LITHOS

Geoenvironmental Appraisal

Land at Flockton Working Men's Club

For Barratt and David Wilson Homes Yorkshire West

Report no: 2211/1

Date: October 2015

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SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2211	**Site area/ha**	2.5
Client:	Barratt and David Wilson Homes Yorkshire West	**NGR:**	SE 241 150
Site:	Flockton Working Men's Club	**Nearest postcode:**	WF4 4AA

The site currently comprises an open grassed field to the rear of Flockton Green Working Men's club on Barnsley Road. The club building and car park is situated in the south-east; the far south-west is currently in use as the rear gardens of adjacent properties.

Lithos were commissioned by BDW to provide a geoenvironmental appraisal of the site. It is understood that the site is to be redeveloped with housing. Lithos' investigation included a review of the site's history and environmental setting, and a ground investigation comprising 17 trial pits and 6 rotary open probeholes.

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

Issue	Remarks
Made ground	Opencast backfill comprising suspected clayey gravel of mudstone was encountered in the former opencast. PH04, drilled within the area encountered bedrock at 6.7m.
Natural ground	Topsoil (typically 300mm in thickness), over residual cohesive or granular soils (firm clay or medium dense gravel). Bedrock was encountered at an average depth of 1.3m beyond the area of opencast. Coal (Flockton Thin seam) was encountered in TP02 from 1.4m to 1.8m in the west of the site.
Contamination	Topsoil, typically 300mm thick underlies the majority of the site. Testing has yielded marginally elevated arsenic levels, but these are not considered to be of great concern.
Mining & quarrying	This site is located within a Coal Mining Development High Risk Area. A former opencast is present in the north-west. Shallow mineworkings were encountered across the east of the site within the Flockton Thick which will require mitigation measures (i.e. consolidation by drilling & grouting). At this stage, it should be assumed that the whole site east of the Flockton Thick outcrop will require treatment; about 2 ha.
Hazardous gas	The site is underlain by shallow mineworkings and a former opencast is present in the north-west and immediately adjacent to the site. Consequently, gas monitoring wells have been installed in 6 boreholes across the site. A gas risk assessment will be forwarded upon completion of the monitoring programme.
Preparatory works	Topsoil strip & stockpile. Demolition of working men's club.
Foundations	Two foundation solutions are considered likely to be most appropriate for proposed dwellings at this site: • Strips/trench fill for plots located beyond the opencast backfill; and • Piles for plots located within the opencast backfill Vibratory ground improvement might be an option, but only for plots located wholly within the opencast backfill, and probably some distance from high walls. Further advice should be sought from a specialist vibro contractor. Any plot layout for this site should take account of the known high walls
Groundwater & excavations	A groundwater inflow was encountered in TP01 at 2.5m. Dipping of the wells to date indicates that groundwater lies at depths in excess of 3.5m.
Flooding & drainage	The site lies within flood zone 1. Based on the in-situ testing and topography, soakaways are considered unlikely to provide a suitable drainage solution. Water balancing will likely be required.
Highways	Natural deposits should yield CBR values in excess of 3%. Made ground within the former opencast should be excavated up to a maximum of 2m beneath the footprint of proposed highways. It is considered likely that the made ground should be suitable for re-engineering, subject to confirmatory laboratory testing and field trials.

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

- Grouting of mineworkings.
- Piled foundations for any plots located within the opencast backfill, with consideration of high wall issues.
- Demolition of the WMC and grubbing up of associated hardstand.

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

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Some further work is required, most notably:

- Supplementary investigation in the south-east following demolition of the existing working men's club building.
- Trenching to locate highwalls associated with the former opencast.
- Consideration could be given to cable percussion boreholes, with SPTs, to provide geotechnical data for the opencast backfill.
- Location of four mine entries.
- Consideration should be given to a geophysical survey. Follow-up intrusive investigation (pitting) would be recommended to determine the cause of any anomalies identified by the geophysics.

APPENDICES

Appendix A - General notes

01	Environmental setting
02	Ground investigation fieldwork
03	Geotechnical testing
04	Contamination laboratory analysis & interpretation
05	Hazardous gas
06	Soakaways

Appendix B - Drawings

Drawing	Revision	Title
2211/1	-	Site location plan
2211/2	-	Proposed site layout
2211/3	-	Site features
2211/4	-	Site photographs
2211/5	-	Preliminary conceptual site model
2211/6	A	Exploratory hole locations
2211/7	-	Revised conceptual site model
2211/8	-	Mining Mitigation Measures

Appendix C - Commission

Appendix D - Historical OS plans

Appendix E - Search responses

From	Date	Content
Landmark	23/09/15	Environmental search data
Coal Authority	23/09/15	Mining report
Coal Authority	25/09/15	Mine entry datasheet
Coal Authority	28/09/15	Abandonment Plan 17778

Appendix F to G - Exploratory records

Appendix F	TP01 to TP15 & TT16 to TT17
Appendix G	PH01 to PH07

Appendix H - Geological cross section

Appendix I - Chemical test results

Appendix J - Geotechnical test results

Appendix K - Gas monitoring results

Appendix L - Soakaway test results

FOREWORD (geoenvironmental appraisal report)

This report has been prepared for the sole internal use and reliance of the Client named on page 1. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Lithos Consulting Limited (Lithos); such authorisation not to be unreasonably withheld. If any unauthorised third party comes into possession of this report, they rely on it at their peril and the authors owe them no duty of care and skill.

The report presents observations and factual data obtained during our site investigation, and provides an assessment of geoenvironmental issues with respect to information provided by the Client regarding the proposed development. Further advice should be sought from Lithos prior to significant revision of the development proposals.

The report should be read in its entirety, including all associated drawings and appendices. Lithos cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context. However, it should be noted that in order to keep the number of sheets of paper in the hard copy to a minimum, some information (e.g. full copy of the Landmark/Groundsure Report) is only included on the accompanying CD.

The findings and opinions conveyed in this report (including review of any third party reports) are based on information obtained from a variety of sources as detailed within this report, and which Lithos believes are reliable. All reasonable care and skill has been applied in examining the information obtained. Nevertheless, Lithos cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

The report represents the findings and opinions of experienced geoenvironmental consultants. Lithos does not provide legal advice and the advice of lawyers may also be required.

Intrusive investigation can only investigate shallow ground beneath a small proportion of the total site area. It is possible therefore that the intrusive investigation undertaken by Lithos, whilst fully appropriate, may not have encountered all significant subsurface conditions. Consequently, no liability can be accepted for conditions not revealed by the exploratory holes. Any opinion expressed as to the possible configuration of strata between or below exploratory holes is for guidance only and no responsibility is accepted as to its accuracy

It should be borne in mind that the timescale over which the investigation was undertaken may not allow the establishment of equilibrium groundwater levels. Particularly relevant in this context is that groundwater levels are susceptible to seasonal and other variations and may be higher during wetter periods than those encountered during this commission.

Where the report refers to the potential presence of invasive weeds such as Japanese Knotweed, or the presence of asbestos containing materials, it should be noted that the observations are for information only and should be verified by a suitably qualified expert.

This report assumes that ground levels will not change significantly from those existing at present and that houses will be of two storey construction. If this is not to be the case, then some modification to this report may be required.

Lithos cannot be responsible for the consequences of changing practices, revisions to waste management legislation etc that may affect the viability of proposed remediation options.

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

GEOENVIRONMENTAL APPRAISAL
of land at
FLOCKTON WORKING MEN'S CLUB

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Barratt and David Wilson Homes Yorkshire West (BDW) to carry out a geoenvironmental appraisal of land at Flockton Green Working Men's Club, Flockton.

1.1.2 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:

- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- A mining risk assessment in accordance with Coal Authority guidance.
- An intrusive ground investigation comprising 15 trial pits (with soakaway testing in 5), two trial trenches and 7 rotary probeholes
- Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
- A qualitative assessment of contamination risks
- Recommendations for the necessary site preparatory works

1.1.3 Primary aims of this phase of investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and enable BDW to obtain budget costs for: foundations; gas protection measures; and site preparatory works.

1.2 The proposed development

1.2.1 It is understood that consideration is being given to redevelopment of the site with 92 two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A new working men's club building will also be developed in the centre-south. A site layout has been provided by BDW (Drawing reference KSL-01, dated April 2015) which is reproduced as Drawing 2211/2 in Appendix B to this report.

1.3 Report format and limitations

1.3.1 All standard definitions, procedures and guidance are contained within Appendix A, which includes background, generic information on:

- Assessment of the site's environmental setting
- Ground investigation fieldwork
- Geotechnical testing
- Contamination testing
- Hazardous gas
- Soakaways

1.3.2 General notes and limitations relevant to all Lithos geoenvironmental investigations are described in the Foreword and should be read in conjunction with this report. The text of the report draws specific attention to any modification to these procedures and to any other special techniques employed.

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 2211/1 presented in Appendix B to this report. Site details are summarised in the Table below.

Detail	Remarks
Location	Flockton Village, 10 km south-west of Wakefield town centre
NGR	SE 241 150
Approximate area	2.5ha (6.2 acres)
Known services	Overhead electric & telecommunications

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on the 28th September 2015.

2.2.2 The site currently comprises a Working Men's Club with an associated tarmac car park in the south-east, and an open, grassed field to the north and west.

2.2.3 The site generally slopes to the south, with gentle sloping also to the south-east and south-west. A steep slope runs along northern boundary of the site, creating a batter roughly 3m high.

2.2.4 Land along the southern boundary is heavily vegetated, and slopes steeply down to a stone retaining wall, roughly 0.5m high. Terraced houses are present to the south-west, behind which retaining walls, up to around 3m high, can be seen situated along the site's southern boundary.

2.2.5 Overhead electric cables cross the western half of the site running north to south and north-east to south-west.

2.2.6 Rough footpaths cross the site in several locations, leading to adjacent playing fields, a playground, and a gate into Flockton Primary School.

2.2.7 The far south-western corner of the site is currently occupied by the rear gardens of properties on Barnsley Road; it is understood that this land is currently rented by the adjacent properties.

2.2.8 Approximately 6,500m^2 in the south of the site is overgrown with dense brambles and undergrowth; a 1.5m long piece of (possibly asbestos-containing) cement guttering was noted here.

2.2.9 Scattered mature trees line the eastern and northern boundaries of the site. Dense mature trees line the western boundary of the site.

2.2.10 A smoking shelter is present within the vicinity of the Working Men's Club with an asbestos-cement roof.

2.2.11 Existing salient features, at the time of the walkover are presented on Drawing 2211/3 in Appendix B to this report, and summarised in the Table below.

Feature	Remarks
Current Access	Off Barnsley Road
Topography	Slopes to the south
Approximate areas	400m^2 buildings 2,000m^2 tarmac hardstand 16,000m^2 grass 6,600m^2 dense weeds
Nature of boundaries	North– scattered mature trees and dilapidated fencing East- scattered trees, dilapidated fencing South – brick retaining wall onto Barnsley Road; fences, lost in overgrown weeds onto houses West- mature trees and hedges
Surrounding land uses	North– open fields East- Allotments and housing South - Barnsley Road, with housing beyond West – Flockton Primary School and playing fields

2.2.12 A selection of site photographs is included on Drawing 2211/4.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1854 have been examined. Some of these plans are presented in Appendix D to this report.

3.2 The Table below provides a summary of the salient points relating to the history of the site. It is not the intention of this report to describe in detail all the changes that have occurred on or adjacent to the site. Significant former uses/operations are highlighted in **bold** text for ease of reference.

Date	Site	Surrounding land
1854	Fields.	Fields to the east, north & west. Barnsley Road immediately south. Church and Flockton Village to the south-west. Housing shown immediately south-west.
1893	No significant changes.	Small **quarry** (c.10m^2) shown 100m west. School shown immediately south-west.
1906		Quarry no longer shown. Sewage works shown 200m south.
1930	'Football Ground' shown in the north-east (likely a field, not shown as a structure). **Buildings** shown in the south-east (Working Men's Club).	Housing and allotments shown immediately east.
1948		Housing shown immediately north-east.
1961	Position of football ground changed.	Post Office shown immediately south.
1975	South of the site shown as allotments.	No significant changes.
2015	South of site no longer shown as allotments.	

4 ENVIRONMENTAL SETTING

4.1 General

4.1.1 Notes describing how the site's environmental setting has been assessed are included in Appendix A to this report. Extracts from the responses received from Landmark and the Coal Authority are presented in Appendix E. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:10,000 BGS map (Sheet SE 21 NW)	Drift – None shown. Solid – Lower Coal Measures; Sandstone unit in the east. Shallowest coal seam – Flockton Thick shown to outcrop in the west trending north-south. Further details in Section 4.2. Strata dip - east. Faults – none.
Mining	Coal Authority	This site is located within a Coal Mining Development High Risk Area. Past and present workings – the site is in the likely zone of influence from workings in 5 seams at shallow to 210m depth. Opencast – the site is within the boundary of a former opencast site. Mine entries – four shown on site. Further details in Section 4.2 below.
Quarrying	Historical OS plans	Former opencast immediately north, encroaching into the far north.
Landfills	Envirocheck Report	No known landfills within 250m.
Radon	BRE Report BR211	No measures required.
Hydrogeology	Envirocheck Report	Source Protection Zone? No. Aquifer: Secondary A (Solid). Groundwater abstractions? None within 1km. Soil leaching potential - low. Pollution incidents? None of significance.
Hydrology	Envirocheck Report	Nearest watercourse(s) – Mill Beck, 190m south, flowing west to east. Water quality - unknown. Pollution incidents? 10m east, wrong sewage connection causing pollution at Spen Beck/Dean Beck, category 3 minor incident. Date not supplied. Abstractions? None within 1km. Discharge consents? Numerous at 190m to 200m south relating to sewage discharges to tributary of Flockton Beck, issued August 1958.
Flood risk	Environment Agency	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. The site area is greater than 1 hectare, therefore a Flood Risk Assessment, focused on the management of surface water run-off, will be required. Development that increases the amount of impermeable surfaces can result in an increase in surface water run-off, which in turn can result in increased flood risk both on site and elsewhere within the catchment.

4.2 Coal & mining

4.2.1 In July 2011 the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology relating to coal mining development areas. This Section (and Section 7.8) provides the necessary mining risk assessment required by the proposed planning application.

4.2.2 Coal has been mined in Yorkshire for centuries; the first mining probably took place in the fifteenth century. Early mining methods included drifts or adits from outcrop. Where mining extended further from the crop, bell pits were often sunk, and as the coal got deeper still, shafts were used to access gallery workings (pillar & stall).

4.2.3 The shafts associated with bell pits are typically only about 1.2m in diameter, and the bell pit itself was typically 5m to 10m in diameter (bell pit size would have been constrained by roof stability).

4.2.4 The depth limit of bell pit mining is almost certainly 15m, and this is considered a deep bell pit; the vast majority were probably less than half this depth.

4.2.5 At greater depths, pillar and stall workings appear to have been the preferred method, and such workings were often accessed via a single shaft. Consequently, shafts associated with such workings are more widely spaced.

4.2.6 Bell pits may be present beneath this site, and given the absence of loose superficial deposits, it is considered unlikely that such mine entries would have been lined.

4.2.7 The BGS Geological plan shows the Flockton Thick coal seam outcropping on site in the west, trending north-south. In addition, the Tankersley Ironstone outcrops in the far north-east. The Tankersley Ironstone is a seam rich in iron-ore which has, in some areas, been worked from outcrop and via bell pits.

