



Harworth Estates Investments Limited

Houghton Main

Coal mining risk assessment

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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Harworth Estates Investments Limited (Harworth) to carry out a Coal Mining Risk Assessment (CMRA) of the land at Houghton Main, Little Houghton, to the east of Barnsley. The project was carried out to an agreed brief as set out in RSK's proposal (Ref. 322835-TL01, dated 6 May 2021).

A preliminary risk assessment (PRA) has been completed for the site, as reported in RSK report 322835-R01(00), and that report should be consulted alongside this document.

The area is proposed for a commercial/industrial redevelopment.

The assessment provided in this report is required due to the site being within an area defined by the Coal Authority as a Development High Risk Area. A CMRA needs to consider a number of sources of information to determine coal mining issues relevant to a site. It then needs to identify and assess the site-specific coal mining risks and propose an appropriate mitigation strategy relevant for the proposed site end-use. This approach has been followed in the current assessment.

Guidance from the Coal Authority outlines the assessment stages required for a CMRA, which are included in the following sections of this report:

Stage 1 - Sources of information

- Sections 1 and 2 provide background information
- Section 3 presents available desk-based information

Stage 2 - Assessment of site-specific coal mining risks

- Section 4 presents an assessment of the site-specific coal mining risks

Stage 3 - Mitigation strategy proposed

- Section 5 presents the required mitigation measures to address the identified risks

1.1 Scope of coal mining risk assessment

The scope of this CMRA is to:

- present a review of all available information on the coal mining issues which are relevant to the site
- use that information to identify and assess the risks to the proposed development from coal mining legacy, including the cumulative impact of issues
- identify any required mitigation measures to address the site-specific coal mining risks prior to site redevelopment works.

1.2 Limitations

The comments given in this report and the opinions expressed are based on information gathered during the desk study, the sources of which are presented within the report for reference. This report is subject to the RSK service constraints given in Appendix A.

2 THE SITE

2.1 Site location and description

Site location details are presented in Table 1 and a site location plan is provided as Figure 1.

Table 1 **Site location details**

Site name	Houghton Main
Full site address and postcode	Land in the area of the former Houghton Main Colliery, Park Spring Road, Little Houghton, nearest postcode S72 0HR
National Grid reference (centre of site)	442070, 405916

2.2 Site description

The site boundary and current site layout are shown on Figure 2. The site covers an area of approximately 5.9 hectares and is located to the south of the ASOS warehouse, and east of the A6195 near Little Houghton.

The site is currently mainly covered by vegetation and is overgrown in most parts, particularly along the line of drainage features. There is evidence of fly-tipping and former buildings, with some waterlogged areas noted.

2.3 Proposed development

Redevelopment proposals for the site are shown on the masterplan drawing, provided in Appendix B.

2.4 Geology

2.4.1 Anticipated geological sequence

Geological records for the area (British Geological Survey Onshore GeoIndex, accessed May 2021) and available historical borehole logs indicate the geology of the site to be characterised by the succession recorded in Table 2. There are 15 publicly available BGS boreholes located on or within 250m of the site, which are presented in Appendix F.

Table 2 Site geology

Strata	Description	Estimated thickness	Hydrogeology
Made ground	Made ground may be present outside of the opencast areas, associated with historical buildings or colliery infrastructure previously on-site	Not known, but expected to be relatively shallow	N/A
Made ground (opencast backfill)	Backfill placed after opencast mining, generally a mixture of reworked mudstones, siltstones and sandstones	Between 10m and 16m (see Section 3.6 Error! Reference source not found. for more details)	N/A
Alluvium (superficial deposit)	Most of the site has no superficial deposits. Alluvium comprising clay, silt, sand and gravel is present only close to the River Dearne, in the north western site corner	Not known	Secondary A aquifer
Pennine Middle Coal Measures (bedrock)	Present across the whole site, comprising mudstone, siltstone and sandstone with coal seams	Up to 650m. Shafton coal seam likely to be shallow on the eastern side of site (seam thickness around 1.4m)	Secondary A aquifer
Information sources: BGS Geoindex, BGS borehole logs, WYG report			

Linear features are shown on the GeoIndex mapping in the form of coal seams sub-cropping across the site approximately from north west to south east, and fault lines present just off-site to the south, and to the west of the River Dearne. The longer north east to south west fault line is reported to be downthrown to the south east, with a movement of less than 2m (getting smaller further to the south west).

As the site is known to have been used for open cast coal extraction, there is infill material across the majority of the site, which was placed under supervision following a Department of Transport specification for road and bridge works standards, 1976 (WYG, 2008). Information from BGS borehole logs on the site is provided in Section 3.9.

2.4.2 Coal seams beneath the site

The following coal seams are known to have been worked beneath the site. They are listed, along with approximate depths below ground level (further details are provided in Section 3.5):

- Shafton coal seam (excavated by opencast methods to a depth of up to a maximum of 20m in the far north eastern extent, which is off-site by approximately

850m. The depth within the site area is not specified on the completion plan). This seam may have been partially worked by underground methods (unrecorded), but no evidence of this was encountered during opencast workings (WYG, 2008))

- Meltonfield coal seam (mined beneath and around the site at depths varying from 300m to 340m)
- Beamshaw Low coal seam (mined to the north west and north east of the site at depths of 358m and 404m)
- Winter coal seam (mined to the north east of the site at 359m)
- Barnsley coal seam (mined beneath and around the site at depths from 463m to 488m)
- Dunsil coal seam (mined to the north and north east of the site at 524m and 548m)
- Fenton (coal seam mined to the south west and west of the site at 661m and 664m)
- Parkgate coal seam (mined to all directions around the site, at depths varying from 681m to 750m)
- Silkstone coal seam (mined to the south, south west and south east, at depths varying from 758m to 845m)
- Middleton Main coal seam (mined to the north east of the site at 802m and 808m).

