Land
 - Fuel and lubricating oils
 - PCBs
 - PAHs
 - Ash
 - Herbicides and creosote
 - Ethylene glycol
 - Asbestos
- Power Stations
 - Metals and metalloids
 - Asbestos
 - PCBs
 - PAHs
 - Fuel and lubricating oils
 - Inorganic compounds E.G. sulphates and phosphates
- Waste recycling, treatment and disposal sites
 - Contaminants too varied to list comprehensively

7.2.3 While the DETR industry profile lists a highly varied range of potential contaminants on landfills, potential contaminants associated with Thornhill Power Station landfill are considered likely to reflect those shown in the DETR profile for Power Stations.

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

Agricultural activity	Potential contaminant
Sewage farming, slurry spreading	Methane, metals, nitrates, oxygen depletion
Carcass burial	Anthrax & other biohazards
Crop & animal protection	Pesticides & herbicides
Timber processing/treatment	Metals, PAH, chlorinated organics
Field sports	Lead shot
Fuel storage	Hydrocarbons, methane, oxygen depletion
Equipment maintenance	Hydrocarbons, metals
Waste burial, land levelling, backfilling ponds/quarries	Methane, metals, PAH etc
Derelict buildings	Asbestos
Naturally occurring contaminants	Arsenic, metals

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

7.3 Ground investigation design & strategy

- 7.3.1 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 technique	Purpose
Trial pits	To determine the general nature of soils underlying the site, including the: - nature, distribution and thickness of areas of made ground - nature, degree and extent of any contamination - proportion of undesirable elements eg biodegradable matter, foundations etc - suitability of the ground for founding structures and highways
Cable percussion Boreholes	To determine the nature, extent and depth of backfill in the former quarries and coal pits To retrieve geotechnical data from depth in the north of the site (glaciofluvial deposits) To install gas and groundwater monitoring wells
Rotary probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings To install gas and groundwater monitoring wells
Geophysical surveys	To locate recorded and unknown mine entries

- 7.3.2 Given the size of the site, a phased ground investigation might be commissioned, with an initial, 'exploratory' phase of very widely spaced exploratory holes across the entire site, followed by appropriate supplementary investigation(s). Alternatively, it might be more appropriate to commission more comprehensive investigation of each discrete parcel of proposed development on a rolling programme as development proceeds.
- 7.3.3 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 7.1 above.
- 7.3.4 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.

- 7.3.5 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)
- 7.3.6 Cable percussion boreholes should be advanced in order to retrieve geotechnical data from depth in areas of deep made ground and the Glaciofluvial deposits, and also allow the installation of gas/groundwater monitoring wells.
- 7.3.7 The in-situ undrained shear strengths of any cohesive soils encountered should be determined by use of a hand-held shear vane.
- 7.3.8 Soakaways may provide a viable solution for the disposal of surface water in parts of the site, particularly in areas underlain by the Lepton Edge and Birstall Rock sandstones at shallow depth. However, soakaways are unlikely to provide a viable drainage solution in areas of Glaciofluvial deposits.
- 7.3.9 Soakaways will not provide viable solutions for the disposal of surface water in or within influencing distance of areas of made ground or landfill on the site. If soakaways are located topographically high in the site, they may contribute to existing springs or create new springs down slope. Furthermore, the drill and grout works the site is likely to require may change the hydrogeological characteristics of the site.
- 7.3.10 As such, soakaway testing is not recommended on this site.
- 7.3.11 Routine geotechnical soils analysis (moisture content, Atterberg limits, pH, water soluble sulphate) should be scheduled.
- 7.3.12 Within 'greenfield' areas of the site testing of potentially contaminated samples should only be required if made ground is encountered in exploratory holes. Analysis of topsoil across the site (for pH, metals, TOC, speciated PAH and asbestos ID) should be undertaken in order to confirm its suitability for re-use.
- 7.3.13 Within 'brownfield' areas of the site appropriate chemical analyses based on the findings of this Report should be allowed for. This is likely to comprise a suite including heavy metals, asbestos ID, TOC, CV, banded TPH (with supplementary speciation where appropriate), and speciated PAH. Testing for dioxins and PCBs should be undertaken at the Thonhill Power Station landfill.
- 7.3.14 Probeholes should be advanced to determine whether or not old mineworkings are present in coal seams underneath the site.
- 7.3.15 It will be necessary to submit an application (with the associated fee) to the Coal Authority (CA) for 'Permission to enter CA mining interests'.
- 7.3.16 Given the size of the site it should be possible to advance probeholes at least 50m from surrounding properties; therefore air or air-mist should be a suitable flushing medium for probeholes.
- 7.3.17 The generation potential of potential gas sources (landfills and shallow mineworkings) is considered likely to be Moderate. Therefore, in accordance with CIRIA Report C665, it would be prudent to initially allow for 12 visits over a 12 month period. Revision of this monitoring programme should be possible in light of actual masterplan proposals.