4.2.8 The general dip of the strata shown on the BGS plan is to the east.

4.2.9 An area of '*infilled ground backfilled opencast coal sites/sandstone quarries*' is marked in the north-west of the site on the BGS plan, labelled as 'Flockton Thick' indicating that the Flockton Thick seam has been mined via opencast methods here.

4.2.10 In summary, the following seams are expected to underlie the site at shallow depth:

Seam	Approx. depth below site (m)	Max. recorded thickness (m)
Flockton Thick	Outcrops in the west	1.1
Flockton Thin	14	0.8
First Brown Metal	31	0.7

4.2.11 Approximate outcrops are shown on Drawing 2211/3.

4.2.12 Given dip and topography, the Flockton Thick is expected to underlie all areas of the site east of its outcrop, excluding the area of opencast where it will have most likely been removed.

4.2.13 The site is shown to fall within a Coal Authority Development High Risk Area – an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.

4.2.14 A CA mining report states that:

- *The property is in the likely zone of influence from workings in 5 seams of coal at shallow to 210m depth*. This indicates recorded past workings are present at shallow depth beneath the site, and most likely relates to the Flockton Thick and underlying seams.
- *The property is not in the likely zone of influence of any present underground coal workings*.
- The property is not in an area for which the Coal Authority is determining whether to grant a licence to remove coal using underground methods.
- *Within, or within 20 meters of the boundary there are 4 mine entries.* Examination of the plan supplied by the CA shows all 4 mine entries to be on site.
- *The Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining.* This confirms the absence of any known significant geological faults below the site.
- *The property is within the boundary of an opencast site from which coal has been removed by opencast methods.*
- *There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property*.
- The property is within an area for which notices of entitlement to withdraw support were published in 1972.

4.2.15 UK Coal generally work on a five-year rolling plan updated annually in March/April. Given closure of the Denby Grange Collieries in the mid-1980s, there is no current 5 year plan, and with respect to coal beneath the proposed development, and it considered extremely unlikely that coal will be extracted from beneath the site in the foreseeable future.

4.2.16 It is our understanding that if a new colliery were ever opened, and mining were to proceed in the future, then UK Coal/The Coal Authority would be liable for damage claims arising from future mining beneath the site.

4.2.17 Immediately prior to development it would be prudent to check the above with UK Coal, but risks appear negligible.

4.2.18 Mine entry data for all 4 of the known mine entries on site was requested from the CA, however, other than the co-ordinates for each entry, no other useful information regarding target seams, capping, treatment etc is known. The mine entry datasheet is included in Appendix E.

4.2.19 The locations of the mine entries on the CA plan are shown on Drawing 2211/3 in Appendix B. Two are located in along the eastern boundary, the other two are shown in the far south-west.

4.2.20 An abandonment plan was obtained from the CA (ref. 17778) relating to the Flockton Thin seam which shows the site to lie within an area where this seam has been worked. No abandonment plans for any workings within the Flockton Thick are available. The abandonment plan is included in Appendix E.

4.2.21 Based on the above, it is considered possible that workings within both the Flockton Thick and Flockton Thin seams exist beneath the site, which could pose a risk of instability at the surface. In addition opencast mining, targeting the Flockton Thick seam, has occurred in the north-west.

4.3 Mineral safeguarded areas

4.3.1 The site is underlain by coal and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).

4.3.2 MSAs are areas of known mineral resources that are of sufficient economic or conservation value to warrant protection for generations to come. The purpose of MSAs is not to preclude automatically other forms of development, but to make sure that mineral resources are adequately and effectively considered in land-use planning decisions.

4.3.3 Specialist guidance on Mineral Safeguarding "A Guide to Mineral Safeguarding in England" has been produced by The Coal Authority and the British Geological Survey.

4.3.4 Paragraph 143 of the National Planning Policy Framework (NPPF) requires Local Authorities, when preparing Local Plans to:

- Define Minerals Safeguarding Areas and adopt appropriate policies in order that known locations of specific minerals resources of local and national importance are not needlessly sterilised by non-mineral development, whilst not creating a presumption that resources defined will be worked; and define Minerals Consultation Areas based on these Minerals Safeguarding Areas.
- Set out policies to encourage the prior extraction of minerals, where practicable and environmentally feasible, if it is necessary for non-mineral development to take place.

4.3.5 NPPF Paragraph 144 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.

4.3.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require BDW to consider the opportunity to recover (extract) the coal. Applicants submitting planning applications may need to demonstrate to the Local Authority that they will extract the coal, unless:

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

4.3.7 The viability of coal extraction at this site is considered later in this Report (Section 14.5) in light of the findings of Lithos' intrusive mining investigation, which comprised the drilling of seven rotary probeholes (see Section 7.8).

5 GROUND INVESTIGATION DESIGN

5.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	Likely backfill within the former opencast, possibly re-worked natural soils
Natural soils	Residual soils (firm gravelly clay/medium dense gravel)
Bedrock	Lower Coal Measures (mudstone, siltstone, sandstone) in the east, sandstone in the west; likely within 3m.
Mineworkings	Possible at very shallow depth (<5m) within the Flockton Thick, and at around 20m depth within the Flockton Thin.
Groundwater	Likely at depth within the bedrock.

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

Type of issue	Specific issue	Remarks
Potential on-site contamination sources	1. Made ground – opencast backfill 2. Made ground – vicinity of Working Men's Club 3. Made Ground – former allotments 4. Shallow mineworkings	1. Inorganics 2. Inorganics/organics 3. Inorganics/organics 4. Hazardous gas generation
Potential off-site contamination sources	1. Opencast & shallow mineworkings	1. Hazardous gas generation
Potential geotechnical hazards	1. Relict buried obstructions 2. Deep MG 3. Steep slopes 4. Shallow workings 5. Shafts	1. Foundations etc associated with Working Men's Club 2. Former opencast 3. Along northern and southern site boundaries 4. Within the Flockton Thick & Thin seams 5. CA show 4 shafts on site
Other potential constraints	1. Overhead utilities	1. Run through the centre of the site

5.2 Preliminary conceptual site model

5.2.1 A preliminary conceptual site model, presented as Drawing 2211/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 5.1 inclusive of this report. Potential pollutant linkages are shown on the preliminary conceptual site model.

5.2.2 The most significant sources of contamination include any backfill within the former opencast and made ground associated with the working men's club in the south-east. The opencast and any shallow mineworkings are also a potential source of hazardous gas.

5.2.3 Receptors include site workers, future residents, vegetation and the underlying Secondary A Aquifer.

5.3 Ground investigation design & strategy

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

Exploratory holes	Purpose
TPs 01 to 14	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of made ground • Nature, degree and extent of contamination • Proportion of undesirable elements eg biodegradable matter, foundations etc • Suitability of the ground for founding structures and highways
TPs 02 & 11	To identify the location of the Flockton Thick and Tankersley Ironstone outcrops
TPs 04 to 08	To identify the depth, nature and lateral extent of the any made ground within the former opencast
TPs 01, 03, 09, 11 & 12.	To determine whether soakaways could be utilised for storm water drainage
TTs 01 & 02	To attempt to locate the mine shafts within the east of the site
PHs 01 to 06	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings
PH04	To ascertain the depth to bedrock within the former opencast
PHs 01A to 06A	To install monitoring wells across the site in order to monitor for hazardous gas and any shallow groundwater.

5.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site and to target potential areas of interest identified in Section 5.1 above. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

5.3.3 The number of representative samples taken will be reflective of the geological complexity actually encountered.

6 FIELDWORK

6.1 Objectives

6.1.1 The original investigation strategy is outlined in Section 5.3 above.

6.1.2 The additional exploratory holes listed below were advanced in light of ground conditions actually encountered.

Exploratory holes	Purpose
TP 15	To gain better coverage in the east of the site
PH07	To target the position of Flockton Seam outcrop

6.2 Exploratory hole location constraints

6.2.1 No access was available in the far south-west corner as this area is currently in use by adjacent properties as rear gardens. Two of the CA recorded mine entries are shown in this area.

6.2.2 An easement was given to the overhead powerlines.

6.2.3 No access was available in sections of the south due to dense woodland and undergrowth.

6.2.4 The Working Men's Club is still in use and so intrusive investigation could take place within the footprint of the building or the surrounding car park; this is to be done at later date.

6.3 Scope of works

6.3.1 Fieldwork was supervised by Lithos on the 28th & 29th September and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 1 to 15	1.2m to 3.4m	Vane tests in cohesive soils
Soakaway tests	Within TPs 01, 02, 09, 11 & 12	0.8m to 2.4m	
Rotary open-hole probeholes	PHs 01 to 07	3.0m to 33.0m	
Rotary open-hole probeholes	PHs 01A to 06A		Drilled adjacent to corresponding probeholes to allow installation of monitoring wells

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

6.3.3 Exploratory hole logs are presented in Appendices F & G to this Report. These logs include details of the:

- Samples taken
- Descriptions of the solid strata, and any groundwater encountered.
- Results of the in-situ testing
- The monitoring wells installed

6.3.4 Exploratory hole locations are shown on Drawing 2211/6A presented in Appendix B.

7 GROUND CONDITIONS

7.1 General

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

7.2 Made ground

7.2.1 Made ground was encountered within the opencast backfill.

7.2.2 Four trial pits were excavated within the area of opencast (TPs 04 to 07), none of which bottomed out the opencast backfill within 3.4m depth. TP08 was excavated towards the edge of the opencast and encountered opencast backfill to 1.6m, with residual soils below.

7.2.3 Materials encountered comprised clayey gravel of mudstone and occasional coal, or firm clay with gravel of mudstone and coal (Opencast Backfill). This material is likely to be of variable strength. In the absence of borehole SPT tests, it is tentatively estimated to vary between loose and medium dense. Given the likely age of the opencast backfill, it is expected that much of any self-weight settlement will have already occurred, and therefore deeper backfill is likely to be medium dense.

7.2.4 One probehole (PH04) was drilled within the opencast and encountered bedrock at 6.7m.

7.3 Obstructions

7.3.1 No intrusive investigation has taken place within the immediate vicinity of the Working Men's Club Building. However, a supplementary investigation of this area is recommended once demolition has taken place, during which trenching across the building's footprint should be undertaken assess the nature and depth of any associated obstructions.

7.4 Natural ground

7.4.1 Natural ground was encountered in all exploratory holes beyond the opencast backfill, and typically comprised topsoil (300mm), over firm clay with gravel of sandstone and mudstone, often with clayey gravel and cobble of mudstone/sandstone below.

7.4.2 Wet and softened clay was encountered within TP01 from 1.6m to 3.0m; a water inflow was noted in this trial pit at 2.5m.

7.4.3 Sandstone bedrock was encountered in TPs 9, 12 and 14 at depths between 1.5m, and 1.6m. In the far east of the site very weak mudstone bedrock was encountered at respective depths of 0.9m (TTs 16 & 17), and 1.6m (TP15).

7.4.4 Bedrock was encountered in all probeholes from depths of between 1.0m and 3.1m beyond the area of opencast.

7.4.5 TP02 was positioned along the projected line of the Flockton Thick coal seam outcrop and encountered weathered coal from 1.4m to 1.8m.

7.4.6 A summary of ground conditions encountered within the trial pits is provided in the table below.

Summary of ground conditions, Flockton Green Working Men's Club

Hole	Final depth (m)	Depth to base of (m):				Depth to Bedrock (m)
		Topsoil	Opencast Backfill	Cohesive Residual Soil	Granular Residual Soil	
TP01	3.1	0.3		3.0*	>3.1	
TP02	2.3	0.4		1.0	>2.3^	
TP03	1.7	0.3			>1.7	
TP04	3.4	0.2	>3.4			
TP05	3.2	0.2	>3.2			
TP06	2.8	0.2	>2.8			
TP07	3.2	0.2	>3.2			
TP08	1.8	0.3	1.6	>1.8		
TP09	1.8	0.3			1.5	1.5
TP10	1.2	0.3			>1.2	
TP11	2.5	0.3		2.1	>2.5	
TP12	1.8	0.4		1.6		1.6
TP13	2.1	0.4		1.9	>2.1	
TP14	1.7	0.3		1.5		1.5
TP15	2.2	0.2		1.6		1.6
TT16	2.9	0.2		0.9		0.9
TT17	2.2	0.2		0.9		0.9

* *clay was soft from1.6m to 3.0m*
^ *weathered coal (Flockton Thick) from1.4m to 1.8m*

7.5 Visual & olfactory evidence of organic contamination

7.5.1 No visual or olfactory evidence of organic contamination was noted in any of the trial pits.

7.6 Groundwater

7.6.1 A water inflow was encountered within TP01 at 2.5m. The surrounding clay was wet and soft from 1.6m to 3.0m.

7.6.2 With the exception of TP01, groundwater was not encountered within the trial pits.

7.6.3 Water levels have been dipped within PHs 01A to 06A on one occasion to date. The results are summarised in the table below:

Hole ID	Response zone (depth range & strata)	Standing water level (m bgl)
PH01A	2.0m to 4.0m Mudstone & Sandstone	3.6
PH02A		Dry
PH03A		Dry
PH04A		Dry
PH05A		3.6
PH06A		Dry

7.7 Stability

7.7.1 Stability of excavations within natural ground was generally good.

7.7.2 Some spalling and collapse occurred when excavating through made ground within the former opencast.

7.8 Mining investigation

7.8.1 The preliminary investigation (see Section 4.2) identified the following information:

- The Flockton Thick outcrops in the west of the site, trending north-south
- The next shallowest seam is the Flockton Thin at around 14m depth with the First Brown Metal at around 31m depth
- General strata dip is to the east
- Four mine entries are present on site
- A former opencast is present in the north-west where it is understood the Flockton Thick was extracted
- Abandonment plans obtained from the CA indicate workings within the Flockton Thin across the site

7.8.2 Trial pitting has confirmed the presence of opencast backfill in the north-west. PH04 indicates that this backfill is around 7m deep.

7.8.3 Trenching was carried out in the east (TTs 16 & 17) within the vicinity of two mine entries shown on CA plans. Neither mine entry was located; areas excavated as part of the search are shown on Drawing 2211/6A in Appendix B. No access was available in the south-west where two other mine entries are shown.

7.8.4 The outcrop of the Flockton Thick was identified in TP02 from 1.4m to 1.8m as weathered coal and also within PH07 from 1.3m to 1.5m.

7.8.5 Seven probeholes were drilled to determine whether the site is underlain by unrecorded shallow mine workings.

7.8.6 Those probeholes that intercepted the **Flockton Thick** are summarised below.

Hole ID	Final depth (m)	Depth to rockhead (m)	Depth to base of Flockton Thick (m)	Thickness of coal (m)	Evidence of workings?	10x competent cover present above coal/workings?
PH01	18.0	1.3	9.5	-	Yes, 1.5m of broken ground	No
PH02	15.0	1.3	9.5	-	Yes, void 8.0 to 9.5m	No
PH03	15.0	1.0	11.5	-	Yes, 5m of broken ground	No
PH05	33.0	1.4	7.8	1.5	No	No
PH07	3.0	1.3	1.3	0.2	No	No

7.8.7 Those probeholes that intercepted the **Flockton Thin** are summarised below

Hole ID	Final depth (m)	Depth to rockhead (m)	Depth to base of Flockton Thin (m)	Thickness of coal (m)		10x competent cover present above coal/workings?
PH04	27.0	6.7	21.7	0.7	No	Yes
PH05	33.0	1.4	23.07	0.7	No	Yes
PH06	18.0	1.5	15.6	-	Yes, void 15.1 to 15.6m	Yes

7.8.8 Probeholes to the east of the Flockton Thick outcrop were typically taken to the depth of the Flockton Thick coal, plus a nominal depth below to prove solid ground beneath the seam.