3 COAL MINING DESK STUDY

3.1 Introduction

A review of available information has been undertaken to establish the historical development of the site in relation to coal mining activities and to ascertain the environmental setting relating to geology. The following sources of information have been used within the review:

- Historical Ordnance Survey mapping (1854-2021) available within a site-specific Environmental database report (Envirocheck report reference 279017115, provided in full in Appendix C of the RSK PRA report, reference 322835 R01 and reproduced in part in Appendix G of this report);
- British Geological Survey, Sheet Number 275FS, Yorkshire, scale six inch to the mile, dated 1875 (see Figure 3);
- British Geological Survey mapping accessed via the online GeoIndex;
- The Coal Authority, Consultants Mining Report, reference 51002535621001, dated 20 May 2021 (presented in Appendix C);
- Plan showing site boundary (see Figure 2);
- British Geological Society borehole logs (provided in Appendix F);
- WYG Environmental, Geo-environmental Desk Study Report: Little Houghton, reference E35220-2, November 2008;
- South Yorkshire Mining Advisory Service (SYMAS), Mineral Report, Houghton Main Colliery Site, Little Houghton Proposed Redevelopment, reference IJ/M461/6, March 2008 (presented as an appendix to the WYG 2008 report); and
- Abandonment mine plans obtained from the Coal Authority Mining Records Office (shown in Appendix D).

It should be noted that an approach was made to SYMAS to ensure that all relevant data was obtained from the site, however they confirmed that they no longer provide a reporting service. Data that would previously have been provided by SYMAS can either be obtained from the Coal Authority (who have already been consulted) or via consultation with the local authority (which has been undertaken already).

3.2 Site history

A review of the historical maps for the site from between 1854 and 2021 was undertaken using the historical maps provided within the Envirocheck report. Historical maps are provided in Appendix G.

The development history of the site and surrounding area based upon assessment of historical plans and records is detailed in Table 3. Further details have been obtained from mapping of coal seam workings taken from the SYMAS report (2008).

Table 3 Summary of historical development

Date	Historical Land Use (on-site)
1854	The site is occupied by fields, with a lane crossing the centre roughly from north to south east.
1893	Houghton Main Colliery present with rail lines, buildings, chimneys, tanks, etc in northern and central areas. Row of cottages present on-site, and other buildings around southern end. Deep mining included working of eight coal seams from the Meltonfield coal seam at 316m to the Silkstone coal seam at 790m.
1906	Sewage works including sludge beds and filter beds in centre of site, as well as colliery. Some evidence of excavation works in south area.
1932	Institute building present in south east of site, with recreation site partly within boundary south east of that.
1962	Pond marked in north east corner of site.
1975	Mine adit discovered within the site boundary, indicating the likelihood of some working of the Shafton Coal seam. Although it is not recorded, this is assumed to have been removed during opencast workings.
1983	Reduction in colliery infrastructure present across site (particularly rail lines).
1997	Opencast working commenced on-site, in the Shafton coal seam. Prior to this date, all colliery buildings and infrastructure had been removed. A6195 road passes directly through site (from south to north east).
2000	Opencast works were completed by 2000 and excavations had been backfilled (with compaction of backfill during restoration to form a development platform, according to the WYG report).
2021	Route of A6195 moved to south west, so no longer passing through site.
Date	Historical Land Use (off-site)
1854	Midland Railway immediately adjacent to site to west, with River Dearne and associated flood plain west of that.
1893	Houghton Main Colliery extends off-site to the north. Clay pit to north of colliery. Manor House off-site to south east.
1906	Dearne Valley Colliery off-site to the south.
1922/23	Houghton Main Colliery shafts constructed at this time (just off-site to north), up to 730m deep (to reach Thorncliffe Coal Seam).
1932	Further extension of colliery to north of site. Spoil heaps off-site to north east, include aerial cables.
1955	Spoil heaps extensive to north east.
1967	Spoil heaps still extensive off-site to north east.
1983	Route of River Dearne straightened on west of main railway line.
1993	Three mineshafts off-site to north thought to have been filled and capped shortly after 1993 to British Coal specifications.
2000	Railway to west of site disused. Quarry marked to north of site where colliery was previously located.

	During opencast works (both on- and off-site, the three shafts north of the site were uncovered, caps were removed and new caps were installed at the base of the opencast void (approximately 11m deep), before backfilling operations were completed.
2002	Post-backfill monitoring indicated that groundwater levels stabilised by 2002, after a period of rising following the cessation of pumping associated with the mining activities.
2007	A coal mine methane extraction plant was constructed north west of the site to generate electricity. This is connected to the substation to the south east of the site via an underground cable passing beneath the site along the south west and south east boundaries.
2021	A6195 road now present along former route of disused railway. Large warehouse facility (ASOS) present off-site to the north
Information sources: Historical OS maps, Aerial photography, Coal mining abandonment plan, coal workings drawings, SYMAS report, WYG desk-based assessment report	

The key historical coal mining events affecting the site are the deep mining history, and the opencast workings that were subsequently backfilled. Any contamination resulting from deep mining is expected to have been removed during opencast works.