- 7.3.18 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.

8 CONCLUSIONS & RECOMMENDATIONS

8.1 General

- 8.1.1 It is understood that Miller are considering acquisition of the site with a view to redevelopment with up to 4,000 homes and 3 schools.
- 8.1.2 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 and educational redevelopment of the site.
- 8.1.3 Ideally, the final development layout will take account of constraints identified to date; see Drawing 2336/8. Most notably, residential development on, and within 50m of, landfilled ground in the north-west (Thornhill Power Station landfill) which extends across an area of about 5 hectares), may need to be avoided.
- 8.1.4 With regards to mine entries, there is no merit in avoiding these features when developing the masterplan further due to their potential inaccuracy on Coal Authority plans. Mine entries should be located during an intrusive phase of investigation and minor revisions made to the layout proposals if/as necessary.

8.2 Mining and quarrying

- 8.2.1 Geological plans suggest the site is underlain by 10 coal seams at shallow depth. Furthermore there are known workings in 8 seams of coal at shallow to 300m depth. Consequently, the majority of this site is located within a Coal Mining Development High Risk Area, with remaining parts lying within Low Risk Areas.
- 8.2.2 Coal Authority abandonment plans show that mineworkings are recorded at shallow depth beneath around 50% of the site; mostly associated with three former collieries at Lady Wood, Calder, and Ingham Combs.
- 8.2.3 The most extensively worked seam is the New Hards seam, with recorded workings covering around 45% of the site's area; the Wheatley Lime seam is also extensively worked in the south and east.
- 8.2.4 Where mineworkings 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
- 8.2.5 In addition to mineworkings, there are areas of opencast workings associated with Lady Wood Colliery in both the New Hards and Green Lane seams in the west.
- 8.2.6 There are 51 mine entries are recorded within, or within 20m of, the site boundary.
- 8.2.7 The Coal Authority discourage development over or adjacent to shafts. However, such features are typically of less concern where they only extend to relatively shallow seams. The recommended no build zone around deep shafts is usually defined by a line drawn up at 45° from the top of the shaft, where it intercepts rock head.

8.3 Hazardous gas

- 8.3.1 Given the presence of shallow mineworkings, landfilled ground in the north-west, areas of made ground across the site and within 250m of the site boundary, a robust ground gas investigation will be required.
- 8.3.2 Gas protection measures will almost certainly be required for new buildings across the site.
- 8.3.3 The maximum radon potential is 1-3% for the majority of the site, but significant areas in the south and east have maximum radon potential of 3-5%.
- 8.3.4 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%).
- 8.3.5 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.
- 8.3.6 Basic radon measures should comprise:
- Use of 1200 gauge polyethylene DPM\DPC, with suspended concrete floors or ground bearing floor slabs
 - Continuous membrane across cavity walls
 - Cavity tray in external walls
 - Fully sealed service entries/exits