7.8.9 Workings within the Flockton Thick were encountered within PHs 01, 02 & 03 from depths of between 6.5m and 11.5m.

7.8.10 PH05, advanced in the centre-south, encountered the Flockton Thick from 6.3m to 7.8m and the Flockton Thin from 23.0m to 23.7m. This probehole was advanced to 33m depth; the First Brown Metal seam was not encountered.

7.8.11 PH06 was advanced to the west of the Flockton Thick outcrop to target the Flockton Thin at, what should be, its shallowest point on site. The Flockton Thin seam was found to be worked from 15.1m to 15.6m.

7.8.12 CIRIA ('Construction over abandoned mine workings', 1989) suggest a thickness of solid rock through which a void can migrate as 7h to 10h above the roof of the workings, where h is the height of the workings (generally assumed to be similar to the seam thickness). The lower end of this range (7h) is generally only applicable where the overlying strata are predominantly thickly bedded sandstones, which is not typical of this site, therefore the 10h rule should be used.

7.8.13 Assuming a maximum seam thickness for the Flockton Thick of 1.5m (therefore 10h = 15m), it can be concluded that there is insufficient competent cover above workings identified within this seam in PHs 01 to 03. No workings were encountered in PH05, but this is probably due to a solid 'pillar' of coal rather and workings are considered quite likely in this area.

7.8.14 Consequently, at this stage, it would be prudent to assume that underground workings exist within the Flockton Thick across the entire site east of its outcrop, excluding the area of opencast (approximately 75% of the site area). Further drilling could be commissioned to reduce uncertainty regarding the actual lateral extent of workings in the Flockton Thick.

7.8.15 PH05 suggests that the thickness of rock between the Flockton Thick and underlying Flockton Thin is around 17m. Assuming a maximum thickness of 0.7m, it can be seen that there is sufficient competent cover between workings within the Flockton Thin and the overlying Flockton Thick.

7.8.16 In addition, there is sufficient competent cover above the Flockton Thin at its shallowest point in the west where it lies at 13.6m below rockhead; and below the former opencast where it lies 14.3m below rockhead at the base of the backfill.

7.8.17 Consequently, risks associated with workings within the Flockton Thin need not be considered any further.

7.9 Revised conceptual ground model (ground conditions)

7.9.1 The Preliminary Conceptual Site Model has been revised in light of data obtained during the ground investigation, most notably with respect to:

- The strength, nature and depth of underlying natural strata
- The presence of coal and shallow workings
- The nature and distribution of contamination (based on visual/olfactory evidence only)

7.9.2 The revised Conceptual Site Model is presented in Appendix B, as Drawing 2211/7. Geological cross sections are presented in Appendix H.

7.9.3 Further refinement of the Conceptual Site Model is presented in Section 10.2, where the results of laboratory testing for contaminants have been considered.

8 SOAKAWAY TEST RESULTS

8.1 General notes about soakaways, including their location, design, and Lithos' test methodology are presented in Appendix A.

8.2 UK guidance does not explicitly state that soakaways cannot be constructed in made ground, but such construction is not generally considered good practice. However, UK guidance does state that the soakaways should not be built where the presence of contamination could result in pollution of groundwater. Furthermore, there may be a risk of settlement caused by wash out of fine soil particles if soakaway waters are allowed to infiltrate into made ground.

8.3 Given water table depth and topography it is considered possible that springs will appear down-gradient. If springs are possible, soakaways should be discounted.

8.4 Five soakaway tests were carried out in general accordance with BRE Digest 365[1] "Soakaway Design". The locations of the soakaways are shown on Drawing 2211/6A presented in Appendix B to this report.

8.5 Infiltration rates for each soakaway test have been calculated (where possible) in accordance with BRE Digest 365. This design takes into account the time for water level in to fall from 75% to 25% of its effective depth. The effective depth is the difference between the starting water level and the soakaway pit base depth.

8.6 Drainage of water during tests in TPs 02, 03 & 11 was considered too slow to enable calculation of infiltrations rates.

[1] BRE Digest 365. Soakaway Design (1991).

8.7 Where the water level did not quite reach the 25% effective depth, the data has been interpolated in order to derive a representative infiltration rate; this was the case for the test in TP12.

8.8 Calculated infiltration rates for each successful test are summarised in the Table below, and copies of the associated calculations are presented in Appendix L to this report.

Soakaway	Stratum	Infiltration rate (m/s)	Remarks
TP02	1.3m to 2.2m (Granular Residual Soil and Coal)	N/A	Still > 75% full after 3.5 hours
TP03	0.8m to 1.7m (Granular Residual Soil)	N/A	Still c. 75% full after 4.0 hours
TP09	0.9m to 1.9m (Granular Residual Soil & Sandstone Bedrock)	1.12×10^{-5}	
TP11	1.6m to 2.4m (Cohesive & Granular Residual soils)	N/A	Still > 75% full after 4.0 hours
TP12	0.9m to 1.8m (Cohesive Residual Soil & Sandstone Bedrock)	7.66×10^{-6}	Data interpolated

8.9 Given that 3 of the 5 tests yielded unsuccessful results, it is considered unlikely that soakaways will provide a suitable drainage solution at this site.

8.10 However, it should be noted that the two soakaway tests which yielded successful results (TPs 09 & 12), both encountered Sandstone bedrock at the base of the trial pit.

8.11 Soakaway percolation in bedrock is predominately via joints within the rock mass. The relatively small-scale soakaway test pits may not intercept such joints and this can result in variable test results. It is possible that the larger surface area associated with soakaway construction during development will intercept such joints; although this cannot be guaranteed.

8.12 Increasing the soakaway effective depth might offer a solution, but consideration should be given to the cost of excavation (especially given the strong nature of the bedrock).

8.13 Consideration could therefore be given to additional testing within the bedrock strata to further assess the suitability of soakaways as a drainage solution; however at this stage, an allowance for water balancing should be made.

8.14 Drainage solutions are discussed further in Section 13.8.

9 CONTAMINATION (ANALYSIS)

9.1 General

9.1.1 The north-west of the site was formerly part of an opencast pit; made ground encountered within this area comprises re-worked natural soils. In addition, no significant made ground was encountered in the south-west of the site where allotments were formerly present.

9.1.2 Consequently the site's former usage is considered unlikely to have given rise to any significant ground contamination. However, samples of the made ground from within the former opencast have been tested for potential contaminants and samples of topsoil have been recovered in order to confirm its suitability for re-use.

9.1.3 In the context of risks to human health associated with residential redevelopment, the Tier 1 Soil Screening Values referenced in this report have been derived via the CLEA default conceptual site model (CSM) used for generating SGVs, but amended, where appropriate, to be more specific to redevelopment within the planning process.

9.1.4 Where available, Category 4 Screening Levels (C4SL) have also been referenced.

9.1.5 This site is essentially greenfield and no evidence of significant contamination was noted. Consequently, the Tier 1 Values used in this report have been derived with reference to a CSM that assumes a residential with gardens end use, with no clean soil cover will be placed in gardens/landscaped areas (Lithos Scenario A).

9.1.6 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

9.2 Testing scheduled

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

Type of sample	No. of samples	Determinands
Made ground	6	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) Asbestos ID TOC Speciated Poly Aromatic Hydrocarbons (PAH)
Topsoil	6	

9.3 Soil contamination results

9.3.1 The soil contamination test results are summarised in the Tables on page 17.

9.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix I to this report.

Summary of degree of soils contamination (inorganics)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with garden**s end-use.												
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Zn $	PAH		Asbestos I.D.
														B(a)P ∞	Naphthalene	
				37	5	26	3000	200	200	169	127	350	200	5	4	
TP01	0.1	Topsoil	6.8	36	<1	<1	23	49	74	<1	27	<3	150	<0.1	<0.1	N.D.
TP03	0.1	Topsoil	6	25	<1	<1	23	37	65	<1	25	<3	110	<0.1	<0.1	N.D.
TP05	0.1	Topsoil	6.2	22	<1	<1	23	33	56	<1	29	<3	100	<0.1	<0.1	N.D.
TP11	0.1	Topsoil	6.4	**46**	<1	<1	25	60	110	<1	39	<3	130	<0.1	<0.1	N.D.
TP12	0.1	Topsoil	6.9	**49**	<1	<1	25	73	110	<1	34	<3	180	<0.1	<0.1	N.D.
TP14	0.1	Topsoil	5.6	13	<1	<1	18	24	32	<1	21	<3	110	<0.1	<0.1	N.D.
TP04	1.2	Opencast Backfill	7.5	29	<1	<1	16	72	65	<1	90	<3	**210**	<0.1	<0.1	N.D.
TP04	3.2	Opencast Backfill	6.7	6	<1	<1	24	38	33	<1	45	<3	120	<0.1	<0.1	N.D.
TP06	1	Opencast Backfill	7.5	12	<1	<1	23	50	59	<1	58	<3	130	<0.1	<0.1	N.D.
TP07	1.5	Opencast Backfill	7.1	21	<1	<1	17	57	24	<1	42	<3	49	<0.1	<0.1	N.D.
TP08	0.6	Opencast Backfill	6.9	16	<1	<1	22	42	33	<1	45	<3	110	<0.1	<0.1	N.D.
TP08	0.8	Opencast Backfill	7.1	18	<1	<1	19	39	32	<1	46	<3	110	<0.1	<0.1	N.D.

Key	
36	Parameter tested for and found to be in excess of Tier 1 concentration.
179	Parameter tested for and found to be > 5 x Tier 1 concentration.
12	Parameter tested for but not found to be in excess of Tier 1 concentration.
	Parameter not tested for.
♣	Tier 1 Value is pH dependent.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.

Source of guidance trigger level	
With the exception of those annotated with one of the symbols below (∞, $, ~), all Soil Screening Values in brackets above have been derived using CLEA v1.06.	
∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
$	Ministry of Agriculture, Fisheries & Food. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
~	Engineering judgement (Lithos). Boron is a phytotoxic, although most phytotoxic compounds can pose a risk to human health if sufficient concentrations are present. However, plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.

Inorganic determinands

9.3.3 One of the six samples of Opencast Backfill tested yielded a slightly elevated Zinc (210mg/kg cf. Lithos' Tier 1 value of 200mg/kg). Two of the six samples of Topsoil tested contained slightly elevated Arsenic (46 & 49mg/kg cf. Lithos' Tier 1 value of 37mg/kg).

9.3.4 No other inorganic contamination was encountered.

9.3.5 Statistical analysis of 6 results of Topsoil and Opencast Backfill has been carried out in general accordance with the methods outlined in "Guidance on Comparing Soil Contamination Data with a Critical Concentration", CIEH/CL:AIRE (2008) (see comments in Appendix A, Contamination Testing) and the results are summarised below.

Stratum	No. of samples	US_{95} values for contaminants that have yielded one or more Tier 1 exceedances for a given made ground type	
		Arsenic (37)	Zinc (200)
Opencast Backfill	6	n/a-	161
Topsoil	6	**44**	n/a

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

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

9.3.6 Where there is 95% confidence or greater that the true mean concentration of a given contaminant within a particular soil type is less than the Tier 1 value, it can be concluded that the contaminant does not pose a significant risk to human health.

9.3.7 No outliers were detected in either of the ground types.

9.3.8 This statistical analysis indicates that the upper 95th percentile bound value (US_{95}) for arsenic in Topsoil is slightly elevated compared to Lithos' Tier 1 value of 37mg/kg.

9.3.9 The US_{95} for Zinc is below Lithos' Tier 1 value of 200mg/kg; the marginal exceedance of 210mg/kg in TP04 at 1.2m is therefore not considered significant.

Asbestos

9.3.10 No asbestos fibres were identified in any of the 12 samples screened.

Organic determinands - Poly Aromatic Hydrocarbons (PAH)

9.3.11 Speciated PAH analysis has been undertaken in order to determine concentrations of the key "marker" compounds: benzo(a)pyrene (considered the most toxic of the PAHs); and naphthalene (the most mobile and volatile of the PAHs).

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

10 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

10.1 Summary of significant contamination

10.1.1 Topsoil, typically 300mm thick underlies the majority of the site. Testing has yielded marginally elevated concentrations of arsenic which are not considered to be of great concern given the site's history and the absence of any other contaminants, or made ground.

10.1.2 Consideration could be given to further sampling, with subsequent bioaccessibility testing, but this is not considered essential.

10.1.3 No access was available within the vicinity of the Working Men's Club and car park and the possibility of localised contamination in this area cannot be entirely discounted at this stage. A post-demolition investigation has been recommended.

10.2 Revised conceptual ground model (contamination)

10.2.1 The Preliminary Conceptual Site Model has been amended in light of data obtained during the ground investigation, most notably with respect to the distribution of made ground and contaminants.

10.2.2 A revised Conceptual Site Model is presented as Drawing 2211/7 in Appendix B.

10.3 Waste classification

10.3.1 Some excess arisings may be generated by excavations for foundations, sewers etc.

10.3.2 Classification of soils as inert, non-hazardous or hazardous should be undertaken in accordance with the Environment Agency's Technical Guidance WM3[2], and is quite a complex process (as of 1st July 2015 WM2 was archived, and replaced by technical guidance WM3). However, all soil arisings generated by excavations at this site are likely to be classified inert.

10.3.3 Off-site disposal to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[3] any excess natural soil arisings should be suitable for Direct Transfer to another development site, for use either as clean cover material, or bulk fill for use, without the need for waste legislation to be applied.

[2] Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015
[3] The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

11 HAZARDOUS GAS

11.1 General

11.1.1 Consideration of the conceptual site model and potential linkages has enabled a preliminary qualitative assessment of risks associated with gas:-

Source	Receptors	Hazard	Pathway	Initial risk
On-site and adjacent opencast backfill	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Very Low**: made ground essentially re-worked natural
	Buildings	Explosion		
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Very Low**: no significant thickness of low permeability drift or bedrock above workings. Grouting is anticipated.
	Buildings	Explosion		

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

11.1.3 The generation potential of the gas source was initially considered to be Very Low and this has been confirmed by the monitoring results obtained. Consequently, in accordance with CIRIA Report C665, given the proposed residential end use, 6 visits have been scheduled over a 3 month period.

11.2 Scope of works

11.2.1 To date, the wells have been monitored on one occasion for groundwater levels and soils-gases, and the results are presented in Appendix K.

11.2.2 A standard procedure was followed, in accordance with CIRIA guidance:

- Ambient oxygen concentration
- Atmospheric temperature & pressure
- Methane, oxygen and carbon dioxide concentrations and flow rates using a Gas Data LMSx infra-red gas analyser
- Standing water level using a dipmeter
- Ambient oxygen concentration (check for instrument drift)

11.3 Monitoring results

11.3.1 The results of the monitoring completed to date are summarised below.

Monitoring well	Response zone	Peak Methane (% v/v)	Peak Carbon Dioxide (% v/v)	Steady flow rate (litre/hour)
PH01A	2.0m to 4.0m (Sandstone/Mudstone)	0.0	2.0	0.0
PH02A		0.0	2.6	0.0
PH03A		0.2	0.6	0.0
PH04A		0.0	2.1	0.0
PH05A		0.0	4.3	0.0
PH06A		0.1	3.3	0.0

11.4 Discussion

11.4.1 Generic Notes outlining how monitoring results are included as Generic Note 05 in Appendix A.

11.4.2 A hazardous gas risk assessment incorporating all of the results will be issued on completion of monitoring in January 2015.