3.3 Identification and assessment of coal mining issues

The following table summarises potential risks associated with coal mining and identifies those that are applicable to the Houghton Main site.

Table 4 Identification of site-specific coal mining issues

Item	Applicable to site?	Comment
Development High Risk Area on-site	Yes	-
Coal mine entries	Yes	One mine adit was found to be present within the site boundary, on the western side of the site, but this is understood to have been removed during opencast works. Two adits are shown in the Coal Authority report, one assumed to be that mentioned above, and one located further west, possibly just off-site along the A6195. The nearest mine shafts are all off-site to the north, and treatment details are provided in the Coal Authority report.
Past shallow workings (recorded)	Yes	An adit found during opencast workings suggests that shallow workings may have been present within the Shafton coal seam

Item	Applicable to site?	Comment
Probable shallow workings	Yes	The Coal Authority report indicates that shallow workings may be present in the area
Coal seam outcrops	Yes	An outcrop from one coal seam is shown to cross the site (Shafton coal seam, worked by opencast operations)
Surface mining (opencast)	Yes	The site was part of a wider area of opencast workings
Other	Mine gas conversion	There is an electricity generation station converting mine gas into electricity located to the north west of the site

3.4 Coal Authority Consultants Mining Report

The report is provided as Appendix C, and details are summarised below:

- the site is potentially underlain by 35 separate recorded workings, operating in nine different coal seams, with the shallowest workings at 300m, and the deepest at 845m. Workings were undertaken between 1890 and 1990.
- shallow underground workings in the Shafton coal seam are not recorded, but may have occurred on-site (suggested by the presence of an adit encountered during opencast works from 1997 to 2000), although no records of any identified workings were made during opencast works.
- three shafts are present just off-site to the north and two adits are present within the site (orientated approximately north east to south west, see Figure 4).
- an outcrop of the Shafton coal seam is present crossing the site, on an orientation of approximately south east to north west, dipping towards the north east at between 3° and 5° (see Figure 5).
- a geological fault is recorded crossing the southern part of the site (approximately north east to south west, see Figure 5).
- the site is shown as being within an area of opencast mining (which worked the Shafton coal seam, see Figure 6).
- there are no Coal Authority operated tips within 500m of the site.
- there are no records of coal mining subsidence within 50m of the site.
- there are no mine gas issues recorded within 500m of the boundary.
- there are no recorded mine water treatment schemes within 500m.
- the property is not in an area that is likely to be affected from any planned future underground coal mining.
- no notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

3.5 Coal Authority plans and information

Further to the Consultants Coal Mining Report, additional information was requested in relation to issues which may affect the redevelopment of the site. Deeper coal mining is not considered to pose a potential risk to surface developments, and therefore a detailed assessment of the deep coal mining records is not required as part of this CMRA. Summary details are included in the following sections. Where appropriate, details obtained from the SYMAS report (2008) are also incorporated in this section.

3.5.1 Shallow underground coal mining

The Shafton coal seam is mapped as outcropping across the site and is known to have been excavated by opencast workings. Although not recorded, there may have been historical underground workings of this seam close to the surface, as an adit was encountered in the seam during opencast works between 1997 and 2000 (see Section 3.5.3). However, the WYG report (2008) indicates that no evidence of workings in the Shafton seam were identified during opencast workings. The locations of two adits present on-site are shown on Figure 4.

3.5.2 Deep coal mining

As noted above, deep coal mining was completed as part of the Houghton Main Colliery works. The deep coal seams beneath the site are listed below, with the shallowest seam first. Not all the workings are directly beneath the site:

- Meltonfield coal seam: five areas of recorded workings, two directly beneath the site and the others to the south west and north west at depths varying between 300m and 340m. Workings beneath the site were completed in 1923 and 1950, with other workings in 1909, 1922 and 1948. The extraction thickness was quite consistent, between 127cm and 175cm. As this is the shallowest of deep seams, a plan of the workings is provided for information as Figure 8, but there will be no impact from these workings on the surface development due to the significant depth below ground level.
- Beamshaw Low coal seam: this seam was mined to the north west and north east of the site (not directly beneath the site) at depths of 358m and 404m. The workings occurred in 1948 and the worked thickness was recorded as 91cm to 110cm.
- Winter coal seam: this seam was mined to the north east of the site at a depth of 359m. Workings were completed in 1953, with a seam thickness of 73cm.
- Barnsley coal seam: mined beneath and around the property (to the north west, north east and south) at depths ranging from 463m to 488m from 1890 to 1939. Extracted thicknesses vary from 173cm to 217cm.
- Dunsil coal seam: mined to the north and north east of the site at 524m and 548m, with an extracted thickness of 140cm to 148cm, with workings carried out in 1979 and 1983.
- Fenton coal seam: mined to the south west and west of the site at 661m and 664m, with extraction thickness of 168cm and 210cm and workings completed in 1977 and 1980.

