Harworth Estates

Rockingham, South Yorkshire

Appraisal of Ground Conditions and Coal Mining Review

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RSK GENERAL NOTES

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Title: Appraisal of Ground Conditions and Coal Mining Review: Rockingham, South Yorkshire

Client: Harworth Estates, AMP Technology Centre, Brunel Way, Waverley, Rotherham, South Yorkshire, S60 5WG

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Author	Frances Clayton	**Technical reviewer**	Gary McGuicken
Signature		Signature	
Date:	July 2013	Date:	July 2013
Project manager	Jon Clayton	**Quality reviewer**	Ang Wallis
Signature		Signature	
Date:	July 2013	Date:	July 2013

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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Harworth Estates to carry out a desk based study of available information and site walkover in order to complete an appraisal of ground conditions and coal mining review of land at the Rockingham site in South Yorkshire.

1.1 Objective and aims

The objective of this review is to determine a strategy for assessing ground conditions and ground treatment required to enable the proposed future redevelopment of the land for commercial/industrial end use.

Due to the historical coal mining carried out at this site, the review has also included an assessment of coal mining issues in relation to the proposed development.

1.2 Scope

The scope of works for this report was set out in RSK's proposal reference 321393TL01 dated 7 May 2013. The brief included:

- review of key reports already available (including Mott MacDonald Completion Reports and RJB Mining Completion Plans)
- review of reports held by RSK for the adjacent Shortwood Business Park Area
- search of records available from the Coal Authority (CA) and SYMAS in relation to opencast works and underground workings and mine
- a site visit to inspect for surface monitoring pins (installed by Mott MacDonald).

The available reports include GroundSure reports for the site, which, along with information from other sources, will provide data to allow the following items to be completed:

- a review of the geology and hydrogeology of the site
- a review of the environmental database to determine:

    records of past pollution or other incidents relevant to the site

    information regarding the location of recorded landfill sites within the site vicinity

    details of groundwater abstractions (location, water use, source strata)

details of surface water quality classifications

information relating to ground stability

- a review of historical maps included with the database report to identify historical uses of the site and surrounding area
- preparation of this interpretative report, including recommendations for further investigation.

2 SITE INFORMATION

2.1 Site location

The overall site is extensive and the north and south areas are separated by a dual-carriageway link road. The western end of the area to the north of the road is referred to as Rockingham 1 (the area where compaction has been carried out), and the southern area as Rockingham 2. Figure 1 shows the site location and Figure 2 provides information relating to the site boundary. The approximate centre of the site is located at Ordnance Survey National Grid reference 435400 4010000. The site occupies an area of approximately 79 hectares and is situated at an elevation of approximately 130m above Ordnance Datum (AOD). The site lies between the residential areas of Birdwell and Hoyland in South Yorkshire.

2.2 Site description

The site is currently mainly grassed land, with some areas of woodland. Historically, the site was subject to deep underground mining (Rockingham Colliery pre-1893 and 1980) and used for opencast coal mining (1991 to 1995), and subsequent backfilling and restoration, which was completed by 2002. A site boundary plan is included in Figure 2.

In some sections of this report, the site is subdivided into three parts. The first is the area at the western end of the site, north of the road. This is the part of the site where backfill was placed in a controlled manner and compacted (Rockingham 1). The remainder of the area north of the road was not subjected to controlled backfill. The area south of the road has not been compacted, and is referred to as the Rockingham 2 area. It should be noted that an area outside the site boundary was also subjected to compaction as part of the completion works for the Rockingham Colliery (south of the compacted area mentioned above, as shown in grey shading on Figure 2). Comments on the area of the site that has been compacted would be equally applicable to the compacted area outside the site boundary.

2.3 Proposed site use

It is understood that the site is being considered for redevelopment, potentially for commercial and retail purposes, including industrial and distribution facilities with supporting office and retail units and that outline planning permission was gained for this in 2000.

2.4 Geology and hydrogeology

Published records indicate that there are no superficial geological units across the site. The bedrock is recorded as being Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone with coal seams. The bedrock units are a secondary A aquifer.

Three BGS borehole records have been reviewed for the site. These were drilled many years ago before the opencast coal operations. One is located in the central area of the Rockingham 1 site. This indicates a thin layer of soil and clay over coal with occasional intervening beds of shales (borehole reference SE30SE13). The second borehole is located off-site to the east (reference SE30SE217). This recorded made ground down to 5.9m, overlying mudstone and siltstone with a thin layer of coal around 9.8m (this hole ended at 11.5m). The third record is for a location just off-site to the south (borehole reference SE30SE14) and shows many thin layers of siltstone, clay, ironstone and coal to a depth of approximately 85m. Borehole records are provided in Appendix A.

There are no groundwater protection zones on or around the site.

2.4.1 Coal Authority coal and brine report

Non-residential coal and brine reports were provided by the Coal Authority in two parts (reference 00072739-11, dated December 2011 and reference 51000293997001, dated May 2013). These indicate that substantial mining activity has occurred on site, as listed below:

Area to the north of the road (including Rockingham 1)

- the site is within the likely zone of influence from 13 worked coal seams, from shallow depth to 430m below ground level, last worked underground in 1977
- reserves of coal exist which may be worked in the future
- one coal mining subsidence claim has been made within 50m of Rockingham 1 (a property on Shortwood Villas to the east of the site)
- seven mine entries are present in the area, or very close to the area, covered by this coal mining report. Three shafts were reportedly completely removed by opencast mining. Shaft reference 435401-003 was filled in 1990. It was partially removed by opencast mining and subsequently capped at the base of the opencast excavation in June 1992. No treatment details are available for shaft number 435401-001. Shaft number 435401-011 is off-site to the east and was searched for by drilling in an area adjacent to the plotted position by RSK Group in 2010 but was not found. The Coal Authority held no record of what steps, if any, have been taken to treat this shaft. Shaft 435401-002 was plugged below the Flockton seam level and filled in 1990. It was partially removed by opencast mining and subsequently capped at the base of the opencast excavation in June 1992

- the site is within the boundary of a historical opencast site
- the site is not within an area likely to be affected by brine subsidence.

Rockingham 2

- the site is within the likely zone of influence from 17 worked coal seams, between 70m and 440m below ground level, last worked underground in 1977
- ground movement from these workings should have ceased by now
- there is also likely to have been coal close to the surface which may have been worked
- reserves of coal exist which may be worked in the future
- no notice of the risk of land being affected by subsidence has been given
- seven mine entries are present in the area of site covered by this coal mining report. All seven were reportedly completely removed by opencast mining during the 1990s
- the site is within the boundary of a historical opencast site
- the site has been subjected to remedial works as part of a mine gas investigation
- the site is not within an area likely to be affected by brine subsidence.

2.4.2 Rockingham Colliery Completion Plans

A set of plans has been provided by the Coal Authority showing details of the Rockingham colliery site at the time of completion of works. These plans are referenced below and key information is summarised in this section.

Plans relating to underground mining are as follows:

- Rockingham Colliery, Thorncliffe Seam (signed 5 May 1981). Coal Authority catalogue number NE856 Sheet info
- Rockingham Colliery, Flockton Thick Seam (signed 21 November 1980). Coal Authority catalogue number NE852 Sheet info
- Rockingham Colliery (incorporating Wharncliffe Silkstone Colliery), Low Fenton Seam (signed 16 April 1981). Coal Authority catalogue number NE854 Sheet info.

The Coal Authority coal and brine reports (detailed in Section 2.4.1) indicate that there is no risk of further movement from these workings.