8.4 Site regrade & slope stability

- 8.4.1 Given existing topography (much of the site is sloping, with gradients of up to 1 in 4), some significant site regrade is anticipated, with the need for underbuild and retaining walls.
- 8.4.2 Careful consideration will need to be given to earthworks design, and implications for slope stability, retaining walls, foundations, highway gradients and drainage.
- 8.4.3 Earthworks modelling will be required, but some cut into bedrock is anticipated. Shallow bedrock is likely to include hard sandstone, and it would be prudent to allow for excavation of hard rock in any deep excavations such as those that may be required for drainage etc.
- 8.4.4 Any digital terrain modelling undertaken, or commissioned by the Developer should be made available to their Engineering Designer prior to issue of an External Works Drawing. Wherever possible, Lithos recommend that excavated soils are retained on site.
- 8.4.5 Earthworks might result in the extraction of coal, and the removal of risks posed by shallow mineworkings and mine entries.
- 8.4.6 On completion of the necessary earthworks modelling it might be necessary to consider slope stability issues via appropriate computer modelling. In the meantime, it is considered likely that batters of around 4H:1V within residual soils, and 2.5H:1V within bedrock, should be possible. Consideration might be given to a simple crib wall in order to protect any exposed rock face from the longer-term effects of degradation caused by weathering.
- 8.4.7 Natural ground underlying this site is likely to be 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.

8.5 Foundations

- 8.5.1 At present, no geotechnical ground investigation data is available and consequently it is only possible to estimate the 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.
- 8.5.2 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. Consequently, alternative foundation solutions (e.g. vibro or piles) will be required in any areas of deep made ground (greater than about 1.5m).
- 8.5.3 The published geological data suggests that the majority of the site is underlain by Pennine Lower Coal Measures (undifferentiated mudstones, siltstones and sandstones. Other units include: the Birstall Rock (fine & medium grained sandstones) in the south-west and centre of the site; and the Lepton Edge sandstone in a band across the north. The only drift deposits on site are approximately 15ha of Glaciofluvial deposits in the north of the site.
- 8.5.4 Weathered Coal Measures or firm cohesive drift deposits should provide sufficient bearing capacity to enable the adoption of strip footings for two storey housing.
- 8.5.5 Where 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.
- 8.5.6 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.

8.6 Highway and drainage

- 8.6.1 If any new highway spans a quarry 'high-wall', the following preliminary precautions are recommended to protect highway and drainage infrastructure from damage due to differential settlement.
- 8.6.2 The made ground should be excavated over the full width of the adoptable highway to at least 1.0m below deepest sewer invert. The base of the excavation (1.5m below sewer invert) should be reinforced with two layers of Tensar Triax TX160 (or equivalent) geogrid sandwiched within at least 300mm of suitable aggregate
- 8.6.3 A minimum length of 5m either side of any highwalls associated with the former quarry should be treated to the above specification, although the final specification should be agreed with the adopting authority.
- 8.6.4 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.
- 8.6.5 Given anticipated ground conditions, soakaways are considered unlikely to provide a viable solution for the disposal of surface water. Consequently, it may be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.
- 8.6.6 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.

- Rain-gardens - shallow landscape depressions with shrub or herbaceous planting.
- 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.
- Reed beds and other wetland habitats that collect, store, and filter dirty water whilst also providing a habitat for wildlife. Reed beds may also be incorporated into a system for the treatment of ochre water.

8.6.7 SuDS rationale is to try to replicate natural systems that use cost-effective solutions, with low environmental impact, to drain away surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into watercourses.

8.6.8 SuDS solutions should be easy to manage, requiring little or no energy input (except from environmental sources such as sunlight, etc.), resilient to use, as well as being aesthetically attractive.

8.7 Contamination

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

8.7.2 The majority of 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.

8.7.3 Areas of made ground and landfill on the site probably present the most significant risks to current and end-users of the site. At this stage, little information is available regarding potential contaminants associated with these.

8.7.4 Locally, a veneer of made ground associated with existing buildings, hardstand and former railway is anticipated. Deeper made ground associated with a former landfill and backfilled coal pits/ quarries is also anticipated.