- Parkgate coal seam: mined to all directions around the site, at depths varying from 681m to 750m. Dates of working were between 1925 and 1968. Extraction thicknesses were 161cm to 203cm.
- Silkstone coal seam: mined to the east, south east, north east and north at depths varying from 758m to 845m. Dates of working were between 1978 and 1990 and extraction thicknesses were from 99cm to 119cm.
- Middleton Main coal seam: mined to the north east of the site at 802m and 808m, with an extraction thickness of 190cm, in 1975 and 1976.

3.5.3 Opencast coal extraction

The Houghton Main opencast site operated from 1997 until 2000 and worked the Highgate and Shafton coal seams. The opencast area is shown on Figure 6 and extended off-site to the north. A separate opencast area is known to have been present off site to the south. Backfilling of the site was completed during 2000, with compaction completed to provide a development platform. Vertical sections through the opencast areas within the site boundary are provided in Figure 9.

The UK Coal Completion Plan for the Houghton Main site indicates that beneath the subject site there are possibly three different areas of workings. These are partially separated by areas which do not appear to have been excavated and this includes an area around the site entrance in the south east. In all the areas where excavations are recorded the Completion Plan indicates backfill as “areas of compaction”. The records indicate that beneath parts of the subject site the Shafton coal seam has been worked by opencast methods but in other areas it may remain in situ (it might also be the case that some of the areas outside the UK Coal workings the Shafton coal seam reserves were absent, having previously been mined underground).

During the opencast work, the three mine shafts off-site to the north were partially excavated, with new caps installed at the base of excavation understood to be a depth of approximately 11m bgl, prior to backfilling of the opencast excavation.

3.5.4 Abandoned mine plans

Copies of the following documents were obtained from the Coal Authority:

- Houghton Colliery, Highgate and Shafton coal seams (Opencast), abandoned date July 2000 (UK Coal Mining Limited drawing number 48/CP/1; Coal Authority document reference 17937/1)
- Dearne Valley Colliery, Shafton seam (Underground mining), abandoned date May 1974 (Coal Authority document reference NE806)

Full copies of the plans are provided in Appendix D and excerpts including the site boundary location are shown in Figure 6 and Figure 7, respectively.

The first of these two plans is a completion plan for the Houghton Main opencast workings in the Shafton seam. The legend indicates that coaling was commenced in April 1997 and completed by July 2000. The drawing shows workings for four coal seams, but only one of these is within the boundary for the subject site. This is the plan of workings in the Shafton coal seam (code BU00) and the excavations are shown as several smaller areas within the south west of the site and along the north eastern site edge. However, the area

that was later subjected to compaction of backfill appears to be larger than the area indicated to have been excavated. The area of compacted backfill covers the majority of the subject site, with the exception of an area in the south east, closest to the off-site substation. Two vertical sections are included, which are within the site area, labelled Section 6 and Section 7. Section 6 is within the north east part of the site, and shows the presence of the Shafton seam at a depth of 21.89m (base of seam), with a thickness of 1.41m. The original ground level in this location was 31.33m AOD. Section 7 shows the ground level at 38.40m AOD, with the Shafton seam at 27.38m and a seam thickness of 1.19m. Information that is available on the backfilling operations that were carried out is reviewed in Section 3.6.

The second plan is an abandonment plan for the Shafton coal seam, and the majority of the plan is off-site to the south east. The fault line shown running along the top left hand corner of the plan is approximately aligned with the southern site boundary. This means that all the marked workings are off-site if the mapping is accurate, with the exception of the adit shown in the top left corner (approximate grid reference 442049 405813). The adit is marked as having been found on 14 April 1975. Dimensions or depths shown on the drawing seem to indicate that the Shafton workings were quite shallow, at around 15m below ground level. The map indicates that the mine was constructed in March 1959 and abandoned by 3 May 1974.

3.5.5 Mine entry data (shafts and adits)

Data from the Coal Authority shows two mine adits present in the central/western section of the site, and three shafts just off-site to the north (approximately 50m from the site boundary). Available details for these features are provided in this section. Figure 4 shows the location of the shafts and adits in relation to the site boundary.

Mine adit reference 442405-001 (grid reference 442049 405813). This adit is located on-site and it is indicated as having an orientation of 58 degrees (towards the north east). Although there were no recorded underground workings of the Shafton coal seam in this area (recorded workings are all off-site to the south, and it is reported that no shallow workings were encountered during opencast works), it is assumed that this adit is associated with a limited extent of shallow workings. Information provided in the previous report for the site (WYG, 2008) indicate that this mine adit was likely to have been removed entirely during opencast operations within the Shafton coal seam opencast excavations (the area of the site where the adit was located is within the boundary of the area from which coal was extracted by opencast methods). This would also apply to any limited unrecorded workings within the Shafton coal seam. Information relating to the opencast works indicates that the deepest areas of excavation were approximately 20m below the original ground level. Co-ordinates provided for this feature in the SYMAS report are slightly different (442056 405820).

Mine adit 442405-008 (442032 405766). Based on the mapped location of this adit, the entrance point could be slightly off-site to the west, however the adit orientation is 86 degrees (almost due east) so the original adit will have been present on site. This mine adit is shown on the abandonment plan for the Shafton coal seam workings, suggesting that it connected to the relatively shallow workings associated with that seam. However, further information on this adit is not available. Although it is likely that this adit would have been removed as part of opencast workings at the site, this has not been recorded.