Plans relating to opencast mining are:

- Rockingham Completion Plan, RJB Mining (UK) Limited, dated 13 February 1998. Sheets 1 to 7. Drawing numbers 82/CP-1 to CP-7.

Sheet 1 of the completion plan shows an overview of the Rockingham site, highlighting the area where compaction of backfill had been undertaken and areas in which coal seams had been worked. Each of the subsequent sheets provides details of areas of working for specific coal seams. The names of the worked seams are listed below, starting with the shallowest:

- Beamshaw BB
- Kents Thin BA
- Unnamed 1AZ
- Kents Thick AZ11
- Unnamed 1AY
- Barnsley Rider Upper A
- Barnsley Rider Lower A
- Barnsley AVX
- Dunsil Rider Upper 2AU
- Dunsil Rider Lower 1AU
- Dunsil AU
- Swallow Wood Rider 1AR
- Swallow Wood Ar
- Unnamed 1AQ.

Figure 3 in this report shows the outlines of worked areas for all coal seams. The shallowest worked seam on site was the Beamshaw, with the base of excavation for this (within the site area) being just below 150m AOD. It is evident that this seam, along with all the others, dipped downwards towards the north-east. Due to this dip, the excavation area for each seam gradually moves westwards. The excavation for the Dunsil Rider Upper seam, for example, extended across both sides of the road, and was at its deepest around the area of the Elsecar fault, with the base here being around 110m AOD.

The basal seam worked at the site was the unnamed 3 seam (1AQ). This was very extensively worked both on and off the site. Figure 4 shows the extent of the excavation for this seam. The maximum depth reached was 76m AOD, at the eastern end of the workings. At the western end of the Rockingham 2, the site was excavated to around

112m AOD, while the western end of Rockingham 1 was dug out to approximately 130m AOD.

Based on the given depths of workings and the known site levels, the amount of fill material now present on site is variable. At the eastern end of the site to the north of the road, fill thickness is likely to be around 20m, with thicknesses increasing to as much as 70m at the eastern extent of the workings in Rockingham 2. At the western end of Rockingham 2, fill thicknesses are likely to be in the region of 30m to 40m. At the western end of Rockingham 1, the current ground level is only 1m to 2m higher than the base of the excavation.

2.5 Environmental database review

The GroundSure environmental database report is available for the wider site and comments from this are included in this section. Locations presented in these reports are based on approximate National Grid references and distances quoted cannot be relied upon as being accurate.

2.5.1 Pollution incidents

One pollution incident is recorded, from 2003, relating to pollution due to inert construction waste materials. This incident was categorised as a category 3 (minor) impact.

2.5.2 Surface water quality

Blacker Dyke is present approximately 300m north and west of the site, with a chemical grade of C and a biological grade of D. Warren Dyke is present west of the site (approximately 480m), with chemical grade C and biological grade E.

2.5.3 Water abstractions

A number of revoked water abstractions are listed in the GroundSure databases for the various parts of the site, but none are within 1km of the site.

2.5.4 Flood areas

No flood areas at risk from surface water flooding are identified on or close to the site.

The site is listed as being susceptible to flooding from groundwater, although the risk is low.

2.5.5 Sensitive areas

The site is within an area designated as a surface water Nitrate Vulnerable Zone (NVZ).

There are no nature conservation sites or ecologically designated sites within the Rockingham boundary. A local nature reserve is present over 900m to the southwest of the site (the Potter Holes Plantation Ramsar site).

2.5.6 Planning Issues relating to nearby projects

The proposed HS2 railway line is within 100m of the eastern boundary of Rockingham 2.

2.5.7 Landfilll sites and waste management facilities

There are no landfill sites or waste management facilities within the site boundary.

Historical landfill sites close to the site are listed below, in order of proximity to the site.

- British Rail Railway Cutting, licensed as a historical landfill site for inert and commercial waste from 1983 to 1992, operated by Hartwood Exports Machinery Ltd (3m south of the western end of the site)
- a historical waste transfer site was located 39m southwest of the site at Unit 12 Rockingham Road, Birdwell. The waste type is given as “difficult”
- Marshall’s Brickworks is a historical landfill site 230m to the northeast of the site
- an operational waste treatment/transfer site is present 260m southwest of the site; a vehicle dismantlers at Hangmanstone Depot
- Birdwell Common Quarry, licensed as a historical landfill site approximately 370m to the west of the site. No information about the waste type accepted, dates of filling or operator are provided
- Lidget Garage on Sheffield Road is licensed as a physico-chemical treatment facility and is 394m to the south of the site
- Shortwood historical landfill site was licensed for inert and industrial waste from 1979 to 1992, operated by Hoyland Marshall Limited. This site was over 800m northeast of the site.

Records of ground workings for the site show that there are a large number of slag heaps, areas of cuttings and tips and water storage features across the colliery site.

2.5.8 Ground stability hazards

There is a negligible risk of areas of compressible ground hazards, collapsible rocks, running sand or soluble rocks being present within the site boundary.

The risk due to shrinking/swelling minerals in the ground is very low.

There is a potential risk from landslides onside and slope instability may be a problem.

With respect to radon, the site is within an area where less than 1% of homes are at or above the action limit. No radon measures are required in the construction of new homes.

A fault crosses the site, known as the Elsecar Fault. This crosses the site in approximately a northwest to southeasterly direction, and is downthrown by between 60m and 70m on the northeastern side. The fault plane is inclined at between 60º and 80º.

2.6 Review of historical maps

A summary of pertinent information from the historical plans is provided in Table 1.

Table 1: Summary of site history

Map date	Site Details	Surrounding Area
1893	The northern area of the site includes the Rockingham Colliery, with large coking ovens, railway lines, shafts, air shafts and a saw mills. Hoyland brickworks and clay pit are located at the eastern end. Part of a reservoir is within Rockingham 2, as are Singleton Woods. Short Wood Dyke passes through the centre of Rockingham 2, passing into the northern area of the site. An old quarry is shown south of the railway in the centre.	There are a number of residential properties in the area.
1905-1906	The clay pit has expanded slightly, but no other significant changes.	Sewage tanks are present off-site to the west.
1929 and 1931	The old quarry appears to have been replaced by a spoil heap, with a further linear spoil heap north of the railway.	Filter beds are present 30m southwest of the site and commercial/industrial buildings are also present.
1938	No significant changes.	No significant changes.
1948	Evidence of expanding spoil heaps across southern area.	No significant changes.
1951	No significant changes.	No significant changes.
1955-1960	Significant changes to topography indicated by additional spoil heaps in central area of site and at eastern end. Pond indicated along line of Short Wood Dyke.	Further residential development to southwest.
1965-1966	Increased area of spoil heaps in central area of site.	No significant changes.
1977-1980	Entirety of Rockingham 2 marked as a spoil heap.	Slurry ponds off-site to west, where sewage tanks were previously.

Map date	Site Details	Surrounding Area
1987	Tip across majority of site marked as disused. All colliery buildings gone. Some works buildings present in area of brick works.	No significant changes.
1987-1992	No significant changes.	The slurry ponds are no longer present.
2002	Site appears to have been restored, with no spoil heaps or buildings indicated.	A factory 320m to the southeast and works buildings approximately 80m west.
To present	Shortwood Business Park has been constructed to the north of Rockingham 2 in the vicinity of the former brickworks and clay pit.	No significant changes

3 REVIEW OF AVAILABLE REPORTS

3.1 Geotechnical stability report, Rockingham, reference 053965, March 1990, British Coal Opencast Executive, central north region

The aim of this report was to assess stability aspects relating to the site, including an appraisal of the engineering parameters of deposited material. The report discusses the areas it refers to as the Rockingham Area (described as the part of the site within which excavation and coaling operations are contained) and the Barrow Area (where material from the Rockingham area was to be deposited).