12 GEOTECHNICAL TESTING

12.1 General

12.1.1 A total of 9 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

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

12.2 Atterberg limits

12.2.1 The plasticity indices of 5 samples of cohesive soil have been determined; results are summarised below.

Soil type	Range of Plasticity Indices* (average)	Shrinkability
Weathered Coal Measures	21-37 (28)	Medium

* Modified where appropriate in accordance with revised Chapter 4.2 of the NHBC Standards.

Note. The term Shrinkability is equivalent to the term Volume Change Potential used in Chapter 4.2.

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

12.3 Soluble sulphate and pH

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

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

12.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 9 samples were determined. The highest soluble sulphate concentration was 53mg/l and the lowest pH was 6.4.

12.3.4 As pH values were all above 5.5, concentrations of chloride and nitrate are considered insignificant.

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

12.4 Undrained shear strength testing

Hand shear vane testing

12.4.1 Hand shear vane testing was undertaken within trial pits in-situ to around 1.2m depth and from larger blocks of excavated clay below that depth.

12.4.2 Soft clay was encountered in TP01 from 1.6m to 3.0m, with a water inflow at 2.5m. The clay in this location was noted to be wet; it is likely that localised groundwater flow within the vicinity of TP01 has softened the clay.

12.4.3 With the exception of TP01, hand vane readings ranged from 60kPa to 90kPa, confirming field observations that the Cohesive Residual Soil is generally firm to stiff.

13 GEOTECHNICAL ISSUES

13.1 Conceptual site model

13.1.1 Ground conditions generally comprise firm clay, with gravel of sandstone and mudstone, often with clayey gravel and cobble of mudstone/sandstone below.

13.1.2 Sandstone bedrock was encountered in TPs 9, 12 & 14 from depths between 1.5m, and 1.6m. In the far east of the site very weak mudstone bedrock was encountered from respective depths of 0.9m (TTs 16 & 17), and 1.6m (TP15).

13.1.3 Bedrock was encountered in all probeholes from depths of between 1.0m and 3.1m outside of the opencast.

13.1.4 One probehole (PH04) was drilled within the opencast and encountered bedrock at 6.7m.

13.1.5 TP02 was positioned along the conjectured line of the Flockton Thick coal seam outcrop and encountered weathered coal from 1.4m to 1.8m.

13.2 Mining & quarrying

13.2.1 This site is located within a Coal Mining Development High Risk Area.

13.2.2 A former opencast is present in the north-west; bedrock lies at around 7m depth beneath backfill material.

13.2.3 Shallow mineworkings were encountered across the east of the site within the Flockton Thick. Mitigation against the risk of subsidence associated with the shallow mineworkings will likely be required in all plots east of the Flockton Thick outcrop, excluding those within the former opencast; around 75% of the total site area (c. 2 ha). This will likely involve consolidation by drilling and grouting. The area requiring mitigation measures is shown on Drawing 2211/8 in Appendix B.

13.2.4 Based on the findings of this investigation and the anticipated nature of the workings, it is considered that the necessary consolidation (grouting) would require drilling holes on a 3m grid. A viscous grout composed of appropriate proportions of OPC, PFA, sand or pea gravel would then be injected into the workings via these holes.

13.2.5 Further holes would need to be drilled in areas of high grout take (to confirm filling of void space), and in areas where several adjacent holes encountered solid coal (to confirm that the local area is underlain by no workings, rather than pillars).

13.2.6 Drilling and grouting operations should be carried out with engineering supervision, and be undertaken in accordance with a revision of Lithos' "General Specification for the Treatment of Shallow Mineworkings" tailored to the site-specifics.

13.2.7 Given the presence of the Flockton Thick outcrop on site and its shallow depth across the majority of the site, it is possible that bell pits may be present, and consideration should be given to a geophysical survey, although success would be dependent on the "contrast" between shaft backfill and the surrounding ground (i.e. the survey is likely to be more successful if shaft backfill is significantly different material or less dense than the surrounding ground). Follow-up intrusive investigation (pitting) would be recommended to determine the cause of any anomalies identified by the geophysics.

13.2.8 Whilst the Coal Authority (and NHBC) discourage development over or adjacent to shafts, such features are typically of less concern where they only extend to relatively shallow seams. Consequently, they are not expected to result in the need for "no-build" zones, but any found will require grouting, and any plots built over or adjacent to mine entries will require appropriate foundation design.

13.2.9 None of the four mine entries shown on CA plans have been identified to date, these are likely to refer to shafts rather than bell pits. Any shafts encountered during the development of this site should be made safe by grouting the full depth of backfill in accordance with Lithos' *General Specification for the Treatment of Mine Shafts*.

13.2.10 Proposals to treat the mineworkings and shafts will need to be discussed with both the Local Authority (most notably Highways), the Coal Authority and NHBC well in advance of starting works on site.

13.2.11 Build over deeper mine entries is not recommended, not least because of subsequent conveyancing issues, but also abnormal foundation costs etc. NHBC advice is always to re-plan the development to avoid siting plots over, or within 10m of, a shaft.

13.2.12 The Coal Authority also advises against building over shafts. However, the CA have indicated that houses can, in principal, be built over a shaft, subject to:

- the absence restrictive covenant in the Title Deeds for the land.
- appropriate shaft treatment (typically grouting of full depth, and construction of a suitable reinforced concrete cap at rockhead);
- appropriate foundation design, including the incorporation of gas protection measures.

13.2.13 BDW would need to submit treatment designs to the Coal Authority, and the CA would need to issue formal approval.

13.2.14 The CA retain 'ownership' of the shaft, and even after treatment the shaft will appear on future mining reports. Under the terms of the necessary CA Permit, the Consultant\Developer is responsible for any problems that occur within 12 years of construction. Thereafter the CA become liable; hence the CA will seek a robust shaft treatment.

13.2.15 Shaft treatment is less onerous where the mine entry is located in garden or landscaped areas; often only a suitable cap will be necessary (i.e. it will not usually necessary to grout the shaft backfill).

13.2.16 The foundations of any dwellings in the vicinity of the shaft should be taken below a line drawn at 45° from the intersection of a shaft with rockhead.

13.3 Site regrade

13.3.1 The site generally slopes downwards from north to south and therefore some local regrading is anticipated beneath plot footprints to create 'level' surfaces to build off.

13.3.2 A retaining wall, approximately 3m high, is present along the southern boundary in the far south-east; foundations for plots adjacent will be required to extend below a 45° line drawn upwards from the base of the wall. A structural survey of this retaining wall might be prudent.

13.3.3 It is recommended that proposed plots should not be placed within 5m of the top of the steeply sloping land along the southern boundary.

13.4 Foundation recommendations

General

13.4.1 It is understood that consideration is being given to redevelopment of the site with 92 domestic dwellings, associated gardens, POS and adoptable roads and sewers.

13.4.2 Foundation recommendations assume that development will be two or three storey construction and that line loads will not exceed 90kN/m run. If this is not the case significant alteration to these recommendations will be required.

13.4.3 We have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation. Any digital terrain modelling undertaken, or commissioned by BDW should consider implications for the foundation recommendations outlined below.

13.4.4 Made ground is not considered a suitable foundation material and foundations should therefore be taken through these materials into underlying natural strata of adequate bearing capacity.

13.4.5 Sub-surface concrete should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.

13.4.6 Two main foundation solutions are considered likely to be most appropriate for proposed dwellings at this site:

- Strips/trench fill for plots located **beyond** the opencast backfill; and
- Piles for plots located **within** the opencast backfill

13.4.7 Any plot layout for this site should take account of the known high walls. Most notably, the foundations of plots just *beyond* the area of opencast backfill would ideally be placed below a line drawn up at 45° from the base of the high wall. Assuming a quarry depth of 7m and sub-vertical high walls this would effectively result in a sterile zone about 7m wide. However, a slimmer sterile zone of 3m should suffice, subject to NHBC approval, provided plots between 3m and 7m from the high wall are founded entirely in rock. This is likely to be the case for Plots 38, 49, 57 & 60.

13.4.8 Piles for plots that only extend 1m or 2m over a steep high wall may encounter problems with socketing.

13.4.9 Vibratory ground improvement might provide an alternative option to piles, but only for plots located wholly within the opencast backfill, and probably some distance from high walls. Further advice should be sought from a specialist vibro contractor.

Strip/trench fill footings

13.4.10 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses located **beyond** the opencast backfill. This solution is viable where the made ground is less than about 2.5m thick, and firm clay/medium dense gravel (residual soil) or competent rock is the founding material.

13.4.11 Reinforcement, as a precaution against differential settlement, is recommended only where foundation excavations encounter significant lateral and vertical variations in strata. One layer of B385 mesh placed 75mm above the base of the footing is likely to provide suitable reinforcement, but further advice should be sought from the Structural Engineer.

13.4.12 Where the existing working men's club building is to be demolished, all concrete slabs and service ducts will require breaking out prior to re-development. However, relict foundations could probably be left in-situ and an allowance made for local breaking out where these conflict with new foundations.

13.4.13 Foundations of plots placed over relict foundations should be taken to greater depth than the relict foundations and into natural ground of adequate bearing capacity.

13.4.14 Foundations will be required to be placed below a line drawn up at 45° from the base of any service or similar excavation.

13.4.15 Overdeepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.

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

13.4.17 Foundations for plots adjacent to the retaining wall in south will be required to extend below a 45° line drawn upwards from the base of the wall.

Granular soils (completely weathered bedrock)

13.4.18 The weathered in-situ sandstone (sand, gravel and cobbles) is assumed to have a relative density of at least medium dense (in accordance with BS5930:1991).

13.4.19 A safe bearing capacity of around 170kPa (130kPa at 0.45m depth) can be assumed if the following are true:

- A maximum foundation line load of 90kN/m run
- A foundation length of 10m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.6m depth
- An angle of shearing resistance of ϕ=33° for the granular deposits

13.4.20 Assuming the foundation geometry detailed above, minimal settlements would be anticipated.

13.4.21 In accordance with NHBC Standards, a minimum founding depth of 450mm (due to potential frost susceptibility) is required in granular soils. This depth should be taken from finished ground level to the underside of the footing. If finished ground level is to be above existing ground level then the foundation excavation simply needs to ensure that there is sufficient depth of excavation to allow casting of the footing entirely within natural ground (not made ground or topsoil).

13.4.22 However, if the excavation is dug from original ground level in cold conditions when freezing is expected, then foundation depth should be taken from the existing, not finished, ground level.

13.4.23 It should also be noted that the footing may require deepening or stepping in order to allow plot drainage to exit the plot footprint (either over or under the footing).

Clay/cohesive soils

13.4.24 A safe bearing capacity of around 160kPa can be assumed if the following are true

- A maximum foundation line load of 90kN/m run
- A foundation length of 10m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.9m depth
- An undrained shear strength of 60kPa for the firm clay (typical minimum recorded on site)

13.4.25 Assuming the foundation geometry detailed above minimal settlements would be anticipated.

13.4.26 Clay classification tests suggest that natural cohesive soils at the site should be regarded as being of medium shrinkability. A minimum founding depth of 900mm is therefore recommended for all soils on the site where strip footings are proposed.

13.4.27 In accordance with NHBC Standards, founding depths in cohesive soils should be taken from original or finished ground level, whichever is the lower, to the underside of the footing.

13.4.28 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 50% of the site may be affected by trees.

Sandstone & Mudstone bedrock

13.4.29 The sandstone & mudstone bedrock is generally considered to have a safe bearing capacity of at least 250kPa and minimal settlements would be anticipated.

13.4.30 Where rock is encountered at shallow depth foundations should be placed entirely on rock and not partially on rock and partially on soil. This may, depending on surface gradient, necessitate significant overdeepening of foundations.

Coal

13.4.31 Some excavations for foundations in the west of the site may come into contact with coal. Care should be taken not to unnecessarily overdeepen foundations, in order to minimise the chance of encountering coal.

13.4.32 Where foundation excavations do come into contact with coal, the foundation should be taken through the coal seam, into underlying natural in-situ strata of adequate bearing. The full thickness of coal should then be sealed with concrete to create a trench fill foundation. To prevent the ingress of air, the mass concrete fill should be placed as soon as possible after exposing the seam.

13.4.33 By virtue of the provisions of the Coal Industry Act 1994 interests in unworked coal and coal mines previously vested in the British Coal Corporation are now vested in the Coal Authority. The developer will need to contact the Coal Authority to dig or carry away such coal as they encounter in connection with redevelopment of the site (this is often referred to as incidental coal).

Piled foundations

13.4.34 Piled foundations will be required for plots proposed **within** are of the former opencast. The following general comments relating to piling are provided for guidance, and further advice should be sought from a specialist-piling contractor.

13.4.35 Piled foundations should extend into the underlying bedrock. The safe working load that may be supported on a pile is dependent on the pile diameter, its founding depth and the method of installation.

13.4.36 Boreholes indicate that, within the former opencast, competent sandstone/mudstone bedrock lies at around 7m below current ground levels.

13.4.37 Plots in the vicinity of steep high walls should ideally be set-back at least 3m from the high wall and founded entirely on bedrock, or extend over the high wall by between 3m and 6m. Piles for plots that only extend 1m or 2m over a steep high wall are more likely to encounter problems with socketing.

13.4.38 As piles would be founded in bedrock, they will be essentially end-bearing.

13.4.39 Consequently, preliminary estimates for pile lengths in the order of 8m.

13.4.40 Given the presence of cohesive made ground (opencast backfill), it is essential that pile design allows for downdrag (negative skin friction).

13.4.41 It is recommended that flexible service connections are used on this site, especially where they enter the buildings, in order to avoid any possible damage due to self-settlement of the weak strata once the site is developed.

13.4.42 It should be noted that driven piles can induce some ground vibration. Assessment of any vibration risk to adjacent structures and/or existing site features should be undertaken by pile designer.

13.4.43 Should any impenetrable shallow obstructions be encountered, i.e. boulders, they should either be grubbed-up, or alternatively the piling layout could be re-designed (although might also require design of foundations able to span and/or cantilever as necessary).

13.4.44 New houses can be built off ring beams designed to span the piles. In order to bond them to the piles, the tops of the piles must be broken out to expose the reinforcement, which can then be tied to that of the beams.

13.4.45 Where plots are founded close to or over any high walls associated with the former opencast, piles must be socketed into rock and not allowed to deflect off the high wall. This may require pre-drilling and casing of piles. An allowance should also be made for changing piling locations and ground beam design to account for any difficulties encountered with high walls associated with the former opencast.

13.4.46 NHBC generally require pile lengths to be at least 3m; therefore where plots cross a high-wall and rock is encountered at shallow depth (<3m) on the 'outside' of the opencast, pre-boring of piles may be required to reach required depths.

13.4.47 If ground beams are found to span across the high wall it should be ensured that they span from the pile head onto competent rock.