8.7.5 Areas of contamination associated with fuel and heating oil tanks (farmyards etc) should be anticipated.

8.7.6 Ochreous water was observed during site visit, indicating acid mine drainage.

8.8 Potential development constraints

8.8.1 Potential constraints are shown on Drawing 2336/8, and include:

- Areas of woodland and watercourses, including some that are culverted
- Areas of steep ground
- Areas of deep made ground, including:
 - Thornhill Power Station landfill in the north-west of the site
 - Backfilled opencast coal workings
 - Backfilled sandstone quarries
- High pressure gas mains and pylons. Diverting these will generate significant costs, as such it may be more cost-effective to introduce easements into the site masterplan
- Geological faults cross the site, and may require reinforcement of footings
- Mine entries

8.9 Further investigation

8.9.1 Whilst the site is considered suitable for its current and proposed use, the proposed change in use will require intrusive investigation. This would include:

- Machine-excavated trial pits to determine near surface ground conditions including depth to bedrock, the presence of obstructions, groundwater and stability
- Geotechnical soils analysis with grading and compaction testing to inform the design of appropriate earthworks, and to enable foundation recommendations
- Chemical testing on soil and groundwater samples to assess the significance of contamination, if any, as a result of former land use
- Rotary probeholes to confirm depths and seam thicknesses in order to assess risks associated with old mineworkings and surface stability
- Gas monitoring and risk assessment

8.9.2 An appropriate ground investigation strategy is presented in Section 7.3

Appendix A

General Notes

Generic notes – geoenvironmental Investigations

General

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

Geology, mining & quarrying

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

Generic notes – geoenvironmental Investigations

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 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.

Appendix B

Drawings



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CLIENT

miller homes

JOB TITLE

**DEWSBURY
RIVERSIDE**

DRAWING TITLE

**SITE LOCATION
PLAN**

DRAWN

MAR

DATE

11 01 16

CHECKED

REG

DATE

11 01 16

STATUS

FOR COMMENT ☐

DRAFT ☐

FOR APPROVAL ☐

FINAL ☒

SCALE

1:25,000

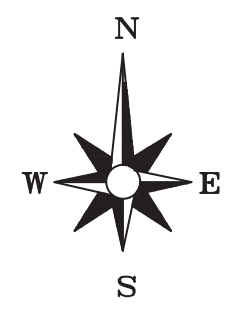
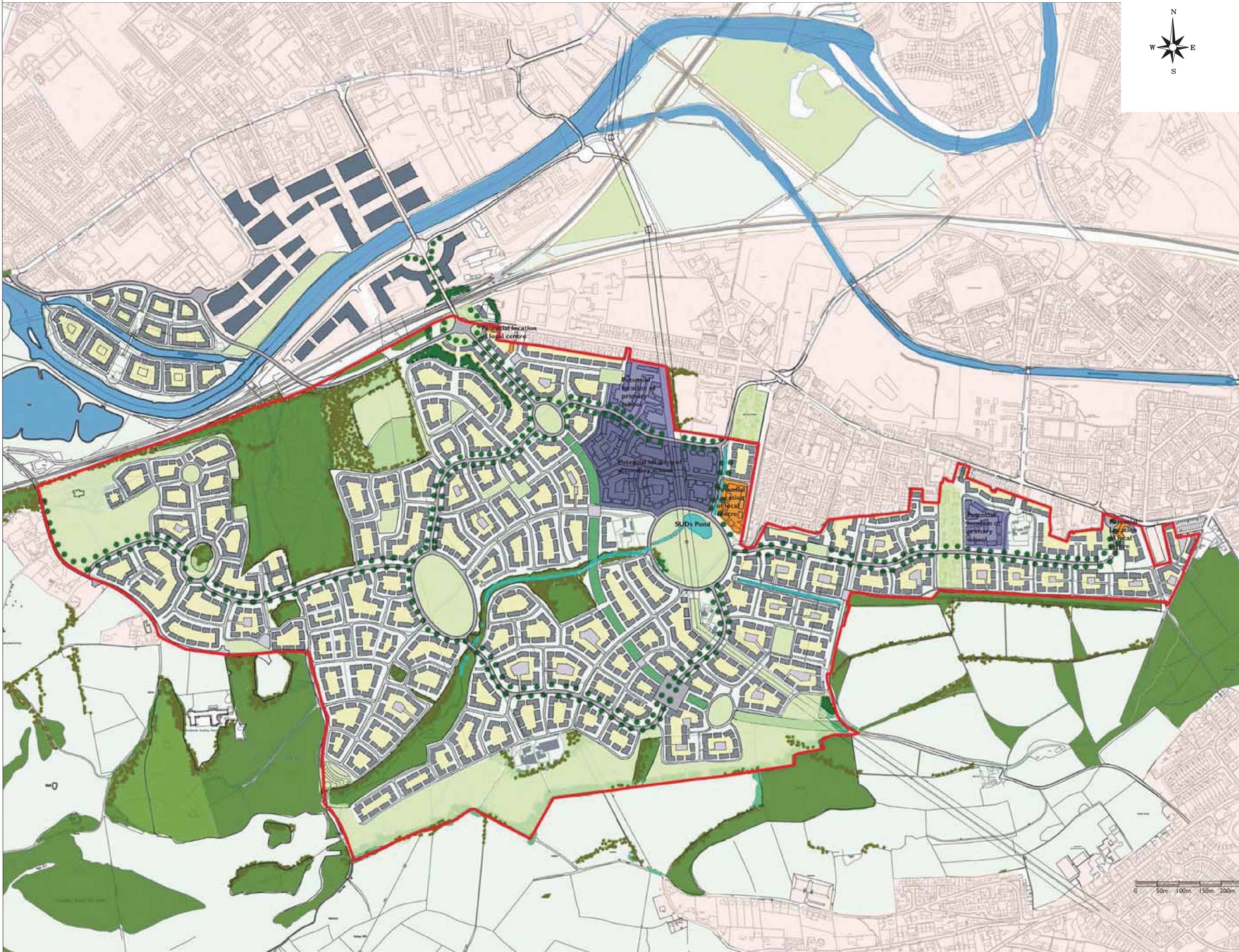
SHEET