Details of geological units encountered indicate the Coal Measures deposits consist of mudstones, siltstones and sandstones with frequent changes from one to the other. The report indicates the extensive nature of workings beneath the Rockingham site, which included workings originating from the Hoyland Silkstone Colliery. Records are provided as to which seams were worked and the opencast workings present.

Details indicate that within the main site, the deepest seam worked underground was the Silkstone seam at approximately 310m bgl.

The spoil tip in the Rockingham area is described as having been completed in 1979, with some self-consolidation of the tailings and discard occurring as the material drained.

One of the appendices to this report is the Site Investigation Report for the Ground Investigation at Rockingham Proposed Opencast Coal Site, July 1988 (reference 52317J, BB Drilling Limited). This report involved a slope stability analysis prior to undertaking opencast operations. At the time of the investigation, the site was made up of spoil heaps, disused railways and ruined/demolished pit buildings. There was visible evidence of unstable spoil heaps. The site investigation identified highly variable depths of made ground (colliery waste and backfill), ranging from none at all to over 40m. Where present, superficial deposits comprised glacial clay with gravel. Bedrock was a sequence of mudstone, siltstone and sandstone with coal seams.

Site work was also undertaken on the Barrow Tip (assumed to be the area within Rockingham 2).

3.2 Rockingham opencast coal site: compaction of backfill certificate report, report reference 10023/3C, February 1997, Mott MacDonald

Mott MacDonald were tasked with supervising controlled reinstatement of Rockingham Opencast Coal Site. This report covered large areas of the Rockingham colliery. In terms of areas of the Rockingham site that are included, this report assesses Rockingham 1, the roadway between the northern and southern areas (Dearne Valley Parkway) and a small area at the eastern end of the area to the north of the road. Areas outside of the site are also covered by this report (Shortwood Business Park and the area to the western end of Rockingham 2).

The works included supervision to ensure that the compaction specification was achieved in all areas of controlled backfill, provision of advice on piezometers and monitoring stations, completing periodic testing to demonstrate compliance and provision of certification on completion of all works. Compaction work was undertaken between 1990 and 1996. It should be noted that chemical analysis of fill materials was not part of this brief, and would be the responsibility of any future developers.

On completion of backfill, surface settlement markers (permanent ground markers – PGMs) were installed. For the first month weekly monitoring was completed, then monthly monitoring for one year, then monitoring every two to four months for the remaining monitoring period (the first monitoring was in 1992 and the last in 1996).

The report indicates that a high wall was present across the site in the northeastern area (compaction zone C69), but it would appear that this area is outside the boundary of the Rockingham 1 and 2 sites. A further high wall area (C6) is also outside the site boundaries, being present to the west of Rockingham 2.

The report concluded that settlement was not proportionate to the consolidation/compaction work undertaken, and that there was a probability that deep mining subsidence had occurred. Ongoing monitoring was recommended as being beneficial to future development proposals. It was recommended that future developments would require careful design of buildings, infrastructure and services to prevent damage due to settlement effects. Particular care was recommended for areas where high walls were present, in terms of foundation selections.

The report concludes that compaction was completed to the required standard in the controlled areas.

3.3 Rockingham opencast site, geo-environmental site assessment, February 2001, Mott MacDonald

The area covered by this report is to the west of Rockingham 2. A spur of the site (from the western roundabout towards the southwest along Dearne Valley Parkway) does enter through the area covered by this report.

This report included a desk-based assessment and intrusive site investigation, followed by a risk assessment.

The desk-study included a review of records for backfill operations between 1991 and 1996. The over burden used was mainly silty mudstone (reworked natural) and was not considered a contamination risk. Very small amounts (proportionally) of burnt and unburnt colliery spoil were included in the fill in some parts of the site and may be a potential contamination source. The report comments on the potential for mine water to migrate onto site from adjacent coal workings.

The ground investigation included laboratory analysis, which allowed the risk assessment to conclude there was a low risk due to historical site uses or due to acid soluble sulphate.

3.4 Site investigation and settlement monitoring, Shortwood Business Park, Hoyland, report reference 10568R4, July 2004, RSK ENSR Limited

This work was undertaken on the site to the east of the part of the Rockingham site to the north of the road, which has now been redeveloped as Shortwood Business Park. The site was extensively worked to extract clay and coal (opencast). Large quantities of overburden were placed to reinstate the ground levels. Variable conditions exist, with a mix of controlled fill, uncontrolled fill and areas of buried high walls. Fill material were predominantly clay and mudstone with cobbles and boulders.

Surcharge loading tests and settlement monitoring was undertaken and results indicated that load induced settlement was recorded during and for a short period after surcharging. There was no evidence of any ongoing self-weight settlement. Calculated long term settlement for the proposed building lifetime were extrapolated from log scale plots, which indicated that surcharge treatment could be used to induce settlements in advance of building construction.

Gas monitoring indicated a need for gas ingress preventative measures. Some remediation was also required with respect to hydrocarbon impact in the area of the old refuse tip at Hoyland brickworks.

3.5 Initial environmental review, Rockingham Colliery, Dearne Valley Parkway, Birdwell, South Yorkshire, project no. UKC053HE, November 2008, BWB Consulting

The Initial Environmental Review produced by BWB covers Rockingham 1 and Rockingham 2 areas. It includes a summary of information from the GroundSure reports for the area. The summary indicates that the mining and related industrial activity at the site included railways and sidings, shafts, coking ovens, tips, slurry ponds, reservoirs and aerial ropeways.

This report identified the following potential sources of contamination:

- made ground (including coal waste, likely to incorporate heavy metals, PAHs and high calorific value soils)
- above ground tanks (fuels)
- electricity substations and transformers (PCBs)
- contamination from coking ovens (PAHs, BTEX compounds, phenols and other hydrocarbons)
- historical railway lines (PAHs, coal waste, solvents, spent oxides and pesticides)
- in-filled excavations and slurry ponds (contaminants unknown until information is available on types of fill material).

The report concluded that there was a moderate likelihood of contamination being present within the subsoil due to mining activities. Asbestos was unlikely to be present and Japanese knotweed had been observed. Intrusive works were recommended.

3.6 Other documents

A review of engineering and environmental constraints has been undertaken by Harworth Estates, which has highlighted the following issues:

- establish if a restoration strategy was agreed with the local planning authority and if it was appropriately implemented and validated (no record of this has been identified to date)
- relocation of the current surface water drainage system will be required (streams, ditches, culverts and ponds)in relation to the proposed layout
- points of connection for future on-site utilities will need to be re-established
- costs and legal issues need to be resolved for diversion/relocation of overhead power cables
- as relates to highways, it will be necessary to establish access from Dearne Towns Link Road and feasibility of a new traffic island junction
- determine solutions to potential ecology issues (newt and water vole) with ponds, stream and surface water ditches
- determine the potential for impact on nesting birds in arranging programming of tree/scrub removal
- there are public rights of way across the site that need to be considered

- there is a Restrictive Covenant issue that requires resolving (from title document plan SYK567528)
- one discharge consent is present on site (Rockingham 1 eastern site boundary)
- site levels / gradients need to be determined against the larger proposed plot areas and proposed access
- the location of the former high wall of opencast needs to be identified, and potential differential settlement across that high wall area factored into the redevelopment plans
- shafts associated with former deep mine operations need to be investigated
- ground validation should be undertaken to establish the nature and compaction of backfill
- undertake a Phase 2 intrusive Geo-Environmental site investigation to establish ground conditions and determine if ground remediation is necessary.