Mine shaft 441406-001 (441921 406014). The Coal Authority Consultants report indicates that this shaft was filled in 1994, with a plug at a depth of 220.66m to 226.66m. The shaft top was excavated in 2000 in connection with opencast mining operations and was found to be filled and uncapped. The shaft was then capped at 21.6m AOD (approximately 11m deep) with a reinforced concrete cap measuring 8.5m diameter and 0.5m thickness. The SYMAS report indicates that the shaft diameter was 4.7m and the shaft was referred to as Houghton Main Shaft No. 2.

Mine shaft 441406-002 (441949 406031). This was recorded as having been filled in 1994, with a plug between 225.04m and 231.04m. The shaft top was excavated in 2000 during opencast mining operations. As with shaft -001, it was found to be filled but not capped. It was subsequently capped at 23m AOD (approximately 11m deep) with a 9.0m diameter and 0.4m thick reinforced concrete cap. The SYMAS report indicated that the shaft diameter was 4.7m (the shaft was referred to as Houghton Main Shaft No. 1).

Mine shaft 441406-003 (441966 406101). This shaft was filled in 1994 and plugged between 228.67m and 234.77m. The shaft top was excavated in 2000 and was found to be filled but not capped. It was then capped at 21.6m AOD with a 10.0m diameter and 0.5m thick reinforced concrete cap. A later phase of investigation in 2013 involved drilling of the cap and underlying shaft. A void of 0.3m between the fill and cap was identified and subsequently grouted in June 2013. This shaft was reported in the SYMAS report to have a diameter of 7m (Houghton Main Shaft No. 3).

All three of these shafts are recorded to have been constructed in 1922/1923, reaching a depth of approximately 730m deep. Working in the Houghton Main Colliery associated with these shafts ceased in August 1993.

3.6 Compaction of backfill in areas of opencast extraction

The WYG report (2008) provides details of how the opencast site was backfilled and restored (referred to as the reclamation scheme). This involved works undertaken by UK Coal to backfill the opencast excavation and provide a suitable development platform for future use of the site. The report refers to a Compaction Certificate Report produced by Babbie Group on behalf of UK Coal (a copy of the Babbie report has not been available to review).

It is noted that backfill was completed to an end-product specification based on the Department of Transport Specification for Road and Bridge Works, 1976 (Series 600), which should have resulted in air voids of less than 10%. During compaction works, Babbie supervised the material placement with field and laboratory testing to ensure that the appropriate specifications were met. Subsequent to backfilling works, Babbie undertook testing and monitoring to assess the impacts on site levels after pumping ceased in February 2000. Monitoring included the use of extensometers and plate load tests. Results indicated stabilisation of groundwater levels in January 2002, associated with some settlement. Plate load tests demonstrated maximum settlements of between 4.5mm (900mm diameter plate) and 5.0mm (610mm diameter plate) for a load of 110kPa.

The WYG report indicated that the Babbie compaction certificate report provided an assessment of ground settlement affecting the backfill material as a result of creep settlement, inundation settlement and settlement due to imposed loads. Calculations suggested that self-weight settlement (creep) of 150mm would be expected within the first

10 years after placement of backfill, with a further 150mm over the ensuing 90 years. Inundation settlement occurs as a result of changes to the backfill material as groundwater levels adjust (in this case after pumping of mine waters ceased and standing levels within the backfill came into equilibrium). Babbie estimated that some inundation settlement had occurred in saturated fill, but that further settlement in the range of 20mm to 45mm could still be expected. In addition to creep and inundation settlement, the presence of loads caused by building structures would be expected to result in further settlement. Based on field testing, Babbie estimated settlement of less than 20mm for structures with shallow spread foundations and loadings of around 100kPa. This was calculated when the site was proposed for residential end-use. It was noted that differential settlement should be expected due to variable conditions across the site, because of the presence of high walls, and distribution of backfill materials and original natural soils. The WYG report recommended that buildings should avoid crossing the areas of the main highwalls.

The A6195 in its current position was constructed after completion of the reclamation works.

3.7 Methane Extraction

A mine gas methane extraction system is present on land to the north west of the site, with electricity being generated from the extracted methane. The facility is connected to the substation which is located off-site to the south east by an underground cable. The cable runs along the south west and south east of the site.

Although details of the system have not been available for review it is evident that significant quantities of mine gases are present in the area and are considered to be a potential risk to future development.

3.8 Other workings

Fireclay and brick clay deposits are known to be present in the area. As there is a layer of fireclay associated with the Shafton coal seam, there is the potential that some fireclay was worked underground within the site boundary.

3.9 British Geological Survey (BGS) information

Two borehole records are available for the southern section of the site; both are deep boreholes, with no details of upper layers of strata (references SE40NW26 and SE40NW27).

Boreholes clustered in the north eastern section of the site show a layer of made ground to a depth ranging between 1.5m to 6.3m, typically comprising ash, burnt mudstone, brick fragments, gravel and clay nearer the surface, with reworked sandstone, mudstone, clay and occasional coal at greater depth. Natural soils were present as sandstone, clay and mudstone. A coal seam was encountered at depths varying between 11m and 14m (to the top of the seam), and the seam thickness varied from 1.3m to 2.35m.