A4

DRAWING NO.

2336/1

REVISION



NOTES

FROM SPAWFORTHS DEWSBURY
RIVERSIDE CONSULTATION DRAFT
MASTERPLAN

REV.	DESCRIPTION	DATE
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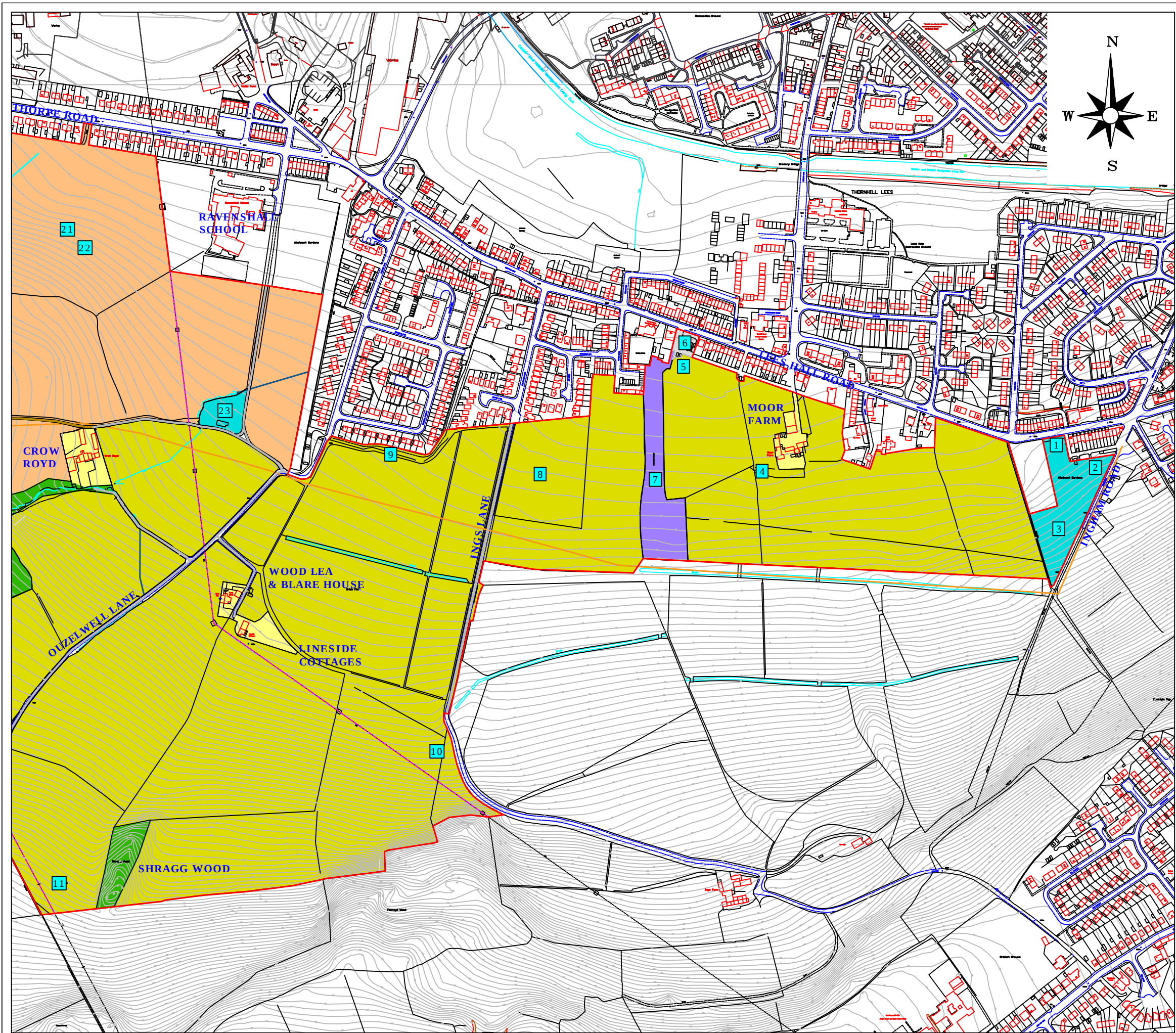
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DEWSBURY RIVERSIDE