13.4.48 For piled foundations suspended floor slabs should be utilised. A pre-cast 'Beam and Block' concrete ground floor construction suspended across the ring beams could be utilised.

13.4.49 A proprietary driven piling system, incorporating ring beams and pre-cast concrete ground floor construction could be considered for this development.

13.4.50 Ground conditions at this site are considered likely to require provision of a piling mat (working platform) and further advice should be sought from the appointed specialist-piling contractor regarding the proposed plant loadings and resulting pressures. This data, together with a knowledge of the strength and variability of the near-surface ground conditions is required in order that design of a mat can be undertaken in accordance with guidance provided in the 2004 BRE document, "BR 470: Working platforms for tracked plant".

13.4.51 The design of working platforms for tracked plant is a geotechnical design process and should be carried out by a competent person. The following parties should have input into the design:

- Permanent works designer, to consider additional uses for platform material as part of the overall development
- Principal contractor, to define any other purposes for which the platform might be used
- Contractor or subcontractor, to specify requirements for the the platform, including gradients, ramps and edges

13.4.52 The number of plots affected by piling will depend on layout proposals, however, it is considered unlikely to exceed 20% of the total number.

Summary of foundation recommendations

13.4.53 In summary, the following foundation solutions are likely to be most appropriate (subject to BDW preferences regarding site preparatory works, final levels & costs associated with each foundation option).

Plot nos	Foundation solution(s)	Remarks (influencing factors)
50 – 54, 58, 59, 67 – 75, 84	Strips at 0.6 to 1.5m	Medium dense grave/ firm clay (0.9m minimum required in clay)
1 – 18, 25 – 35, 65, 66, 76 – 83, 85 – 92	Strips at 1.5 to 2.5m	Medium shrinkability clays & trees
22 – 24	Engineer designed trench fill to 3.0m	Soft clay
38, 49, 57, 60	Deepened strips into bedrock (around 2.0m)	Within vicinity of opencast
36, 37, 39 to 48, 55, 56, 61 to 64	Piles to about 10m	Made ground associated with backfilled opencast, pre-boring for shallow piles may be required

13.4.54 Lithos could prepare a detailed Foundation Schedule if provided with: an External Works Drawing (with proposed FFLs & infrastructure details); a topographic survey; a tree survey;

13.4.55 The foundation solutions outlined in the above table assume that ground levels will not change significantly from those existing at present. If this is not to be the case, further advice should be sought from Lithos.

13.5 Floor slabs

13.5.1 Suspended floor slabs should be utilised where the depth of made ground or engineered stone exceeds 600mm in accordance with NHBC Standards Chapter 5.1 (to negate potential settlement problems).

13.5.2 It is estimated that the thickness of made ground is likely to exceed 600mm beneath at least 25% of the plots.

13.5.3 Where foundations are within the influence of existing or proposed trees, and a trench-fill foundation depth of 1.5m or greater is required, the ground floor should be constructed using block and beam, or another suitable voided construction. A suitable approved compressible void former, should be used on the internal face of all external walls.

13.5.4 The natural ground beneath this site includes cohesive soils and is therefore subject to seasonal variation in moisture content. If ground slabs were constructed on desiccated soil, heave of the slab would occur on re-hydration of the ground. If any significantly desiccated soil is present, a block and beam floor construction should be adopted. In accordance with NHBC Standards Chapter 4.2, a minimum void height of 250mm should be adopted.

13.5.5 Small areas of the site which are outside of the influence of trees and/or are underlain by Granular Residual Soils may be suitable for ground bearing floor slabs. However these areas are likely to be limited and sporadic. It would be prudent therefore to allow for suspended floor slabs in all proposed plots at the site.

13.5.6 In the unlikely event that coal is exposed beneath the floor void, it would be prudent to prevent air ingress and the potential for spontaneous combustion by blinding with concrete, or removing the coal.

13.6 Designated concrete mixes

13.6.1 The following designated mixes in accordance with BRE Special Digest SD1 and BS 8500: Part 1: 2006 will be suitable for use on this site.

Application	**DS-1 conditions ACEC Class AC-1**
Unreinforced strip/trench fill footings	GEN1
Reinforced strip/ trench fill footings (mesh reinforcement)	RC28/35
Pads, rafts and ground beams	RC28/35
Unreinforced concrete floor slabs	GEN2
In situ reinforced concrete floor slabs	RC28/35

Note. The use of an FND mix imposes a strength class of C28/35 on the structural designer; if this is not acceptable a designed mix in accordance with BS8500-1:2006 should be specified.

13.7 Excavations

13.7.1 Groundwater should be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".

13.7.2 Based on the results of the investigation it is unlikely that major groundwater flows will be encountered in shallow excavations across the majority of the site.

13.7.3 However, in the south-west within the vicinity of TP01, groundwater control over and above normal site pumping practices may be required for any excavations in excess of 1.5m deep.

13.7.4 Excavations should remain stable in the short term but if left open for any significant period of time may require shoring.

13.7.5 Shoring will almost certainly be required for excavations in the opencast backfill.

13.7.6 Bedrock was encountered in several exploratory holes. Based on the exploratory hole logs, excavation greater than 2m is likely to prove difficult across much of the site. It would therefore be prudent to allow for excavation of hard rock in any deep excavations such as those that may be required for drainage etc.

13.8 Drainage

13.8.1 Based on observations made during the investigation, soakaways are unlikely to provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

13.8.2 Whilst the site may not lend itself to the adoption of discrete soakaways, ground should have the capacity to absorb surface water run-off, and systems which spread infiltration over a wider area (e.g. an infiltration basin, swales and\or pervious paving) may provide a solution.

13.8.3 Alternative SUDS options (see CIRIA C697:2007 for further details) include:

- Swales – linear grassed features in which surface water can be stored or conveyed. Where suitable, swales can be designed to allow infiltration.
- Infiltration basins – vegetated depressions designed to store runoff and infiltrate it gradually into the ground.
- Pervious Pavements – provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate into subsurface storage, with subsequent infiltration or controlled discharge. Pavement could be porous (water able to infiltrate across entire surface material; e.g. reinforced grass), or permeable (water infiltrates via joints between concrete blocks).
- Ponds – designed to have permanent pool of water, but with capacity to provide temporary storage controlled discharge.

13.8.4 It is recommended that the developer contact Yorkshire Water Services with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

13.9 Highways

13.9.1 Deep made ground is present in the north-west consultation with the adopting authority, regarding the specification of the highways, is strongly recommended.

13.9.2 In the north-west, made ground within the former opencast (up to a maximum of 2m - from existing ground level or proposed highway formation, whichever is the lower) should be excavated and either

- replaced with suitable aggregate in accordance with Series 600 (Earthworks) of The Highways Agency (HA) "Specification for Highway Works" 1998; or
- screened, to allow selection of suitable material, before being replaced in engineered layers (in accordance with Series 600). Unsuitable materials include any soft or wet materials, biodegradables including topsoil, wood, scrap metal, frozen material and oversize

13.9.3 It is considered likely that the made ground should be suitable for re-engineering beneath the proposed highway; this should be verified by laboratory testing (compaction & particle size distribution) and field trials.

13.9.4 If any new highway spans the opencast 'high-wall', the following precautions are recommended to protect highway and drainage infrastructure from damage due to differential settlement.

- The made ground should be excavated over the full width of the adoptable highway to at least 1.0m below deepest sewer invert
- The base of the excavation (1.5m below sewer invert) should be reinforced with two layers of Tensar Triax TX160 (or equivalent) geogrid sandwiched within at least 300mm of suitable aggregate

13.9.5 A minimum length of 5m either side of any highwalls associated with the former opencast should be treated to the above specification, although the final specification should be agreed with the adopting authority.

13.9.6 If any deep excavation beneath a highway results in sub-formation slopes greater than 1:5 (v:h), the sub-formation should be stepped (max. 0.5m high) and benched (min. 1m wide). Where excavation works exceed 1m in depth, the footprint of earthworks should be extended beyond the highway footprint a minimum of 1m, plus the depth of excavation. The Engineer will keep records of any such work undertaken.

13.9.7 Some refinement of the above advice might be possible after highways design (with consideration of the proposed formation level cf existing ground level), and via inspection (and usually CBR testing) of the proposed formation during site preparatory groundworks.

13.9.8 Any residual made ground materials in the base of the excavation should be inspected and (where necessary) any soft spots removed and replaced with suitable engineered fill.

13.9.9 Where the made ground is re-engineered it is considered that a CBR value of at least 3% should be achievable. However, this should be verified by field trials.

13.9.10 Based on visual inspection of the natural materials and the recorded plasticity indices at the site, published tables (Interim Advice Note 73/06 Revision 1 (2009), Chapter 5. Characterisation of Materials Design Guidance For Road Pavement Foundations - Draft HD25) indicate that the natural soils will have a CBR value of at least 3%. These values should also be verified prior to or during construction.

13.10 External works

13.10.1 Any digital terrain modelling undertaken, or commissioned by BDW should be made available to their Engineering Designer prior to issue of an External Works Drawing.

13.10.2 Due to the sloping nature of the site, it is likely that some retaining walls will be required.

13.10.3 In addition, the retaining wall present along the south of the site should be inspected by a suitably qualified structural engineer prior to development.

14 REDEVELOPMENT ISSUES

14.1 General

14.1.1 This report has presented options with respect to foundation solutions etc that are considered technically feasible and in line with current good practice. Consequently, we would expect to obtain regulatory approval for whichever option is adopted, although this cannot be guaranteed. Copies of this report should be forwarded to the relevant regulatory authorities (Warranty Provider & Local Authority) for their comment/approval.

14.2 Remediation strategy

14.2.1 Given the absence of any significant contamination, a remediation strategy is not considered necessary. Nonetheless, some preparatory works will be required, most notably:

- Demolition of the existing working men's club building and post-demolition site investigation
- Location and (if necessary) treatment of mine entries
- General site clearance of surface materials and vegetation
- Topsoil strip & stockpile

14.2.2 It should be ensured that the groundworker understands the need for good materials management. Most notably the importance of not mixing different materials within a given stockpile; i.e. there should be separate stockpiles of: topsoil; grubbed-up tarmac/concrete hardstand; excess clean, natural soil arisings; general construction waste etc.

14.2.3 Immediately prior to demolition of the working men's club, current legislation (as outlined in HSG 264) requires a pre-demolition (formerly Type 3) asbestos survey to be undertaken. The Contractor should request a copy of the survey report from BDW.

14.2.4 It is strongly recommended that the demolition contractor should chase-out all significant buried structures, and survey-in the resultant excavations before making them safe by backfilling. At the very least, relevant features should be surveyed-in before "hiding" them beneath a veneer of rubble. Similarly, it would be prudent to complete a drainage survey prior to blading rubble across the site to leave it safe and secure.

14.2.5 No areas of gross contamination were encountered during the site investigation. However, if any buried drums, "oily", odorous, brightly coloured etc. materials are encountered, further advice should be sought from Lithos.

14.3 Health & safety issues - construction workers

14.3.1 Access into excavations etc. must be controlled and only undertaken in accordance with the Confined Spaces Regulations 1997. The atmosphere in shored trenches in excess of 1.2m should be monitored for oxygen and hazardous gas (methane & carbon dioxide), prior to personnel entering such excavations. Monitoring should continue whilst personnel are working in deep excavations.

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

14.4 New utilities

14.4.1 It is strongly recommended that all statutory service bodies are consulted at an early stage with respect to the ground conditions within which they will lay services in order to enable them to assess at an early stage any potential abnormal costs.

14.4.2 Drainage and other utilities should not be placed within any coal seam; the seam should either be removed to below the base of the lowest service, or services should be placed in oversize trenches cut into the seam & backfilled with inert material.

14.4.3 This site is greenfield, and no previous or current usage of the site or its immediate surroundings is likely to have resulted in ground contamination. Furthermore, no significant made ground was encountered in any of the exploratory holes during the ground investigation.

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

14.5 Coal Extraction

14.5.1 About 75% of the site is underlain by shallow coal; the Flockton Thick.

14.5.2 As discussed in Section 4.3, coal extraction is encouraged by both the Coal Authority and Planning Authorities; largely because a potential mineral resource will not be sterilised by the development.

14.5.3 Extraction is generally considered possible where the overburden above a seam is less than 12 times the seam's thickness, which is expected to be the case here.

14.5.4 There can be financial benefits to extraction, since the extraction contractor would pay the landowner a disturbance allowance for the coal (likely to be between £2 and £4 per tonne).

14.5.5 However, there are also drawbacks associated with coal extraction. At this site include:

- The creation of 'high-walls' around the margins of the extraction area. The batter associated with such high walls would reduce the area available for coal extraction and increase foundation costs for any plots spanning such high walls.
- Development costs would be increased if coal were extracted due to the need for raft foundations instead of strip footings
- The time required to ensure significant settlement of the replaced overburden (anticipated residual settlement must be less than 25mm) is typically at least 12 to 18 months. NHBC generally require 12 months of monitoring before any new houses are built on deep, engineered fill.
- Local environmental issues associated with noise and dust. The site is bounded by housing, most notably Barnsley Road and Park Side.
- Public perception issues. Any application to extract coal is likely to generate considerable anxiety amongst local residents.

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

14.6 Shallow coal in garden areas

14.6.1 Whilst there is no explicit guidance in NHBC Standards, liaison with NHBC suggests their stance is essentially the same as that they would apply to potentially combustible fills (such as Ash & Clinker). So where significant coal is present at very shallow depth in garden areas (uppermost 1m), it should either be removed, or covered with inert subsoil/topsoil so that it lies at greater than 1m depth.

14.6.2 Given seam dip and topography it seems likely that coal will only be present at such shallow depth beneath less than 15% of the area, immediately east of the Flockton Thick outcrop.

14.6.3 The most pragmatic way of dealing with shallow coal in gardens will be to inspect foundation excavations, and where coal is recorded within the uppermost 1m or so then excavate an inspection pit in the rear garden. Further advice should be sought from Lithos during the construction phase.

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

14.7 Potential development constraints

14.7.1 The overhead electricity services present a potential development constraint unless they can be relocated. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required by each service undertaker if they remain in-situ.

15 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

15.1 General

15.1.1 The majority of the site comprises an open grassed field to the rear of Flockton Green Working Men's club, Barnsley Road, Flockton (NGR SE 241 150). The club building and car park is situated in the south-east; the far south-west is currently in use as the rear gardens of adjacent properties.

15.1.2 It is understood that consideration is being given to redevelopment of the site with 92 two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A new working men's club building will also be developed in the central south.

15.1.3 Ground conditions generally comprise firm clay with gravel of sandstone and mudstone, often with clayey gravel and cobble of mudstone/sandstone below at an average depth of 1.3m.

15.1.4 An area of deep made ground exists in the north-west within the footprint of the former opencast. A probehole drilled in this area indicates that bedrock lies at around 7m depth.

15.2 Mining

15.2.1 This site is located within a Coal Mining Development High Risk Area.

15.2.2 A former opencast is present in the north-west; bedrock lies at around 7m depth beneath backfill material.

15.2.3 Shallow mineworkings were encountered across the east of the site within the Flockton Thick seam which will require mitigation measures (i.e. consolidation by drilling & grouting). At this stage, it should be assumed that the whole site east of the Flockton Thick outcrop, excluding the former opencast will require treatment; around 75% of the total site area (c. 2ha).