The BGS Onshore GeoIndex (accessed online) shows the full site area to be within a zone classified as having reserves of shallow coal. The whole of the site is also within an area known to have fireclay and brick clay within the bedrock (associated with the coal layers).

A data set within the GeoIndex shows the approximate depth to the base of the Coal Measures formation. The contour line to the west of the site is 1000m bgl, and to the east of the site is 1100m bgl, suggesting the base of Coal Measures deposits would be between these two values in the area of the site.

4 ASSESSMENT OF SITE-SPECIFIC COAL MINING RISKS

4.1 Opencast workings

4.1.1 Highwall positions

During opencast workings, some areas of highwall were present on-site both around the perimeter of the main excavation but also in irregularly shaped areas between areas of workings. It is also understood that highwalls were locally present, in order to maintain stability, along the route of the A6195 on the site boundary. As a result, there are junctions between natural bedrock material and compacted backfill that are present across parts of the site.

In these areas it is possible that future buildings may encounter differential settlement in response to the differing load bearing characteristics of the materials present. For this reason, the previous reports recommend the adoption of no build zones across these areas. However, the ground conditions and characteristics across the highwall areas have not yet been investigated and it is possible that some forms of construction would be possible or that ground treatment be completed to provide more uniform conditions suitable for building development.

4.1.2 Backfill of opencast workings

Backfill operations were reported to have been supervised by Babbie, but their original reports were not provided for review by RSK. Monitoring was completed, which included settlement monitoring and groundwater level monitoring. It is understood that monitoring was carried out until 2002, by which time groundwater recovery was complete, but no later data is available. The WYG report includes assessment of potential settlement mechanisms and estimates values for short and long-term settlement.

It is evident that although the opencast backfill has been placed under engineering control and following a specification, that some settlement was recorded during the monitoring period and significant long-term settlement was expected.

It is likely (since completion of the monitoring work in 2002) that a significant proportion of the anticipated settlement has now occurred, however further investigation and assessment work will be required to confirm this. This will require conventional site investigation works to confirm conditions and obtain in situ parameters for the backfilled materials. If possible, it could also include further monitoring of existing infrastructure (if still viable) augmented by new installations. The findings of this work could then be used to produce a ground model which would be used to complete geotechnical settlement modelling for the proposed development (including anticipated building loads and performance criteria). This would determine; if the opencast backfill in its current state is suitable to support building development or if some form of ground treatment would be required; it would also determine the most appropriate foundation design.

4.2 Mine entries

Three off-site shafts to the north of the site were provided with new caps during backfilling of opencast workings, and no impact on the on-site development is anticipated as a result of the presence of these shafts.

Two mine adits within the site boundary appear to have been related to the shallow Shafton coal seam, and any evidence of these within the site boundary would have been removed during opencast workings, despite the fact that there do not appear to have been specific reports of this. However, as site investigation works will be required to confirm ground conditions, it is recommended that investigation locations are included in the vicinity of the adits and along their orientation down dip.

There is not considered to be any risk from mine entries affecting future development of the site.

4.3 Shallow worked coal seams

There are no records of shallow workings beneath the site other than the areas worked by opencast operations. However, the Shafton coal seam is recorded as having been worked at shallow depth beneath the land off-site to the south and south east, as shown on Coal Authority drawing NE806. Although it is noted in the WYG report (2008) that no shallow workings were observed during opencast excavation operations, there is the potential that some limited workings were present, as suggested by the presence of two mine adits within the site.

The UK Coal opencast mining Completion Plan indicates that only limited areas of the Shafton coal seam were removed during the operation of the Houghton Main opencast site. This could possibly have been because they had previously been worked underground, but it is more likely that in these areas the coal seam was inaccessible and consequently remains in situ. If there was localised historic (but unrecorded) underground mining in this seam, it would be at sufficiently shallow depth to pose a risk to ground surface stability.

Site investigation works will be required to confirm the ground conditions across the site and this should include an assessment of the potential presence of shallow coal seams. This will require rotary drilling investigation and should focus on those parts of the proposed development site outside the areas where opencast abstraction of the Shafton coal seam is recorded. If workings are present the extent of these would have to be confirmed and then treatment works would be required (drilling and grouting consolidation treatment).

4.4 Deep coal seams

The site is concluded to be stable with respect to any possible collapse that may occur within the deep coal seams, which are recorded as having been worked underground beneath the site. No further assessment of deep mining issues is required.

4.5 Coal mining gases

The underlying Coal Measures are considered a potential source of hazardous ground gas and shallow workings and mine entries can provide preferential migration pathways.

Although there is no current evidence of issues relating to mine gases, it is evident that there is an existing mine gas collection system in the vicinity of the site, which suggests significant mine gas generation potential. To date no ground gas assessment has been undertaken, however this will be required in order to obtain planning permission for any future development. There is a potential for mine gas risks to be present based on the area having been subject to shallow coal mining, opencast backfill and deep mining.

4.6 Conceptual site model

A cross-section of the conditions present beneath the site, based on the information collected as part of this assessment, is provided in Figure 10.

5 MITIGATION STRATEGY

The CMRA completed in the preceding sections has concluded that there may be risks to buildings constructed as part of site re-development and to end-users due to the potential for hazardous ground gases and differential settlement of soils across the site.

Aspects of coal mining discussed in the CMRA, which pose a risk to the proposed development of the site, are covered in turn in this section, with comments provided as to what further assessment or mitigation measures are considered necessary.