DRAWING TITLE

SITE LAYOUT

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CHECKED	MJT	DATE	26 01 16	FOR APPROVAL	DRAFT	☐
				FINAL	FINAL	☒
SCALE	NTS	SHEET	A1	DRAWING NO.	2336/2	REVISION



NOTES		
1	SITE FEATURE REFERENCE	
	ARABLE FARMLAND	
	PASTORAL FARMLAND / PADDOCKS	
	FARMYARDS / RESIDENTIAL DWELLINGS	
	WOODLAND	
	AREA OF NEW PLANTING	
	ALLOTMENTS	
	ROUGH GRASSLAND	
	SURFACE WATERS	
	REGIONAL GAS MAIN (approximate route)	
	CULVERT (based on Groundsure plan)	
	O / H ELECTRICITY CABLES (based on topo information only)	
	TRACK / ROAD	
	ROUGH TRACK / PATH	
	APPROXIMATE SITE BOUNDARY	
REV.	DESCRIPTION	DATE



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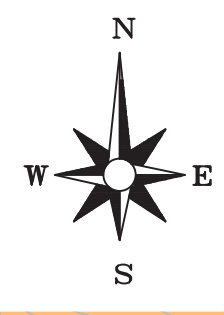
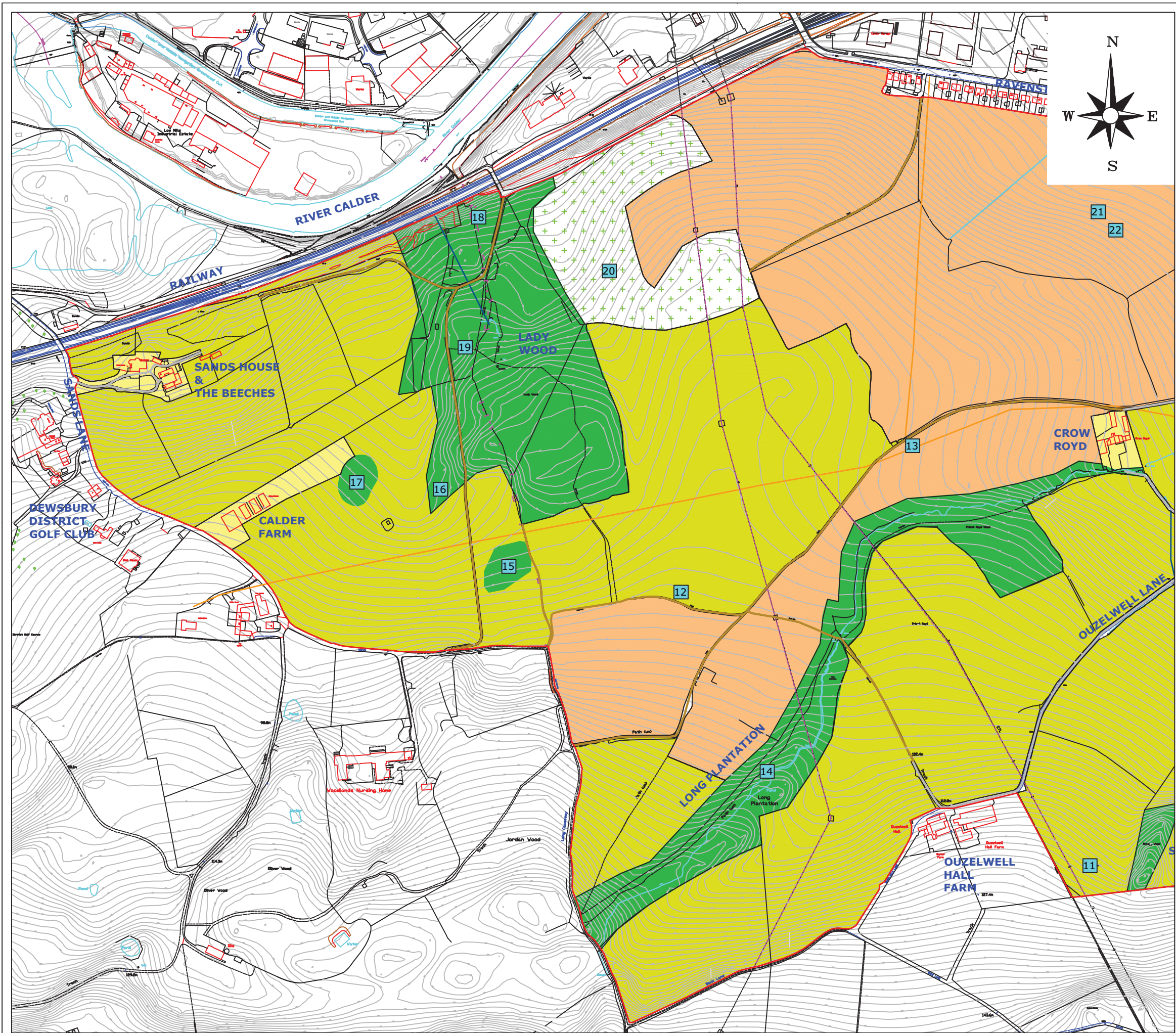
JOB TITLE

DEWSBERY RIVERSIDE

DRAWING TITLE

**SITE FEATURES & LAND USE
(EAST)**

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CHECKED	MJT	DATE	15 01 16	FOR APPROVAL	DRAFT	☐
				FINAL		☒
SCALE	1:5,000	SHEET	A3	DRAWING NO.	2336/3E	REVISION



- NOTES
- 1 SITE FEATURE REFERENCE
 - ARABLE FARMLAND
 - PASTORAL FARMLAND/PADDOCKS
 - FARMYARDS/RESIDENTIAL DWELLINGS
 - WOODLAND
 - AREA OF NEW PLANTING
 - ALLOTMENTS
 - ROUGH GRASSLAND
 - SURFACE WATERS
 - REGIONAL GAS MAIN (approximate route)
 - CULVERT (based on Groundsure plan)
 - O/H ELECTRICITY CABLES (based on topo information only)
 - TRACK/ROAD
 - ROUGH TRACK/PATH
 - APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE



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CLIENT

JOB TITLE

DEWSBURY RIVERSIDE

DRAWING TITLE

SITE FEATURES & LAND USE (WEST)

DRAWN	MAR	DATE	15 01 16	STATUS	FOR COMMENT	☐
CHECKED	MJT	DATE	15 01 16	FOR APPROVAL	DRAFT	☐
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