Records made available from Harworth Estates includes a completion plan for Rockingham opencast (drawing 82/CP-1). Enquiries with the Coal Authority indicate that in addition to this plan there are six further completion records, one for each of the worked seams and these plans are understood to include some information on seam and excavation depths. These records have been ordered from the Coal Authority and if they provide additional information will be commented on separately.

4 SUMMARY OF SETTLEMENT MONITORING RESULTS

The Compaction of Backfill Certificate Report (Mott MacDonald, February 1997) provided a summary of settlement data collected over a period of nearly four years. The original data were not provided in the report (including levels of settlement markers relative to a known datum point), but the summary information is presented here.

A number of settlement monitoring stations (permanent ground markers, PGMs) have been identified on site during a recent site inspection visit by an RSK surveyor, and it is expected that it will be possible to determine the locations of the majority of positions during a follow up site visit by using a metal detector. However, if the original levels of the PGMs cannot be obtained, it will not be possible to ascertain the settlement since the last monitoring round in August 1996, as the summary results include only relative movement. Table 2 provides a summary of all the available settlement data and includes information on the depth of fill at each settlement monitoring point.

It should be noted that only PGMs 10 to 14 are located within the current site area (Rockingham 1), with the remainder being off-site to the south (in the compacted area, as shown on Figure 2) or off-site to the east in the area of the Shortwood Business Park. Full data have been included here for reference.

Table 2: Summary of surface settlement monitoring results (October 1992 to August 1996)

Station number	Depth of fill (m)	Date first surveyed	Movement recorded as of August 1996	Movement/depth of fill (%)
SM1	18.5	Oct 1992	-60	-0.32
SM2	2.2	Oct 1992	-67	-3.05
SM3	3.9	Oct 1992	-42	-1.08
SM4	11.1	Nov 1992	-55	-0.50
SM5	10.0	Nov 1993	-67	-0.67
SM6	11.9	Nov 1993	-70	-0.59
SM7	22.4	Nov 1993	-96	-0.43
SM8	18.3	Nov 1993	-28	-0.15
SM9*	13.9	Nov 1993	-65	-0.47
SM10	6.6	Oct 1992	+12	+0.18
SM11	9.9	Oct 1992	+2	+0.02
SM12	10.7	Oct 1992	-7	-0.07
SM13	16.0	Oct 1992	+21	+0.13

Station number	Depth of fill (m)	Date first surveyed	Movement recorded as of August 1996	Movement/depth of fill (%)
SM14	16.4	Oct 1992	+5	+0.03
SM15	10.9	Nov 1993	+12	+0.11
SM16	8.3	Nov 1993	-59	-0.71
SM17	3.5	Nov 1993	-65	-1.86
SM20	13.1	Aug 1995	-28	-0.21
SM21	15.8	Aug 1995	-18	-0.11
SM22	17.0	Aug 1995	-27	-0.16
SM23	19.1	Aug 1995	-39	-0.20
SM24	11.1	Aug 1995	-25	-0.23
SM25	14.4	Aug 1995	-27	-0.19
SM26	19.7	Aug 1995	-31	-0.16
SM27	19.7	Aug 1995	-71	-0.36
SM28	16.3	Aug 1995	-44	-0.27
SM29	11.7	Aug 1995	-38	-0.32
SM30	21.0	Aug 1995	-49	-0.23
SM31	19.3	Aug 1995	-42	-0.22
Notes: + Heave - Settlement * Damaged, last surveyed May 1996 Results were considered by Mott MacDonald to be unreliable due to suspected deep mining beneath the site				

Table 3 shows the PGMs located during the recent site visit by RSK, along with the depth of fill and settlement recorded by Mott MacDonald in addition an appropriate PGM level in 1996 is presented – this is taken from local spot-heights indicated on the topographical plan included in the Mott MacDonald report. For comparison we have also included levels of the PGMs recorded by the RSK surveyor during the recent site visit.

Table 3: Monitoring locations confirmed by RSK

Station number	Depth of fill (m)	Movement recorded as of August 1996	Approximate PGM level in 1996	Approximate PGM level June 2013
SM4	11.1	-55	140.75	140.902
SM1	18.5	-60	144.25	144.215
SM3	3.9	-42	140.75	140.751
SM13	16.0	+21	129.83	129.837

The levels recorded for the monitoring pins recently surveyed by RSK indicate little movement has occurred in the 17 year period since they were last surveyed. It is likely that a significant proportion of the differences between approximate level in 1996 and the survey results in June 2013 shown above are a result of errors when interpolating spot heights from the Mott Macdonald compaction plans.

In addition, the following boreholes have been located on-site (piezometers, extensometers):

- BH1 CL
- BH2 PL
- BH3 PL
- BH4 GL
- BH5 PL.

5 SUMMARY OF INFORMATION FOR AREAS OF THE SITE

5.1 Rockingham 1(area of compacted fill)

This part of the site was opencast to access the Swallow Wood seam, which outcropped at surface across the site. The depth of the base of the excavation reached a maximum of 20m below ground level in the northeastern corner of the site.

The area covered by the Compaction of Backfill Certification Report is at the western end of the Rockingham site (see Figure 2). There is the greatest confidence regarding the ground integrity in this area, as the certification reports are available which detail the compaction works undertaken. In addition, RSK have worked on the adjacent Shortwood Business Park site, which was similarly compacted and comprised similar materials (of a comparable composition and thickness, and deposited at a similar time). As a result of this, RSK can infer that the engineering properties of the material in this area of the Rockingham site will behave in a similar manner to the compacted material at Shortwood Business Park.

The solution to construction of buildings at Shortwood Business Park was to surcharge the soils over the footprints of proposed buildings prior to construction, to induce settlement in advance of construction. Settlement monitoring was undertaken to ensure that acceptable amounts of settlement were achieved by surcharging so that buildings would not be damaged due to future ground movement.

No high wall areas are indicated as being present within this part of the site, which makes this part of the Rockingham site slightly less complex than the Shortwood Business Park area (NB high wall areas are present beneath parts of the Rockingham site in areas not subject to controlled compaction).

Opencast work in this area worked an unnamed coal seam (1AQ) and the Swallow Wood seam. The excavations would have proceeded from west to east, with the downward dip of the seams. Maximum excavation of the Swallow Wood seam is reported to have been around 20m bgl in the northeastern corner of this part of the site.

Five surface settlement markers were located within this area; which include SM10 to SM14. These markers were located where the thickness of made ground was measured as 6.6m, 9.9m, 10.7m, 16.0m and 16.4m respectively. Relative movement at these markers was measured as a heave of between 2mm and 21mm in four of the five markers, with one location where settlement of 7mm was recorded.

5.2 Northern area where no compaction was undertaken

This area indicates the former colliery where deep mining took place and a large area of opencast workings. A high wall was present as a result of opencast operations, running northwest to southeast through this area (and through the Rockingham 2 area). This in part coincides with the location of the Elsecar fault.

Seams worked in this part of the site by opencast operations were the Swallow Wood, Swallow Wood Rider, Dunsil, Dunsil Rider Lower, Dunsil Rider Upper, Kents Thick and unnamed (1AY) seams.

Figure 2 shows the locations of the high wall and of worked seams.