5.1 Opencast workings

If possible the report compiled by Babbie Group (2004) should be obtained to review the data available relating to the placement of backfill and from subsequent settlement monitoring. A site visit should be carried out to inspect the previously installed monitoring infrastructure to ascertain whether this is in working order and viable for future monitoring. A review of information provided in the Babbie report should also be undertaken to assess the results of settlement monitoring.

If old monitoring infrastructure remains in place and is viable, additional monitoring should be completed. This would then need to be compared to the original data to determine any subsequent settlement or changes in water levels. The findings of this would then help inform locations for subsequent intrusive ground investigation works and possibly additional locations for additional monitoring infrastructure, if required.

Conventional site investigation works, including in situ geotechnical testing will then be required across the areas of the site to be redeveloped, to confirm the ground conditions and obtain geotechnical parameters. The findings of this work could then be used to produce a ground model which would be used to complete geotechnical settlement modelling for the proposed development. This would assess the potential settlement induced by the future development, based on typical building and floor loads. The modelling would determine if the opencast backfill in its current state is suitable to support the proposed development or if some form of ground treatment would be required. It would also help assess the most appropriate foundation design options.

The site investigation works should also include investigation of the location of highwalls and assessment of the variability of conditions across these features.

If the assessment work indicates that the opencast backfill is unsuitable to support the proposed development or that the highwalls do pose a significant risk of differential settlement then options for ground treatment would have to be considered. The options will be dependant on the findings of the proposed site work but could include ground treatment (surcharging, the use of dynamic or high-energy compaction systems or partial re-engineering of the made ground) or alternative foundation types (the use of piles or partial depth treatment by vibro-compaction or similar methods).

5.2 Mine entries

The three mine shafts off-site to the north, have been treated and capped, and no further assessment or mitigation is therefore required.

The two mine adits located within the site boundary appear to have been connected to the shallow Shafton coal seam, and are concluded to have been removed from beneath the site during opencast excavation works from 1997 to 2000. The proposed site investigation works will include locations in the vicinity of these features to confirm their absence.

At this stage no further assessment or mitigation is required in connection to the mine adits.

5.3 Shallow worked coal seams

There are no records of shallow workings beneath the site other than the areas worked by opencast operations as part of the Houghton Main opencast. The UK Coal Completion Plan indicates that only limited areas of the Shafton coal seam were removed from beneath the subject site. This could have been for a number of reasons, possibly because they had previously been worked underground, but it is considered more likely that in these areas the coal seam was not accessible and remains in situ. If the seam is in situ it is at very shallow depth and any historic unrecorded underground workings would pose a risk to ground surface stability.

It will therefore be necessary, as part of the proposed site investigation works, to include an assessment of the potential presence of shallow coal seams. This will require rotary drilling investigation and should focus on those parts of the proposed development site where buildings are proposed that are outside the areas where opencast abstraction of the Shafton coal seam is recorded.

Although not expected to be the case if workings are present the extent of these would have to be confirmed and then treatment works would be required (drilling and grouting consolidation treatment) in areas where buildings are proposed.

5.4 Deep coal seams

No further assessment or mitigation in relation to deep mining is required.

5.5 Coal mining gases

It is recommended that a ground gas risk assessment be undertaken as part of the site investigation works for the new development. This will ensure that any ground gas issues at the site are identified, and new properties can be appropriately protected from the hazards.

The ground gas risk assessment should include the measurement of ground gas concentrations and flow rates and should include a minimum of 6 monitoring visits over a 12 week period (this is the minimum requirement of most local authorities, and depending on the results, additional monitoring may be required).

If elevated hazardous ground gases are found to be present, mitigation measures would be likely to include ground gas protection measures in buildings.

6 CONCLUSIONS

This document provides a detailed assessment of the coal mining history of the Houghton Main site. The results of the assessment indicate that there are potential issues to consider in advance of and during site redevelopment, specifically relating to; the settlement behaviour of the opencast backfill material; the possible differential settlement across highwall areas; the possible presence of shallow coal seams beneath limited parts of the site; and risk from mining/ hazardous ground gases.

The first action to complete is to ascertain whether the Babbie report on compaction of the backfill material can be located, as this would assist in determining what additional assessment would be required in relation to ground stability issues. If this was available, it would also be beneficial to carry out a site inspection of the monitoring infrastructure to see if this was still present and viable for future monitoring.

A programme of site investigation works will then be required to assess the potential coal mining issues identified in the preceeding sections of this report. This would be followed by an assessment of site conditions, including geotechnical modelling to estimate the likely settlements which will be induced by the proposed development. This would inform whether or not any ground treatment works would be required and would be the basis for foundation design.

REFERENCES

Reports

The Coal Authority, Consultants Mining Report, reference 51002535621001, dated 20 May 2021 (presented in Appendix C)

South Yorkshire Mining Advisory Service (SYMAS), Mineral Report, Houghton Main Colliery Site, Little Houghton Proposed Redevelopment, reference IJ/M461/6, March 2008.

WYG Environmental, Geo-environmental Desk Study Report: Little Houghton, reference E35220-2, November 2008.