15.3 Hazardous gas

15.3.1 The site is underlain by shallow mineworkings and a former opencast is present in the north-west and immediately adjacent to the site.

15.3.2 Consequently, gas monitoring wells were installed in 6 boreholes across the site. A gas risk assessment will be forwarded upon completion of the monitoring programme.

15.4 Contamination & remediation

15.4.1 Topsoil, typically 300mm thick underlies the majority of the site. Testing has yielded marginally elevated arsenic levels which are not considered to be of great concern. Consideration could be given to further sampling, with subsequent bioaccessibility testing, but this is not considered essential.

15.5 Foundations

15.5.1 Two main foundation solutions are considered likely to be most appropriate for proposed dwellings at this site:

- Strips/trench fill for plots located **beyond** the opencast backfill; and
- Piles for plots located **within** the opencast backfill

15.5.2 Vibratory ground improvement might be an option, but only for plots located wholly within the opencast backfill, and probably some distance from high walls. Further advice should be sought from a specialist vibro contractor.

15.5.3 Any plot layout for this site should take account of the known high walls.

15.6 Flooding

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

15.7 Drainage

15.7.1 Due to very slow infiltration rates in 3 out of the 5 tests carried out, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off at the site.

15.7.2 Consideration could be given to additional testing within the bedrock however, due to the site's topography and the possibility of springs being created downhill, soakaways are considered unlikely to be suitable. Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

15.8 Highways

15.8.1 Natural deposits should yield CBR values in excess of 3%.

15.8.2 Made ground within the former opencast should be excavated up to a maximum of 2m beneath the footprint of proposed highways. It is considered likely that the made ground should be suitable for re-engineering, subject to confirmatory laboratory testing and field trials.

15.8.3 If any new highway spans the opencast 'high-wall', precautions are recommended to protect highway and drainage infrastructure from damage due to differential settlement.

15.9 Further works

15.9.1 Supplementary investigation should be undertaken in the south-east following demolition of the existing working men's club building.

15.9.2 During this investigation, additional trenching should be undertaken to locate highwalls associated with the former opencast.

15.9.3 Consideration could be given to cable percussion boreholes, with SPTs, to provide geotechnical data for the opencast backfill.

15.9.4 The four mine entries shown to underlie the site on CA plans should be located and, if necessary treated. This could be done as part of the topsoil strip, or during the anticipated drilling & grouting works.

15.9.5 It is possible that bell pits may be present, and consideration should be given to a geophysical survey. Follow-up intrusive investigation (pitting) would be recommended to determine the cause of any anomalies identified by the geophysics.

Appendix A

General Notes

Generic notes – geoenvironmental Investigations

General

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

Geology, mining & quarrying

In order to establish the geological setting of a site, Lithos refer to BGS maps for the area, and the relevant geological memoir. Further information is sourced from the Local Authority and by reference to current and historical OS plans. A coal mining report is obtained from the Coal Authority (CA).

In July 2011, the CA formalised their requirements in relation to planning applications and introduced some new terminology. The CA, using its extensive records has prepared plans for all coalfield Local Planning Authorities, which effectively refines the defined coalfield areas into areas of higher risk (known as the Coal Mining Development Referral Area) and lower risk (known as the Standing Advice Area). The Coal Mining Development Referral Areas contain a range of specific mining legacy risks to the surface, including mine entries; shallow coal workings; workable coal seam outcrops; mine gas; geological features; and previous surface mining sites. The Standing Advice Area is the remainder of the defined coalfield. In this area no known defined risks have been recorded; although there may still be unrecorded issues.

Landfills

Lithos obtain data from the Landmark Information Group, the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Radon

Radon is a colourless, odourless gas, which is radioactive. It is formed in strata that contain uranium and radium (most notably granite), and can move though fissures eventually discharging to atmosphere, or the spaces under and within buildings. Where radon occurs in high concentrations, it can pose a risk to health.

In order to assess potential risks associated with radon gas, Lithos refer to BRE Report BR211, 2007: "Radon: guidance on protective measures for new buildings", and to information from the BGS / HPA (Health Protection Agency) radon potential dataset provided by the Landmark Information Group. The level of protection needed is site-specific and is determined by reference to the maps contained in Annex A of BR211. These maps are derived from the Radon Atlas of England and Wales (2007), and indicate the highest radon potential within each 1km grid square.

Each 1km grid square is classified on the basis of the percentage of existing homes within that grid square estimated to have radon concentrations above the Action Level (average annual radon concentration of 200 Bq.m-3), as follows:

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

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

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

Hydrogeology

Lithos obtain information from the Environment Agency (EA) and the Landmark Information Group with respect to:

- groundwater quality
- recorded pollution incidents
- licensed groundwater abstractions

From April 2010 the EA's Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply), but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey. The maps are split into two different type of aquifer designation:

- Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels
- Bedrock -solid permeable formations e.g. sandstone, chalk and limestone

The maps display the following aquifer designations:

Principal Aquifers: These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary Aquifers: These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:

- Secondary A - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers
- Secondary B - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers
- Secondary Undifferentiated - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type

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

Note: The maps are only display the principal and secondary aquifers as coloured areas. All uncoloured areas on the bedrock designation map will be unproductive strata. However, for uncoloured areas on the superficial (drift) designation map it is not possible to distinguish between areas of unproductive strata and areas where no drift is present. To do this, it is necessary to consult the published geological survey maps.

For the purposes of our Groundwater Protection Policy the following default position applies, unless there is site specific information to the contrary:

- If no superficial (drift) aquifers are shown, the bedrock designation is adopted
- In areas where the bedrock designation shows unproductive strata (the uncoloured areas) the superficial designation is adopted
- In all other areas, the more sensitive of the two designations is used (e.g. If secondary drift overlies principal bedrock, an overall designation of principal is assumed)

The EA have also designated Source Protection Zones, which are based on proximity to a groundwater source (springs, wells and abstraction boreholes). The size of a Source Protection Zone is a function of the aquifer, volume of groundwater abstracted and the effective rainfall, and may vary from tens to several thousand hectares.

Hydrology

Lithos obtain information from the Environment Agency and the Landmark Information Group with respect to:

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

Generic notes – geoenvironmental Investigations

The EA have set water quality targets for all rivers. These targets are known as River Quality Objectives (RQOs). The water quality classification scheme used to set RQO planning targets is known as the River Ecosystem scheme. The scheme comprises five classes (RE1 to RE5) which reflect the chemical quality requirements of communities of plants and animals occurring in our rivers.

General Quality Assessment (GQA) grades reflect actual water quality. They are based on the most recent analytical testing undertaken by the EA. There are six GQA grades (denoted A to F) defined by the concentrations of biochemical oxygen demand, total ammonia and dissolved oxygen.

The susceptibility of a site to flooding is assessed by reference to a Flood Map on the Environment Agency's website. These maps provide show natural floodplains - areas potentially at risk of flooding if a river rises above its banks, or high tides and stormy seas cause flooding in coastal areas.

There are two different kinds of area shown on the Flood Map:

1. Dark blue areas could be flooded by the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year, or by a river by a flood that has a 1% (1 in 100) or greater chance of happening each year
2. Light blue areas show the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements

The maps also show all flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, or floods from the sea with a 0.5% (1 in 200) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

The Agency's assessment of the likelihood of flooding from rivers and the sea at any location is based on the presence and effect of all flood defences, predicted flood levels, and ground levels.

It should also be noted that as the floodplain shown is the 1 in 100 year (or 1 in 200 year as appropriate), areas outside this may be flooded by more extreme floods (e.g. the 1 in 1000 year flood). Also, parts of the areas shown at risk of flooding will be flooded by lesser floods (e.g. the 1 in 5 year flood). In some places due to the shape of the river valley, the smaller floods will flood a very similar extent to larger floods but to a lesser depth.

If a site falls within a floodplain, it is recommended that a flood survey be undertaken by a specialist consultant who can advise on appropriate mitigating measures; ie raising slab levels, provision of storage etc.

COMAH & explosive sites

Lithos obtain information from the Landmark Information Group with respect to COMAH or explosive sites within 1km of the proposed development site. Lithos's report refers to any that are present, and recommends that the Client seeks further advice from the HSE.

Areas around COMAH sites (chemical plants etc) are zoned with respect to the implementation of emergency plans. The HSE are a statutory consultee to the local planning authority for all COMAH sites. The COMAH site may have to revise it's emergency action plan if development occurs. This might be quite straightforward or could entail significant expenditure. Consequently, the COMAH site may object to a proposed development (although it is the Local Authority who have final say, and they are likely to place more weight on advice from the HSE).

Preliminary conceptual ground model

The site's environmental setting (and proposed end use) is used by Lithos to assess the significance of any contamination encountered during the subsequent ground investigation

Assessment of contaminated land is based on an evaluation of pollutant linkages (source-pathway-receptor). Contaminants within the near surface strata represent a potential source of pollution. The environment (most notably groundwater), site workers and end users are potential targets.

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

General

Lithos Ground Investigations are undertaken in accordance with current UK guidance including:

- BS5930:1999 "Code of practice for site investigation"
- BS10175:2011 "Code of practice for the identification of potentially contaminated sites"
- "Technical Aspects of Site Investigation" – EA R&D Technical Report P5-065/TR (2000)
- "Development of appropriate soil sampling strategies for land contamination" – EA R&D Technical Report P5-066/TR (2001)
- Contaminated Land Reports 1 to 6, most notably CLR Report No. 4 "Sampling strategies for contaminated land"
- "Guidance on the protection of housing on contaminated land" – NHBC & EA R&D Publication 66 (2000)
- AGS: 1996 "Guide to the selection of Geotechnical Soil Laboratory Testing"

Exploratory hole logs are presented in Appendices to this Geoenvironmental Report. These logs include details of the:

- Investigation technique adopted
- Samples taken
- Descriptions of the solid strata, and any groundwater encountered.
- Results of any in-situ testing
- Any gas\groundwater monitoring well installed

Exploratory hole locations

Exploratory hole locations are selected by Lithos, prior to commencement of fieldwork, to provide a representative view of the strata beneath the site and to target potential contaminant sources identified during the preliminary investigation (desk study). Additional exploratory locations are often determined by the site engineer in light of the ground conditions actually encountered; this enables better delineation of the depth and lateral extent of organic contamination, poor ground, relict structures etc.

Investigation techniques

Ground conditions can be investigated by a number of techniques; the procedures used are in general accordance with BS5930: 1999 and BS1377: 1990. Techniques most commonly used by Lithos include:

- Machine excavated trial pits, usually equipped with a backactor and a 0.6m wide bucket.
- Cable percussive (Shell & Auger) boreholes, typically using 150mm diameter tools and casing.
- Window or Windowless Sampling boreholes. Constraints associated with existing buildings, operations and underground service runs can render some sites partly or wholly inaccessible to a mechanical excavator. In such circumstances, window sampling is often the most appropriate technique. A window sampling drilling rig can be manoeuvred in areas of restricted access and results in minimal disturbance of the ground (a 150mm diameter tarmac/concrete core can be lifted and put to one side). However, it should be noted that window sampling allows only a limited inspection of the ground (especially made ground with a significant proportion of coarse material).
- Rotary percussive open-hole probeholes are typically drilled using a tricone rock roller bit with air as the flushing medium. Probeholes are generally lined through made ground with temporary steel casing to prevent hole collapse.

Where installed, gas\groundwater monitoring wells typically comprise a lower slotted section, surrounded by a filter pack of 10 mm non-calcareous gravel and an upper plain section surrounded in part by a bentonite seal and in part by gravel or arisings. The top of the plain pipe is cut off below ground level and the monitoring well protected by a square, stopcock type manhole cover set in concrete, or the plain pipe is cut off just above ground level and the well protected by 100mm diameter steel borehole helmet set in concrete. Monitoring well details, including the location of the response zone and bentonite seal are presented on the relevant exploratory hole logs.

In-situ testing

Where relative densities of granular materials given on the trial pit and window sample logs are based on visual inspection only, they do not relate to any specific bearing capacities.

The relative densities of granular materials encountered in cable percussive boreholes are based on Standard Penetration Test (SPT) results. SPTs are carried out boreholes, in accordance with BS 1377 1990, Part 9 Section 3.3. Where full penetration (600mm) is not possible, N values are calculated by linear extrapolation and are shown on the logs as N* = x. The strength of cohesive deposits is determined using a hand shear vane.

Shear strength test results reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

Typically Lithos collect at least three soil samples from each exploratory hole, although in practice a greater number are often taken. The collection of a sufficient number of samples provides a sound basis upon which to schedule laboratory analysis, ensuring:

- A sufficient number of samples from each (common) site material are tested
- Horizontal and vertical coverage of the site is adequate, thereby providing a robust data set for use in the conceptual ground model
- Any localised, significant, but non-pervasive conditions are considered

Made ground and natural soils encountered in the field during a ground investigation often contain a significant proportion of coarse grained material (e.g. brick etc). Soil samples obtained during most investigations are often only truly representative of the in-situ soil mass where there is an absence of particles coarser than medium gravel; i.e the entire soil mass would pass a 20mm sieve.

Representative bulk samples of the **soil mass** are retrieved from coarse soils for specific geotechnical tests (most notably grading and compaction); this typically requires the collection of at least 10kg of soil, and occasionally >50kg. However, in the context of assessing land contamination, it is generally accepted that samples should be representative of the **soil matrix** of the stratum from which they are taken. Consequently, truly representative samples of coarse soils for subsequent contaminant analysis are not obtained - only the finer fraction is placed in sample containers. Coarse constituents not sampled would typically comprise any 'particles' with an average diameter greater than about 20mm (i.e. coarse gravel, cobble and boulder).

At present, neither ISO/IEC 17025 nor MCERTS specify sample pre-treatment with respect to stone removal. Unsurprisingly therefore UKAS accredited testing laboratories do not adopt the same approach to stones[1] – some crush and test the "as received" soil, whilst others sieve out stones and analyse only the residual soil (the sieve size used varies depending on the laboratory).

In essence, samples taken from coarser soils for contaminant analysis are "screened" by the geoenvironmental engineer in the field, and often sieved again by the laboratory during sample preparation. Geoenvironmental engineers do not typically re-calculate soil mass contaminant concentrations by taking account of the unsampled coarse fraction. Likewise, laboratories that remove stones typically report contaminant concentrations based on the dry weight of soil passing the sieve. In the context of land contamination and human health risk assessment, this is considered reasonable, because it is the soil matrix which is of greatest concern. Stones are unlikely to:

- Provide a significant source for plant uptake (consumption of vegetables)
- Remain on vegetables after washing (consumption of vegetables)
- Be eaten (accidentally by an adult, or deliberately by a child)
- Be whipped-up by the wind for dust generation (inhalation)
- Stick to the skin for any length of time (dermal contact)
- Yield toxic vapour (inhalation)

Consequently, Lithos instruct labs to remove all stones >10mm, and to report the results as dry-weight based on the mass of matrix tested. However, the laboratory are given site-specific instruction where coarse stones are coated in say oil, or impregnated with mobile contaminants such as diesel. Where the stones are predominantly natural, or inert (e.g. brick, concrete etc), removal will clearly result in higher reported concentrations, than if the stones were crushed and added to the matrix.

Where the stones include a significant proportion of contaminant-rich material (e.g. slag, fragments of galvanised metal etc) an argument could be made for crushing and analysing. However, provided the stones are stable (i.e. unlikely to disintegrate or degrade) they should not pose a significant risk to human health for the reasons stated above.