Of the six mine entries located in this part of the site, three were completely removed during opencast operations. Of the remaining three, two were partially removed, then plugged/capped at the base of the opencast excavation in June 1992. No treatment details are present for the remaining mine shaft. The Coal Authority report indicates that seams were worked to depths of up to 430m and it is possible that one or more of these shafts may have extended to this depth.

This area is believed to have been backfilled by means of end-tipping and tracking of mechanical plant. However, there is no confirmation of this and there are no records of the material deposited, or of any compaction undertaken.

The records available do not include details of the depth of the base of the excavation but the depth of the Swallow Wood seam in the central part of this area is recorded as being around 20m bgl, so the excavation is likely to have at least reached this depth, if not greater.

5.3 Rockingham 2 area (no compaction was undertaken)

This area was occupied by spoil mounds from former colliery operations before being opencast. As noted for the northern uncompacted area, a high wall extended southwards across the Rockingham 2 area, along the line of the Elsecar fault and around the edge of the opencast.

Seams worked in this part of the site by opencast operations were the Swallow Wood, Swallow Wood Rider, Dunsil, Dunsil Rider Lower, Dunsil Rider Upper, Barnsley, Kents Thick and Beamshaw seams.

Figure 2 shows the locations of the high wall and of worked seams.

Seven mine entries were recorded in this part of the site, all of which were completely removed during opencast operations.

This area is believed to have been backfilled by end-tipping and tracking with mechanical plant. Again, there is no confirmation of this and there are no records of the material deposited, or of any compaction undertaken.

6 CONCLUSIONS AND RECOMMENDATIONS

In this section, for the different areas of compaction, comments are provided on development potential, likely options for ground treatment and outline the work required to demonstrate suitability. Identified constraints are also presented together with key issues to be included in future ground investigations.

There is little available information in relation to groundwater conditions beneath the site either before or since opencast workings. Mott MacDonald did install a small number of piezometers to monitor groundwater recovery, however the integrity of these is not known. In order to comment on the potential for inundation settlement it will be necessary to install a number of new groundwater monitoring wells and monitor groundwater levels within these over time. If any Mott MacDonald installations are still viable these would be included in this assessment. It will also be necessary to carry out an assessment of potential for inundation by surface water which can be undertaken by having a soakage stage for the proposed surcharge loading trials.

Although four of the original PGMs remain in this part of the site, it is recommended that a further 10 pins should be installed, to be monitored alongside the pins installed across the uncompacted areas of site.

6.1 Rockingham 1 (area of compacted fill)

This area is considered to be the most readily developable part of the Rockingham site. This is because there is generally relatively thin backfill (between 6.6m and 16.4m at PGM locations); the backfill material has been placed as an engineered fill and monitoring has recorded negligible settlement.

Information available indicates that the ground surface is stable (no ongoing self-weight settlement) it is therefore only necessary to confirm the loading settlement which would result from future development. This can be assessed by undertaking a loading test with monitoring to confirm performance. If this test records low or negligible settlement it may be possible to build directly on standard shallow foundations. If larger settlements are recorded options such as ground treatment by surcharging or dynamic compaction may be required.

6.2 Northern uncompacted area and Rockingham 2 area (no compaction undertaken)

Over this area there is less certainty in respect of the depth of backfill and its method of placement. The uncompacted nature of placement suggests that the fill in this area would be more susceptible to settlement, however it has been in situ for between 16 and

21 years and over this period much of the anticipated self-weight settlement would have occurred.

The absence of settlement monitoring to date for this area means that it is not possible to determine if self-weight settlement is ongoing. In order to address this it will be necessary to install new surface settlement monitoring pins (PGMs) and monitor these over a period of time. An initial assessment can be completed after 3 months but it is recommended that the PGMs be monitored quarterly for at least one year. The number and position of PGMs will be dependant upon the existing topography, surface vegetation and access. It is understood that a topographical survey will be undertaken as part of the current phase of work. It is being explored whether a remote surveying method may be appropriate, due to the extensive area covered by this site. Once this is anticipated the final number of locations can be agreed but an allowance should be made for 150 PGMs (approximate 50m grid).

If monitoring confirms that the surface is stable and self-weight settlement is not ongoing then loading tests would be required to assess the behaviour of the uncompacted fill to loading. As different worked coal seams and thicknesses of backfill are present to the east and west of the Elsecar Fault it will be necessary to carry out separate tests in each of these areas. It is considered likely that these tests will record a reasonable amount of settlement but the tests are required to confirm the options for ground treatment to permit development.

High walls and the Elsecar Fault are present in both the northern area and Rockingham 2 area. At this stage, as the variation in thickness of fill across these features is not known, both the high walls and fault line should be considered as no-build zones. However, they could be used for roads, car parking and landscaping. It is recommended that the additional Coal Authority completion records are reviewed to confirm depths of workings in the vicinity of these features and that future borehole investigation is carried out to confirm ground conditions.

6.3 Ground investigation

An intrusive site investigation will be necessary to confirm ground conditions across the site to obtain representative samples for geotechnical classification tests to support future earthworks and to assess potential soil, groundwater and ground-gas contamination. The detail of the works (numbers and locations of boreholes for example) will in part be determined by the phasing of planning applications for site development. In advance of this information only an outline of the required works can be made. The ground investigation should include the following:

- placement of new PGMs and quarterly monitoring over at least one year to determine settlement
- trial pit investigation to determine the composition of shallow soils. This will include collecting bulk soil samples for earthworks classification, pH analysis and sulphates testing

- a borehole investigation to measure the in situ geotechnical parameters of backfill materials and allow some sampling of shallow soils and collection of samples. This will also allow for the installation of shallow monitoring wells to assess the ground gas regime at the site

- a borehole investigation to provide information about the depth of fill material in areas of the site where this is not known. This will also allow installation of deeper monitoring wells to assess the groundwater levels, recovery rates and quality

- loading tests to monitor the settlement of the ground as a result of surcharge loading. The loading tests will require careful design to ensure that conditions similar to the proposed developments are achieved. It will also be necessary to ensure that the loading effects the soil to the full depth of the made ground. The loading tests will need to include a stage of groundwater inundation to assess the potential for collapse compression.