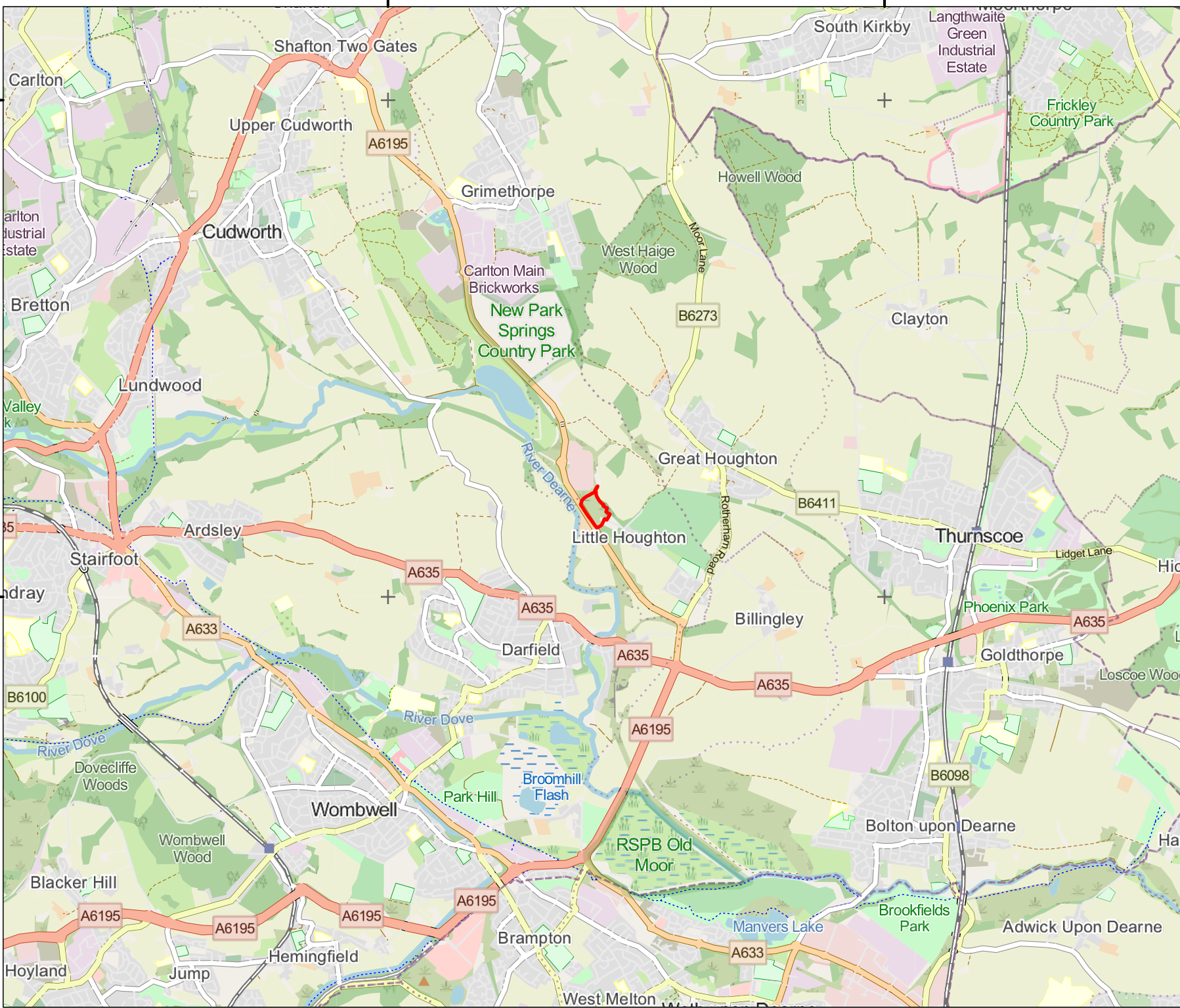
Maps and Drawings

BGS, Yorkshire County series geological map, six inch scale, map sheet Yorkshire 275 FS (1875)

UK Coal, Houghton Colliery, Highgate and Shafton Seams (Opencast), abandoned date July 2000 (UK Coal Mining Limited drawing number 48/CP/1; Coal Authority document reference 17937/1)

UK Coal, Dearne Valley Colliery, Shafton Seams (Underground mining), abandoned date May 1974 (Coal Authority document reference NE806)

FIGURES



Legend:

Site Boundary

Coordinate System:

00	10/06/2021	First Draft	DR	FC	FC
Rev	Date	Description	Dwn	Chk	App

Harworth Estates Investments Limited
Houghton Main

TITLE:

R02 (00) - Figure 1:
Site Location Plan

0 500 1,000

Metres

SCALE: 1:50,000 @ A4

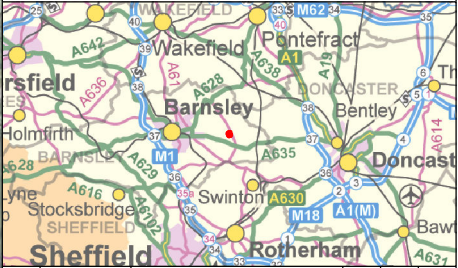
N
W
E
S

REV 00



Legend:
 Site Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

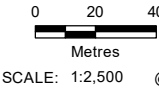


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Rev	Date	Description	Drm	Chk	App

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Houghton Main



TITLE: R02 (00) - Figure 2:
Site Boundary Plan



REV 00