Sometimes it is necessary to obtain samples that are not representative of the wider soil matrix, for example when investigating localised, significant, but non-pervasive conditions. Any such unrepresentative samples are annotated with the suffix '*' (eg 2D*, or 4G*). Lithos' site engineer describes both the unrepresentative sample, and the soil mass from which it was been taken.

[1] *Mark Perrin. Stoned – Sample Preparation for Soils Analysis. Ground Engineering, April 2007.*

Sample Containers (for contaminant analysis). Samples of soil for contaminant testing are placed into appropriate containers (see below). Soil samples for organic analysis are stored in cool boxes, at a temperature of approximately 4°C, until delivery to the selected laboratory.

Anticipated testing	Container(s)
pH & metals only	1 kg plastic tub
organics (TPH, PAH) etc only	500ml wide-necked glass jar. Vial required if TPH is to include GRO.
VOCs (incl. naphthalene and\or GRO) only	Glass vial & 1kg plastic tub
pH & metals, and organics	1 litre wide-necked glass jar & 1kg plastic tub
pH & metals, and organics (incl. VOCs or GRO)	Glass vial; 1 litre wide-necked glass jar; & 1kg plastic tub

Sample Containers (for geotechnical analysis). The majority of samples are only scheduled for PI and sulphate testing, for which 500g of sample is required (a full 0.5-litre plastic tub). However, bulk bags are taken where scheduling of compaction or grading tests is proposed.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork. Long-term monitoring of standpipes or piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

It should be borne in mind that the rapid excavation rates used during a ground investigation may not allow the establishment of equilibrium water levels. Water levels are likely to fluctuate with season/rainfall and could be substantially higher at wetter times of the year than those found during this investigation.

Description of strata

Soils encountered during an Lithos investigation are described (logged) in general accordance with BS 5930. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text. The materials encountered in the trial pits are logged, samples taken, and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

Key to exploratory hole logs

Keys to logs are presented in the Appendix(ces) containing the logs. There are two Keys – Symbols & Legends and Terms & Definitions.

General

Soil samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Lithos. All tests are carried out in accordance with BS 1377:1990. The following laboratory testing is routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

The additional tests are typically only scheduled where significant earthworks regrade is anticipated:

- Grading
- Compaction tests
- Particle density

The test results are presented as received in an Appendix to this Geoenvironmental Report.

Atterberg limits & moisture content

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each "type" of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth. Lithos typically only consider a soil to be shrinkable if the proportion finer than 63µm is >35%. PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003), which advocates the use of modified Plasticity Index (I'p), defined as:

I'p = Ip * (%< 425µm/100)

ie if PI is 30%, but the soil contains 80% < 425µm, then: I'p = 30 * 80/100 = 24%.

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs. Lithos apply engineering judgment where PI results are spread over a range of classifications. Consideration is given to:

- The average values for each particular soil type (ie differentiate between residual soil and alluvium),
- The number of results in each class and
- The actual values

Unless the judgment strongly indicates otherwise, Lithos typically adopt a conservative approach and recommend assumption of the higher classification.

Soluble sulphate and pH

Sulphates in soil and groundwater are the chemical agents most likely to attack sub-surface concrete, resulting in expansion and softening of the concrete to a mush. Another common cause of concrete deterioration is groundwater acidity.

The rate of chemical attack depends on the concentration of aggressive ions and their replenishment at the reaction surface. The rate of replenishment is related to the presence and mobility of groundwater.

Lithos refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2005). SD 1 provides definitions of:

- The nature of the site (greenfield, brownfield or pyritic)
- The groundwater regime (static, mobile or highly mobile)
- The design sulphate class (DC class) and
- The aggressive chemical environment for concrete (ACEC class)

Lithos reports clearly state each of the above for the site being considered.

The concentrations of sulphate in aqueous soil/fill extracts are determined in the laboratory using the gravimetric method. The results are expressed in terms of SO_4 for direct comparison with BS 5328:1997. The pH value of each sample was determined by the electrometric method.

SD1 also discusses determination of "representative" sulphate concentration from a number of tests. Essentially if <10 samples of a given soil-type have been tested, the highest measured sulphate concentration should be taken. If >10 samples have been tested, the mean of the highest 20% of the sulphate test results can be taken. With respect to groundwater, the highest sulphate concentration should always be taken.

With respect to pH (soil & groundwater) the value used is the lowest value if <10 samples have been tested and the mean of the lowest 20% if >10 samples have been tested.

Determination of analytical suite

An assessment of potential contaminants associated with the former usages of the site is undertaken with reference to CLR 8 "Potential contaminants for the assessment of land" and the relevant DETR Industry Profile(s).

Common Contaminants

Common **Inorganic** Contaminants include:

- metals, most notably cadmium, copper, chromium, mercury, lead, nickel, and zinc.
- semi-metals, most notably arsenic, selenium, and (water soluble) boron
- non-metals, most notably sulphur
- inorganic anions, most notably cyanides (free & complex), sulphates, sulphides, and nitrates.

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction.

Complex cyanide is "bound" in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to uv digestion for determination of both free and total CN.

Thiocyanate (SCN) is a different species combined with sulphur.

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO4), sulphides etc

There are 2 forms of chromium (Cr), chromium VI and chromium III. Chromium VI is the more toxic of these. In soils, total chromium is determined by a strong aqua regia acid digestion. Chromium VI is an empirical method based on a water extract test.

Common **Organic** Contaminants include hydrocarbons, phenols, and polychlorinated biphenyls.

Petroleum hydrocarbons are a mixture of hydrocarbons produced from the distillation of crude oil. They include aliphatics (alkanes, alkenes and cycloalkanes), aromatics (single or multi benzene ringed compounds) and hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen.

Petroleum hydrocarbons can be grouped based on the carbon number range:-

- GRO – Gasoline Range Organics (typically C6 to C10). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C10 to C28)
- LRO - Lubricating Oil Range Organics (typically C28 to C40)
- MRO – Mineral Oil Range Organics (typically C18 to C44)

However, it should be borne in mind that the terms "GRO" and "DRO" analysis are purely descriptive terms, the exact definition of which varies.

Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from C5-C40, whereas other define TPH as C10-C30.

The composition of a TPH plume migrating through the ground can vary significantly; this is primarily dictated by the nature of the source (eg petrol, diesel, engine oil etc). Furthermore, different hydrocarbons are affected differently by weathering processes, and this can result in further variation in the chemical composition of the TPH.

Gasoline contains light aliphatic hydrocarbons (especially within the C4 to C5 range) that will rapidly evaporate. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polyaromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present.

Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar nitrogen, sulphur and oxygen-containing compounds (NSO) compounds are also present.

Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

Polycyclic Aromatic Hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic. PAH compounds are present in both petrol and diesel, although in significantly lower concentrations than in coal tars. Certain PAH compounds are carcinogenic (Benzo(a)pyrene) and\or mobile in the environment (naphthalene).

Semi-Volatile Organic Compounds (sVOCs) include a variety of compounds, which as the names suggest have relatively low boiling points; however, VOC's are much more volatile than SVOC's. Examples of VOC's include benzene, chloroform and toluene; SVOC's include phenol, florene. Both groups of chemicals are readily absorbed through skin and some, such as benzene, are believed to be linked to tumour growth.

Phenols are compounds that have a hydroxyl group attached to an aromatic ring (ie include a benzene ring and an –OH group). Most are colourless solids. A solution of phenol in water is known as carbolic acid, and is a powerful antiseptic. However, phenol vapour is toxic, and skin contact can result in burns.

Polychlorinated Biphenyls (PCBs) were used in pre-1974 transformers as dielectric fluids. PCB's are of increasing toxicity relative to the degree of chlorination. Acute symptoms of PCB poisoning are irritation of the respiratory tract leading to coughing and shortness of breath. Nausea, vomiting and abdominal pain are caused by ingestion of PCB's.

Dioxins and furans (polychlorinated dibenzodioxins and polychlorinated dibenzofurans) are some of the most toxic chemicals known; in the environment, they tend to bio-accumulate in the food chain. Dioxin is a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD.

Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxin in the environment comes from waste-burning incinerators and also from backyard burn-barrels. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process and with the production of Polyvinyl Chloride (PVC) plastics and with the production of certain chlorinated chemicals (like many pesticides).

Methods of Analysis (Organic Compounds)

TPH by GC-FID is a more refined analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C10 to C40 (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a breakdown of the TPH results into diesel range organics (DRO) and heavier lubricating oil range organics (LRO).

GRO (PRO) by GC-FID analysis detects the more volatile C6-C9 hydrocarbons (aliphatic and aromatic), including those organic compounds present in petrol.

Speciated VOC (by GC-MS) analysis quantifies the concentrations of 30 USA-EPA priority compounds. These include chlorinated alkanes and alkenes (in the molecular weight range chloroethane to tetrachloroethane); trimethylbenzenes; dichlorobenzenes; and the 4 BTEX compounds (benzene, ethyl-benzene, toluene & xylene).

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

Note: PAHs are hydrocarbons and consequently (where present) will be picked-up when scheduling TPH. by GC-FID. Naphthalene (the lightest PAH) is also one of the 58 US EPA VOCs.

Speciated TPH by GC-FID provides a "banded" TPH, initially split into aromatic and aliphatic fractions and then further divided into fraction specific carbon bandings based upon behavioural characteristics.

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

Current UK guidance

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

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

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

Soil screening values used by Lithos

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

- Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software (Version 1.05) Handbook Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

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

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

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

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

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

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

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

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

Lithos have assumed the source of contamination is directly below the building foundations i.e. a depth to source of 0.15m as opposed to the CLEA default of 0.65m. This assumption provides for a more conservative approach than the UK default. This adjustment has been included to account for sites where made ground is re-engineered to enable new buildings to be established on raft foundations. In such situations contamination may lie directly beneath the foundation.

The Soil Screening Values referred to in this document are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part IIA of the Environment Protection Act 1990;
- End uses such as allotments, sports fields, children's playgrounds, care homes, hospitals etc; and
- Controlled waters

In December 2013 Defra published the results of research project SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. The objective of this project was provide technical guidance in support of Defra's revised Statutory Guidance for Part 2A of the Environmental Protection Act 1990 (Part 2A). The revised Statutory Guidance, published in April 2012, introduced a new four-category system for classifying land under Part 2A where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low. Project SP1010 aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- Demonstration of the methodology, via derivation of C4SLs for 6 substances – arsenic, cadmium, chromium IV, lead, benzene & benzo(a)pyrene.

The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology. Development of Category 4 Screening Levels has been achieved by modifying the toxicological and\or exposure parameters used within CLEA (while maintaining current exposure parameters).

The Part 2A Statutory Guidance was developed on the basis that Category 4 Screening Levels could be used under the planning regime. However, policy responsibility for the National Planning Policy Framework falls to the Department for Communities and Local Government. Defra anticipate that, where they exist, C4SLs will be used as generic screening criteria, and Lithos consider C4SLs to be suitable for use as Tier 1 Screening Values. Lithos have discussed this matter with both NHBC and YAHPAC (collection of Yorkshire & Humberside local authorities) and received confirmation that they are satisfied with this approach.

With respect to **inorganic** determinands, Lithos derived Tier 1 values for the four Scenarios A to D are presented below:

Inorganic contaminant	Source	Tier 1 assessment criteria (mg/kg) for Scenarios A to D						Comments/notes
		SGV*	C4SL*	A	B	C	D	
As	CLEA	32	37	37	Use (A) in SI Report for initial "screen". If >5 x A, then consider increase of cover to 1,000mm	40	640	C4SL adopted
Cd	CLEA	10	26	26		149	410	C4SL adopted
Cr	CLEA			3,000		3,000	30,000	Assumes Cr is CrIII.
Pb	CLEA	450	200	200		310	2,330	C4SL adopted
Ni	CLEA	130		127		127	1,700	Assessment of health risk only
Se	CLEA	350		350		595	13,000	
Hg	CLEA	170		169		238	3,640	Assumes in an inorganic compound
B	Lithos			5		5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu	DoE			80-200		80-200	80-200	
Zn	DoE			200		200	200	
Cyanide	CLEA			527		530	14,000	

* For a residential end use

With respect to **organic** determinands, Lithos derived Tier 1 values for the four Scenarios A to D are presented below:

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to D						Comments/notes
	SGV*	C4SL*	A	B	C	D	
Benzene	0.33	0.87	0.87	0.87	3.3	98	C4SL adopted
Toluene	610		497	1,440	1,690	4,360	
Ethyl Benzene	350		240	416	498	2,840	
Xylenes	240		127	146	183	2,620	
Phenol	420		412	2,360	557	38,700	
PCBs			1.7	1.8	1.8	1.8	Based on toxicity of EC7.
Benzo(a)pyrene		5	5	25	5.3	76	C4SL adopted. Where source is not a coal tar.
Naphthalene			4	4	5	430	
Gasoline Range Organics			15	16	21	1,000	See 3-step assessment of TPH below.
Diesel Range Organics			151	153	232	5,000	
Lubricating Range Org			1,000	5,000	1,000	5,000	

* *For a residential end use*

Note: **PAH** cannot be assessed as a single "total" value, as each individual PAH compound has different toxicity and mobility in the environment. Speciated analysis is required to determine the concentrations of the various compounds, most notably the key PAHs: benzo(a)pyrene (considered the most toxic of the PAHs); and Naphthalene (the most mobile and volatile of the PAHs).

Similarly, **TPH** cannot be assessed as a single "total" value, and reference has been made to the Environment Agency's document P5-080/TR3, "The UK approach for evaluating human health risks from petroleum hydrocarbons in soils". This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down "TPH" into thirteen representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the thirteen bandings.

The significance of speciated TPH results can be assessed by following the 3 steps outlined in the tables below.

Step	Result	Action
1. Consider indicator compounds: Are BTEX, naphthalene, benzo(a)pyrene above their respective Tier 1 values?	Yes	Remediation or DQRA required
	No	Proceed to Step 2
2. Consider individual TPH fractions: are they above respective screening values?	Yes	Remediation or DQRA required
	No	Proceed to Step 3
3. Assess Cumulative effects: Is the calculated Hazard Index for each source >1	Yes	Remediation or DQRA required
	No	TPH compounds pose no significant risk

Step 1 - Assessing indicator compounds

TPH fraction Indicator compound	End use specific screening value (mg/kg)			
	A: Residential no cover	B: Residential with 600mm cover	C: Residential no gardens	D: Commercial\ industrial
Benzene	0.87	0.87	3.3	98
Toluene	497	1,440	1,690	4,360
Ethyl Benzene	240	416	498	2,840
Xylenes	127	146	183	2,620
Naphthalene	4	4	5	430

Step 2 - Assessing individual TPH fractions

TPH fraction		End use specific screening value (mg/kg)			
		A: Residential no cover	B: Residential with 600mm cover	C: Residential with no gardens	D: Commercial/ industrial
Aliphatic 5-6	GRO	41	41	63	5,000^
Aliphatic 6-8	GRO	123	123	191	
Aliphatic 8-10	GRO	30	31	48	
Aliphatic 10-12	DRO	151	153	232	
Aliphatic 12-16	DRO	500^	500^	500^	
Aliphatic 16-21	DRO	1,000^	5,000#	1,000^	
Aliphatic 21-35	LRO	1,000^	5,000#	1,000^	
Aromatic 5-7	GRO	52	56	72	
Aromatic 7-8	GRO	15	16	21	1,000^
Aromatic 8-10	GRO	47	50	77	5,000^
Aromatic 10-12	DRO	212	282	390	
Aromatic 12-16	DRO	683	1,000*	1,000*	
Aromatic 16-21	DRO	1,000^	5,000#	1,000^	
Aromatic 21-35	LRO	1,000^	5,000#	1,000^	

* Calculated Screening Value exceeded soil saturation limit and could indicate free product, therefore calculated soil saturation limit adopted as a target

^ Calculated Screening Value close to soil saturation limit, screening value selected by Lithos considering visual and olfactory impacts.