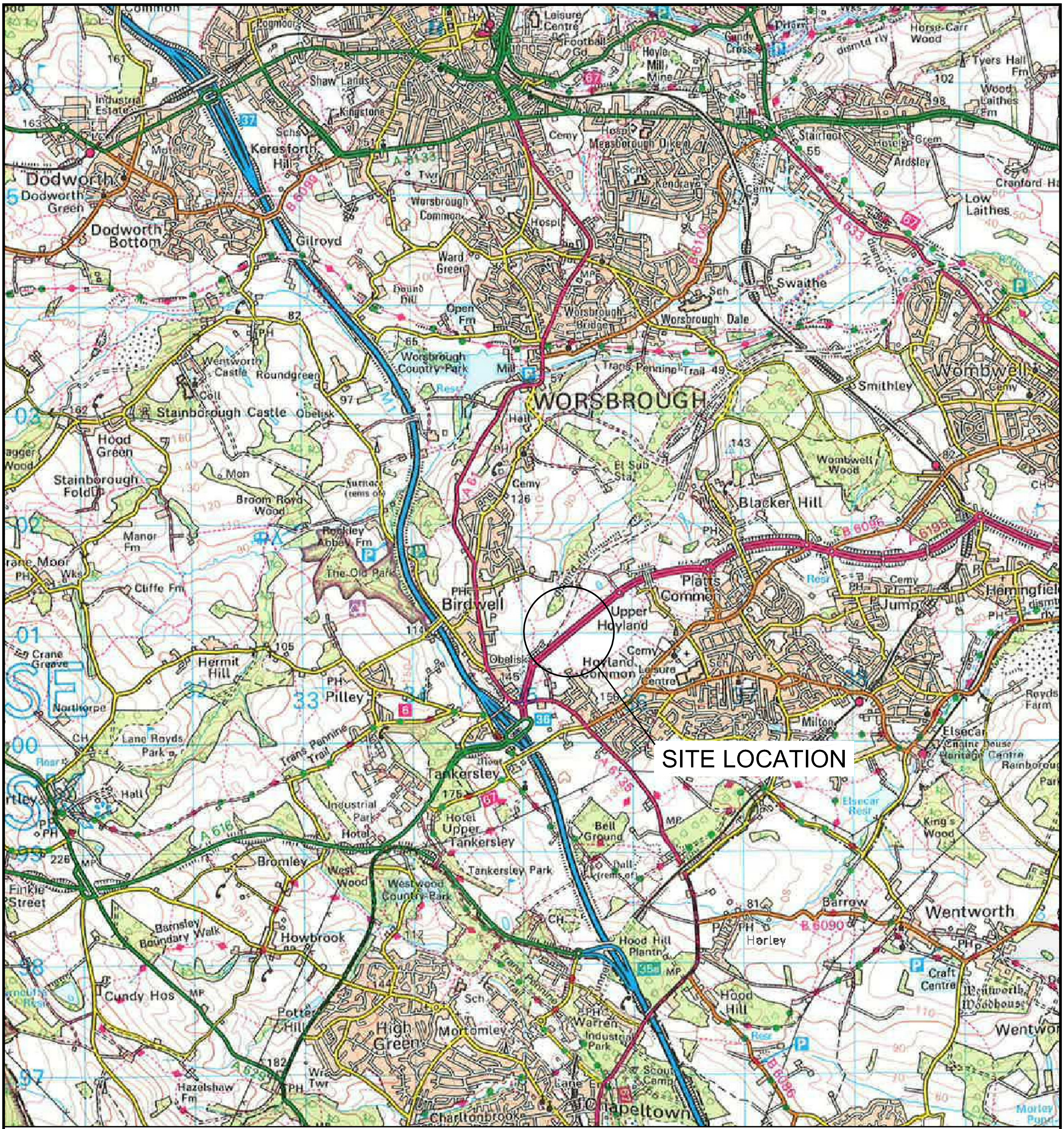
BIBLIOGRAPHY

British Geological Survey (1910), Sheet Number 87, Barnsley. Solid & Drift Edition, scale 1:50,000.

Geological Survey of Great Britain. Six inch map series. Yorkshire (West Riding) 282NE, 1932.

Ordnance Survey (2010),'OS Landranger Map, Sheffield and Huddersfield, Sheet 110, scale 1:50,000.

FIGURES



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RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

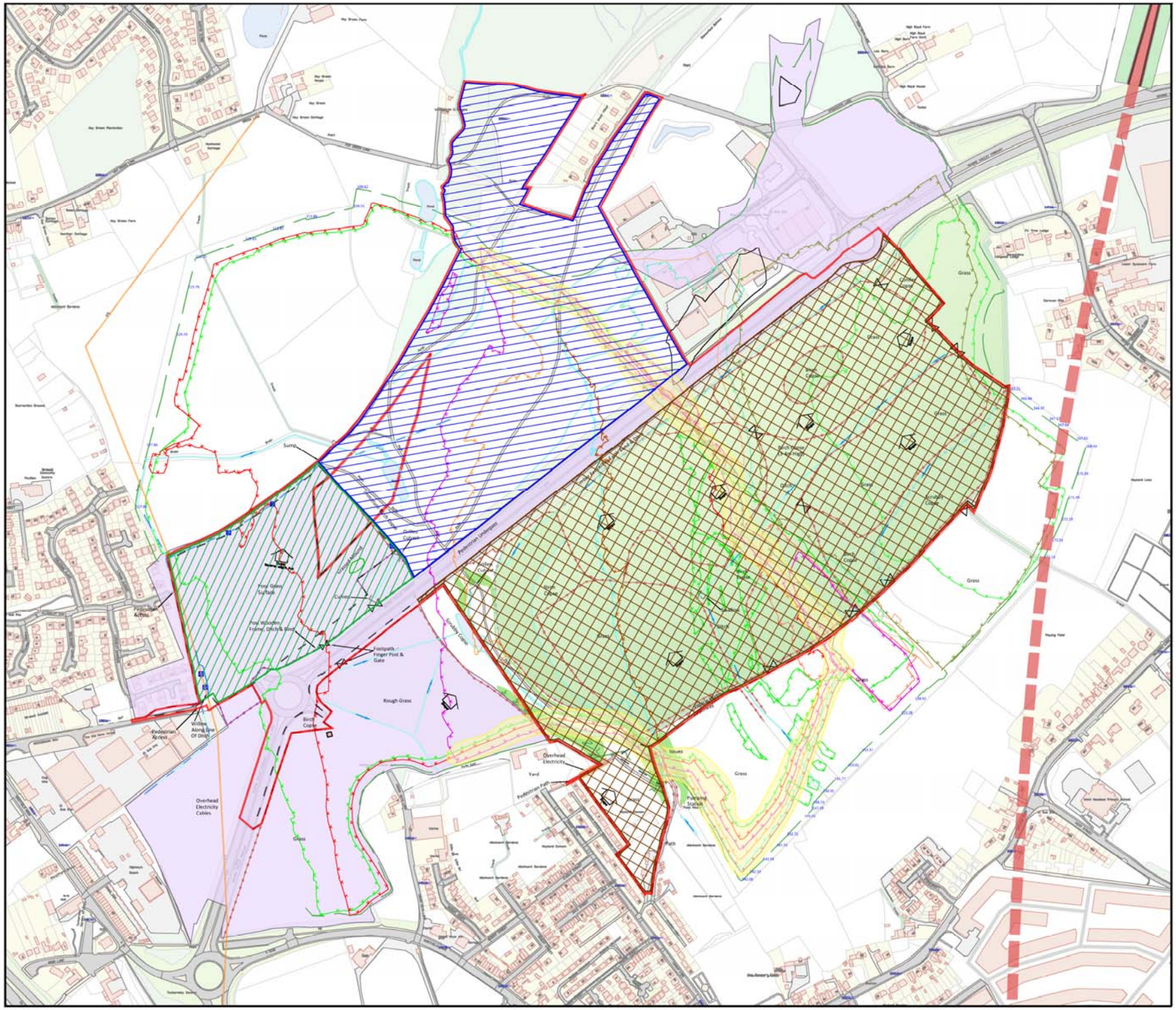
Client: HARWORTH ESTATES

Project Title: ROCKINGHAM

Drawing Title: SITE LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date	Project No.	Drawing File
HD	11.06.13	GMG	11.06.13	GMG	11.06.13	321393	321393-R1(00)D001A

Scale	Orig Size	Dimensions	Drawing No.	Rev.
NTS	A4	—	FIGURE 1	A



LEGEND:

Areas Of Worked Seams

- Barnsley Avx
- Barnsley Low Rider Ay1
- Barnsley Rider Upper Ay2
- Beamshaw Bb
- Dunsil Au
- Dunsil Rider Lower 1au
- Dunsil Rider Upper 2au
- Kents Thick Az11
- Kents Thin Ba
- Swallow Wood Ar
- Swallow Wood Rider 1ar

Engineering Constraints

- Existing Surface Water Drainage
- Existing Utilities Highlight
- Proposed Hs2 Underground Route (tunneled)
- Indicative Shallow Slope Gradient Affecting Layout
- Indicative Steep Slope Gradient Affecting Layout
- Former High Wall/ Elsecar Fault Line
- Rockingham 1(on site area of compaction)
- North area, east of Rockingham 1 (no compaction recorded)
- Rockingham 2 (no compaction recorded)
- Site boundary

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	11.06.13	FIRST ISSUE	HD	GMG	GMG

Dimensions	Projection	Scale	Orig Size
m		1:5,000	A3

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725831
Web: www.rsk.co.uk

CLIENT: HARWORTH ESTATES

PROJECT: ROCKINGHAM

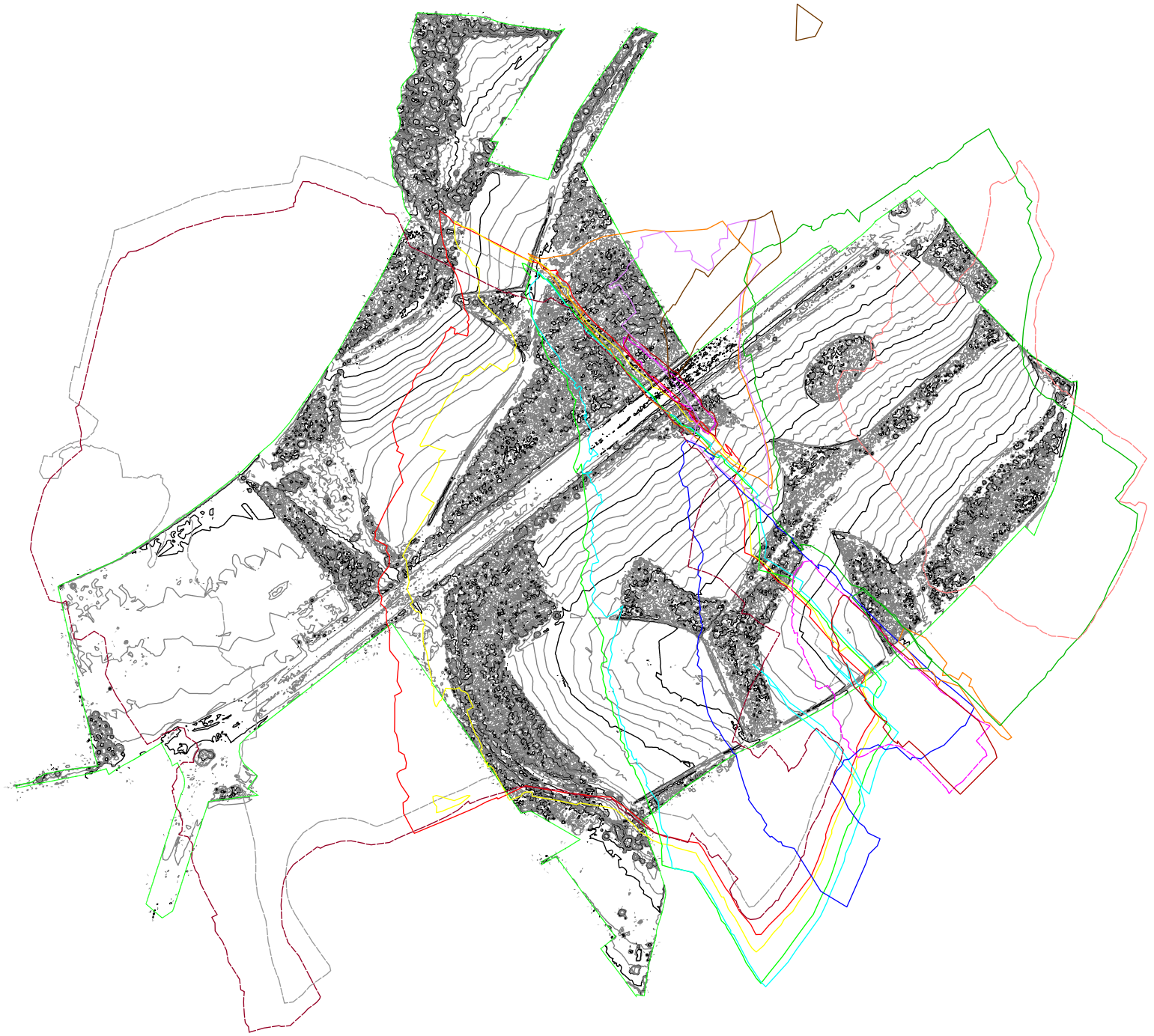
TITLE: SITE BOUNDARY PLAN

JOB No.:	DRAWING FILE:
321393	321393-R1(01)D002A

BY:	DATE:	CONTRACT NO.		REV:
HD	11.06.13		FIGURE 2	A

Scale 1 : 5,000

0 50 100 150 200 250m



- Beamshaw BB
- Kents Thin BA
- Unnamed 1AZ
- Kents Thick AZ11
- Unnamed 1AY
- Barnsley Rider Upper A
- Barnsley Rider Lower A
- Barnsley AVX
- Dunsil Rider Upper 2AU
- Dunsil Rider Lower 1AU
- Dunsil AU
- Swallow Wood Rider 1AR
- Swallow Wood Ar
- Unnamed 1AQ

N

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
A	12.07.13	FIRST ISSUE	HD	JC	JC

Dimensions	Projection	Scale	Orig Size
m		NTS	A2

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES

PROJECT
ROCKINGHAM

TITLE
WORKED AREAS FOR COAL SEAMS

JOB No.:	DRAWING FILE:
321393	321393-R01(01)D003A

BY:	DATE:	CONTRACT NO.		REV:
HD	12.07.13		FIGURE 3	A

LEGEND:

- Site boundary
- Extent of working for Unnamed (1AQ) seam

N

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
A	12.07.13	FIRST ISSUE	HD	JC	JC

Dimensions	Projection	Scale	Orig Size
m		NTS	A2

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES

PROJECT
ROCKINGHAM

TITLE
UNNAMED (1AQ)
BASAL SEAM

JOB No.:	DRAWING FILE:
321393	321393-R1(01)D004A

BY:	DATE:	CONTRACT NO.		REV:
HD	12.07.13		FIGURE 4	A

APPENDIX A
BGS BOREHOLE RECORDS

SE 30 SE/13 301 87/71

(B11857) Wt. 17862—8154—5,000 12/26 Gp. 160. O.A.

SECTION OF Rockingham Colliery at ½ mile east of Birdwell

Maps: One-inch 87 Six-inch 282 NE County Yorkshire

Height above O.D. 425 ft. Latitude 53° 30' 15" Longitude 1° 28' 5"

Communicated by 'Sec. Strata Yks. Clfd' 1927 p.280 Date of Sinking Not stated

Made by Dip of Strata 1 in 18 N 60°E

Summary of published record.

Intervening beds are shales, binds, etc. with thin coalseams.

(CARBONIFEROUS; WESTPHALIAN B; WESTPHALIAN A; SILKSTONE SEAM)

	Thickness (m)	ft	in	Depth from Surface (m)	ft	in
Earth + clay	1.83	6	-		6	-
Swallow Wood Coal	0.93	3	1	20.93	68	8
Stone	30.56	100	3	59.95	196	8
Lidgett quarry	5.36	17	7	84.23	276	4
Lidgett Coal (with dirt)	1.24	4	1	88.47	290	3
Joan Coal	0.46	1	6	127.92	419	8
Tankersley Ironstone	2.34	7	8	145.08	476	-
Flockton Thick Coal (with dirts)	1.98	6	6	154.23	506	-
Flockton Thin Coal (with mid-dirt)	1.14	3	9	181.79	596	5
High Fenton " (with dirts)	1.42	4	8	206.12	676	3
Low " " (with dirt)	1.35	4	5	209.25	686	6
Parkgate Coal (with dirts)	3.43	11	3	227.63	746	10
Rock	8.61	28	3	251.28	824	5
Thorncliffe Thin Coal (with dirts)	3.05	10	-	257.48	844	9
Claywood Ironstone	1.98	6	6	298.30	978	8
Silkstone Coal (with dirts)	1.56	5	1½	309.96	1016	11
Rock	2.39	7	10	312.93	1026	8

Totals given in published record for coal at 978'8" Silkstone + bottom of shaft are incorrect fide Colliery Surveyor (fide J.V. Stephens)
This mistake is due to misprint in item No. 122 Blue bind 0.0.6". This should be 6'.0'.0".

N.B. Drawn up section from Sections of Strata (1950 Edition) correct. C.A. 10/11/78.

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ID: 84439 : BGS Reference: SE30SE13
British National Grid (27700) : 435274,401100

Report an issue with this borehole

- <<
- < Prev
- Page 4 of 5
- Next >
- >>

YORKSHIRE WATER AUTHORITY - Survey of Existing Boreholes

I.G.S. Ref. No SE.30 SE/13 N.G.R. SE.352.011.........

Licence No.

OWNERS NAME ....

ADDRESS ..Rockingham Coll,..................
.....Birdwell..........................

App No

Authorised Abstraction

g.p.h.
g.p.d.
m.g.a.

STRATA DETAILS	Thick^ns	Depth
Earth & clay	6'	
Swallow wood	2'1"	8'8"
coal		
Stone	100'3"	116'8"
Lidgett quarry	111'7"	226'4"
" coal	4'1"	290'3"
Joan coal	1'6"	419'8"
Tankersley Ironst	7'8"	476
Flockton thin	6'6"	506
" thick	3'9"	596'5"
High Fenton	4'8"	616'3"
"	4'5"	696'6"
Parkgate	11'3"	716'10"
Rock	28'3"	811'6"
Thorncliffe Thin	10'	864'9"
Claywood Ironst	6'6"	918'7"
Silkstone	5'1½"	1016'4"
Rock	1'10"	1026'8"

Dia. ....
Depth .1026'8"......
Lining ....
Well sinker ....
Date ....
R.W.L. ....
F.W.L. ....

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

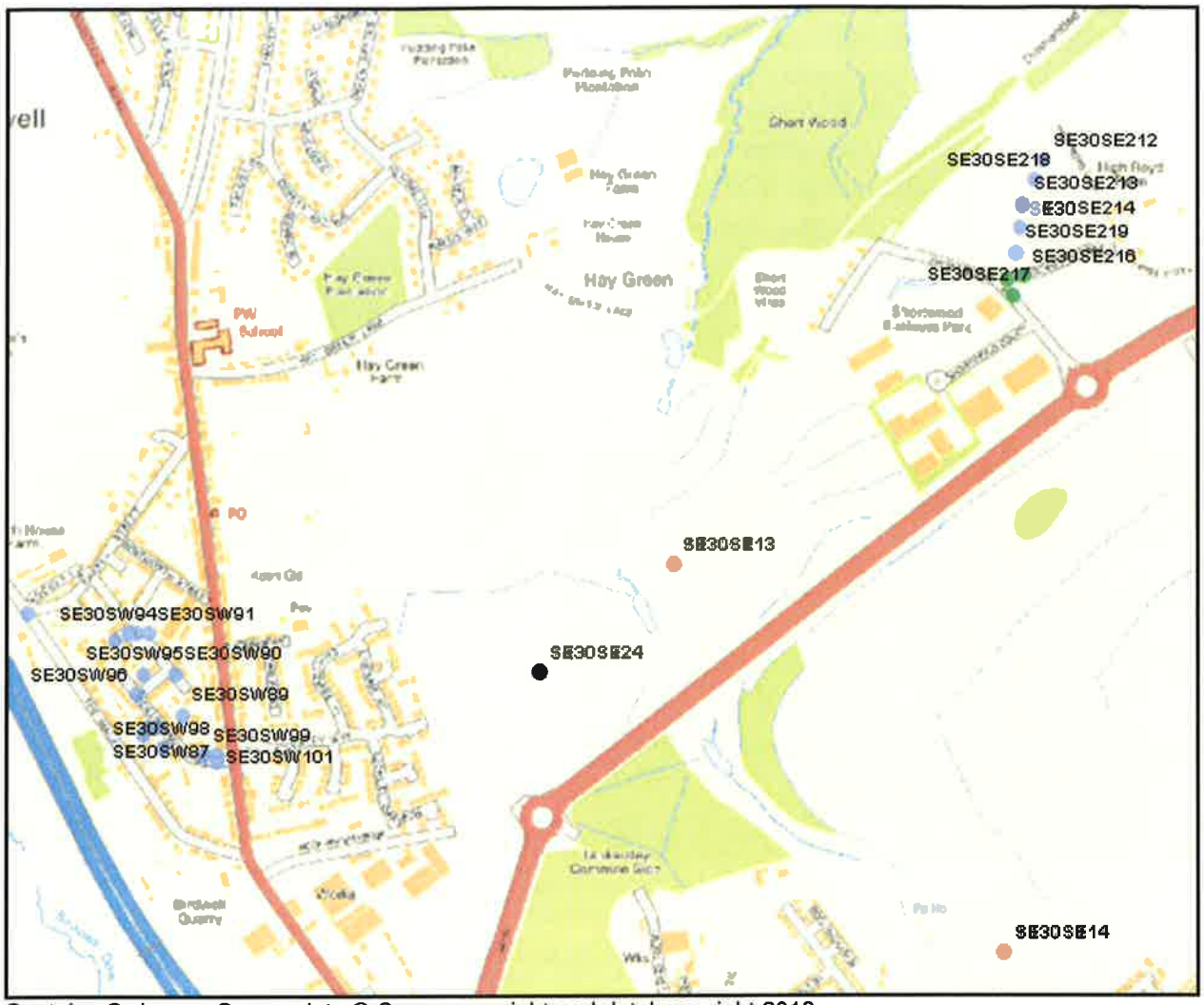
BGS ID: 84439 : BGS Reference: SE30SE13
British National Grid (27700) : 435274,401100 Report an issue with this borehole

- <<
- < Prev
- Page 5 of 5
- Next >
- >>

INSPECTION REPORT	WATER QUALITY	DATE OF INSPECTION:-
Present Owner:-	Date	Other Comments:-
Access (Yes or No)	pH	
½" Probe	Total hard	
3" Instruments	Temp.hard	
Landrover	Alk.	
Access Agreed	Ca	
	Mg	
	Na	
	K	Sketch Plan of Location
Water Level at time of insp.	HCO_3	
..... metres below	SO_4	
Date	Cl	
Datum above O.D.	NO_3	
R.W.L. above O.D.	Fe	
Date		

Print report

GeoIndex Map



Legend

Borehole records

- Confidential
- 0 - 10m
- 10 - 30m
- 30m+