\# Five times the screening value for Scenario A.

Step 3 - Assessing Cumulative Effects

$$HI = \sum_{F_1}^{n} HQ\ F = \frac{\text{Measured concentration } F_1\ (mg\,kg^{-1})}{SGV\ F_1\ (mg\,kg^{-1})}$$

where HI = Hazard Index
HQ = Hazard Quotient
F_1 = Fraction 1
SGV = Soil Guideline Value

Other screening values used by Lithos

Tier 1 risk assessment of **hazardous gas** is undertaken through reference to the following documents (and further information is presented in Generic Note No. 5 – Hazardous Gas):

- Approved Document C, Building Regulations 2000
- Boyle & Witherington (2007) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC
- CIRIA C665 (2006) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2007 – Code of Practice for the characterisation & remediation from ground gas in affected developments

With respect to the assessment of potential **phytotoxic effects** of contaminants, Lithos refer to "The Soil Code" (MAFF, 1998) for copper and zinc. The CLEA SGV is adopted for nickel due to its human health effects.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, 'Concrete in aggressive ground', 2005.

With respect to the interpretation of the **calorific values**, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that:

"In general … it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn".

Generic notes – geoenvironmental investigations

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate or groundwater concentrations with the appropriate water quality standard. Tier 1 Screening Values have been discussed with the Environment Agency, and typically those in **bold** below are adopted.

Analyte	Source of Tier 1 Screening Value (µg/l)			
	Surface Water (Abstraction for Drinking) 1996	Water Supply Regulations 2000	Water Framework Directive	Environment Agency Advice
Arsenic	50	10	**50**	
Selenium	10	**10**		
Cadmium	5	5	**1.5**	
Chromium	50	50	**32**	
Copper	50	2,000	**28**	
Lead	50	10	**7.2**	
Nickel		20	**20**	
Zinc	3,000		**125**	
Boron		**1,000**		
Mercury	1	1	**0.07**	
Petroleum Hydrocarbons				**10**
1,1,1-Trichloroethane			**100**	
1,1 Dichloroethane				**100**
1,2-Dichloroethane		3	**10**	
1,1-Dichloroethene				**100**
Benzene		1	**10**	
Ethylbenzene				**10**
Tetrachloroethene		10	**10**	
Toluene			**50**	
Trichloroethene		10	**10**	
Vinyl Chloride		**0.5**		
Trichloromethane			**2.5**	
Xylenes			**30**	
Chloroethane				**100**

Waste classification & WAC

In the context of waste soils generated by remediation and\or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated 'natural' soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds)
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds)

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

Landfill operators require Waste Acceptance Criteria (WAC) laboratory data, if soil waste is classified as **hazardous**, and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Lithos typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated, for example where redevelopment proposals include basement construction etc. If off-site disposal of soils classified as hazardous waste during redevelopment is anticipated, then WAC analysis should be scheduled at an early stage in the remediation programme. However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous, and these contaminants can often be dealt with by alternative technologies (eg by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (eg WAC) is required.

Possible action in event of Tier 1 exceedance

Should any of the Tier 1 criteria detailed above be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

1. Undertake further statistical analysis following the approach set out in "*Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008*" in order to determine whether contaminant concentrations of inorganic contaminants within soil\fill actually present a risk (only applicable to assessing the risk to human health).
2. Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.
3. Based on a qualitative risk assessment, advocate an appropriate level of remediation to "break" the pollutant linkage - for example the removal of the contaminated materials or the provision of a clean cover.

Prior to undertaking any statistical analysis the issue of the **averaging area** requires further consideration. The CL:AIRE\CIEH document still refers to CLR 7, which suggests averaging area should reflect receptor behaviour and therefore might be a single garden, or an open area used by the local community as a play area. This approach to averaging areas is considered applicable within the context of Part IIA of the Environmental Protection Act (EPA) 1990, in terms of an existing residential development.

However, Lithos consider the concept of a single garden as an averaging area to be inappropriate with respect to brownfield redevelopment, which is regulated by the planning regime. In this context, contamination across the entire site needs to be characterised by reference to the Conceptual Site Model. Consequently, Lithos gather and analyse sample results by fill type, and\or by former use in a given sub-area of the site, before undertaking statistical analysis; ie the averaging area is associated with the extent of a particular fill type, or an area affected by spillage\leakage.

In terms of brownfield redevelopment, this is considered a more appropriate methodology which provides a more representative sample population for statistical analysis. As such the entire site is considered in terms of the proposed end use, be this residential with, or without gardens.

Analysis by soil\fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil\fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass; ie contamination would normally be more pervasive and significant in granular soils than cohesive soils.

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency). In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 1. – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark Information Group, the Environment Agency and the Local Authority and the British Geological Survey. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Where landfilling has occurred within 250m of the site boundary, the Local Planning Authority may request a landfill gas investigation in accordance with the Town and Country Planning General Development Order, 1988.

Sources

Potential sources of hazardous gas are:

- Landfill sites
- Made ground, especially where significant depths are present
- Shallow mineworkings associated with coal extraction
- Geological strata, including peat, organic silts, coal and limestone (reaction with acidic waters), granite (radon)
- Groundwater can sometimes act as a "carrier" for hazardous gas.
- Leakages from pipelines or storage tanks
- Sewers, septic tanks and cess pits

Generation

Wherever biodegradable material is deposited, landfill gas (principally a mixture of methane and carbon dioxide) is likely to be generated by microbial activity. Carbon dioxide is an asphyxiant and toxic; methane is flammable and a mixture containing between 5% and 15% methane by volume in air is explosive. Landfill gas in the ground is unlikely in itself to pose a significant risk, though it may damage vegetation. However, infiltration of landfill gas into confined spaces (e.g. cellars, services, etc) may give rise to considerable risk.

There is no typical figure for the length of time that landfill gas will be evolved, but at many sites significant gas generation continues for at least 15 years after the last deposit of waste.

Migration

Gas migration from a landfill site may occur in several ways. It may migrate through adjacent strata; the distance of migration being dependent on the pressure gradients, volume of gas and permeability of the strata. Where there are faults, cavities and fissures within the strata, gas may move considerable distances. Other migration pathways for gas include man-made features such as mine shafts, roadways and underground services.

Gas migration is influenced by a number of climatic factors, such as atmospheric pressure variations, water table level variations and the influence of a covering of snow or ice over the surface of the site and surrounding area.

Gas monitoring procedure

Lithos adopt a standard gas monitoring procedure, in accordance with CIRIA guidance. This procedure involves the measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration
- Gas emission rate
- Methane, oxygen and carbon dioxide concentrations using an infra-red gas analyser
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism. Where samples of gas are required for laboratory analysis, Gresham Tubes are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Current guidance

CIRIA Report 151 (1995)[i] identified that there was inadequate guidance on trigger concentrations for ground gases. CIRIA concluded that the most important aspect of a gas regime below or adjacent to a site was the surface emission rate, i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. CIRIA Report C665 (2006)[ii] advocates two methodologies for characterising sites:

A – All developments except low rise housing. The advocated methodology is that proposed by Wilson & Card, 1999[iii]

B – Low rise housing. An alternative (traffic light) methodology, derived by Boyle and Witherington, 2006[iv] for NHBC

Both methodologies refer to Gas Screening Values (GSV); previously referred to as limiting borehole gas volume flow.

A – All developments except low rise housing

(Wilson & Card, 1999)[v] revised Table 28 of CIRIA 149[v] in terms of borehole gas volume flow rate (now GSV) in order to achieve a more consistent design of protection measures. This was done to reflect the importance of recognising the gas surface emission rate. Wilson & Card then developed a method for classifying gassing sites (Table 1 below), which took into account the combined gas concentration and GSV.

Characteristic Situation	Gas Screening Value, CH_4 or CO_2 (l/hr)	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% v/v and carbon dioxide not to exceed 5% v/v	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70 litre/hr otherwise increase to Characteristic Situation 3	Natural soil, high peat/organic content
3	<3.5		Old landfill, inert waste, mineworking flooded.
4	<15	Quantitative Risk Assessment required to evaluate scope of protection measures.	Mineworking – susceptible to flooding, completed landfill, inert waste
5	<70		Mineworking unflooded, inactive
6	>70		Recent landfill site

***Notes**: Borehole flow rate = volume of gas (regardless of composition) which is escaping from well (l/hr). Gas Screening Value (litre/hour) = gas concentration (%) / 100 x borehole flow rate (l/hr). To facilitate design implementation, the limiting values for both methane and carbon dioxide are identical.*

B – Low rise housing.

NHBC have developed a characterisation system similar to that of Wilson & Card above, but specific to low-rise housing development (Boyle and Witherington) (Table 8.7). This approach compares measured gas emission rates with generic "Traffic Lights". The Traffic Lights include "Typical Maximum Concentrations" for initial screening, and risk-based Gas Screening Values (GSVs) for consideration of situations where the Typical Maximum Concentrations are exceeded. Calculations are carried out for both methane and carbon dioxide and the worst case adopted in order to establish the appropriate protection measures.

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic light	Methane[1]		Carbon dioxide[1]	
	Typical maximum concentration[2] (% v/v)	Gas screening value $(GSV)^{2.4.6}$ (litres per hour	Typical maximum concentration[2] (% v/v)	Gas screening value $(GSV)^{2.3.4.5}$ (litres per hour
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.13
Red				

Notes:

1. The worst gas-regime identified at the site, either methane or carbon dioxide, recorded from monitoring in the worst temporal conditions, will be the decider for which Traffic Light and GSV is allocated.
2. Generic GSVs are based on guidance contained within "The Building Regulations: Approved Document C" (2004) and assume a sub-floor void of 150 mm thickness.
3. The small room is considered to be a downstairs toilet, with dimensions of 1.50 × 1.50 × 2.50 m, with a soil pipe passing into the sub-floor void.
4. The GSV, in litres per hour, is as defined in Wilson and Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.
5. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgment will be required, based on a thorough understanding of the gas regime identified at the site where monitoring in the worst temporal conditions has occurred.
6. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

---

i Harries CR, Witherington PJ and McEntee JM (1995). Interpreting measurements of gas in the ground. CIRIA Report 151
ii CIRIA (2006) – Assessing risks posed by hazardous ground gases to buildings.
iii Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.
iv Boyle & Witherington (2006) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC
v Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.

06 - Soakaways

Generic notes – geoenvironmental investigations

Background

Soakaways have been the traditional way to dispose of stormwater from buildings and paved areas remote from a public sewer or watercourse. In recent years, soakaways have been used within urban, fully-sewered areas to limit the impact on discharge of new upstream building works and to avoid costs of sewer up-grading outside a development.

Soakaways are seen increasingly as a more widely applicable option alongside other means of stormwater control and disposal. Soakaways must store the immediate stormwater run-off and allow for its efficient infiltration into the adjacent soil. They must discharge their stored water sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent storm. The time taken for discharge depends upon the soakaway shape and size, and the surrounding soil's infiltration characteristics. Soakaways can be constructed in many different forms and from a range of materials.

BRE Digest 365, DG365: 1991 describes design and construction procedures, explains how to calculate rainfall design values and soil infiltration rates, and gives design examples. Further advice is provided in **NHBC** Standards Chapter 5.3 (Section 9 & Appendix F) and CIRIA C697 (Section 6.5). Soakaways should generally be built on land lower than or sloping away from buildings and be sited **at least 5m** from the foundations of a building.

Made ground (and ground within 5m of deep fill) is not generally regarded as suitable for soakaways, due to the potential for inundation settlement and the leaching of contaminants. It should be noted that due to possible structural instability and modification to **Chalk** when wetted, CIRIA Report 11 'Foundations in Chalk' states that "Soakaways should be avoided if at all possible but, if unavoidable, should be sited **at least 20m** away from any structure".

BRE365 states that '**Groundwater should not rise to the level of the base of the soakaway** during annual variations in the water table' this is further reinforced by CIRIA C697:2007 soakaways should not be constructed 'in ground where the water table reaches a level within 1 m below the base of the soakaway at any time of the year'. There may be a requirement to install groundwater monitoring wells at a site and to monitor seasonal variations in groundwater level at least over a wet winter period.

Soakaways should **not be sited on sloping sites**, an assessment should also be made to ensure that infiltrating water will not cause raised groundwater levels, waterlogging of downhill areas or springs, and that slopes are not made unstable.

Test methodology

Lithos undertake soakaway tests in general accordance with BRE Digest 365 "Soakaway Design". The BRE Digest recommends that each soakaway pit is filled and allowed to drain three times to near empty; the three fillings to be on the same or consecutive days. However, each test can take over 2 hours to complete and therefore pits are often only filled and allowed to drain on one occasion, due to the time constraints imposed on the investigation

Three filling\drainage cycles are more important where drainage is primarily via fissures, most notably within a rock mass. Initial drainage within the rock mass may be high, as the fissures fill with water, giving the impression (if only one cycle is undertaken) that soakaways would be a suitable drainage solution. If infiltration through the matrix of the rock is low, then drainage from the test pit becomes slow as the fissures become saturated.

For non-fissile, granular soils infiltration is via the matrix, and consequently one filling\drainage cycle is generally considered sufficient. Soakaway pits are typically excavated to a depth of about 2.5m using a mechanical excavator equipped with a 0.3m wide bucket. The soakaway test pits are rapidly filled with water to the top of the test section. The fall in water level is then monitored at regular intervals.

Infiltration rates

Infiltration rates for each soakaway test are calculated (where possible) in accordance with BRE Digest 365. This design takes into account the time of emptying the soakaway pit between 25% and 75% of its effective depth. The effective depth is calculated from the starting water level to the soakaway pit base. Where the water level did not fall to 25% effective depth, the data was interpolated in order to obtain a representative infiltration rate.

Soakaway design

Soakaway design is carried out in accordance with BRE Digest 365 using the infiltration rates calculated above; assuming a rainfall ratio of 0.39; and that each soakaway will have the capacity to handle storm water from an impermeable area of 100m^2.

Two soakaway types can be designed using BRE Digest 365:

- Perforated concrete ring in a square pit with granular backfill (chamber type)
- Trench with granular backfill (trench type)

The design for the perforated ring type soakaway assumes that the chamber comprises a permeable 900mm internal diameter "hollow" chamber set in a square pit with granular material around the chamber. It is assumed that the granular material will have 30% void space. The design for the trench type soakaway assumes that the trench is 600mm wide filled with granular material, having a void space of 30%.

06 - Soakaways

Generic notes – geoenvironmental investigations

It is generally assumed that soakaways become impracticable on residential developments when:

- The chamber type design requires a square pit with side length in excess of 1.8m, or an effective depth greater than 1.5m.
- The trench type design requires a length greater than about 10m, or an effective depth greater than 1.5m.

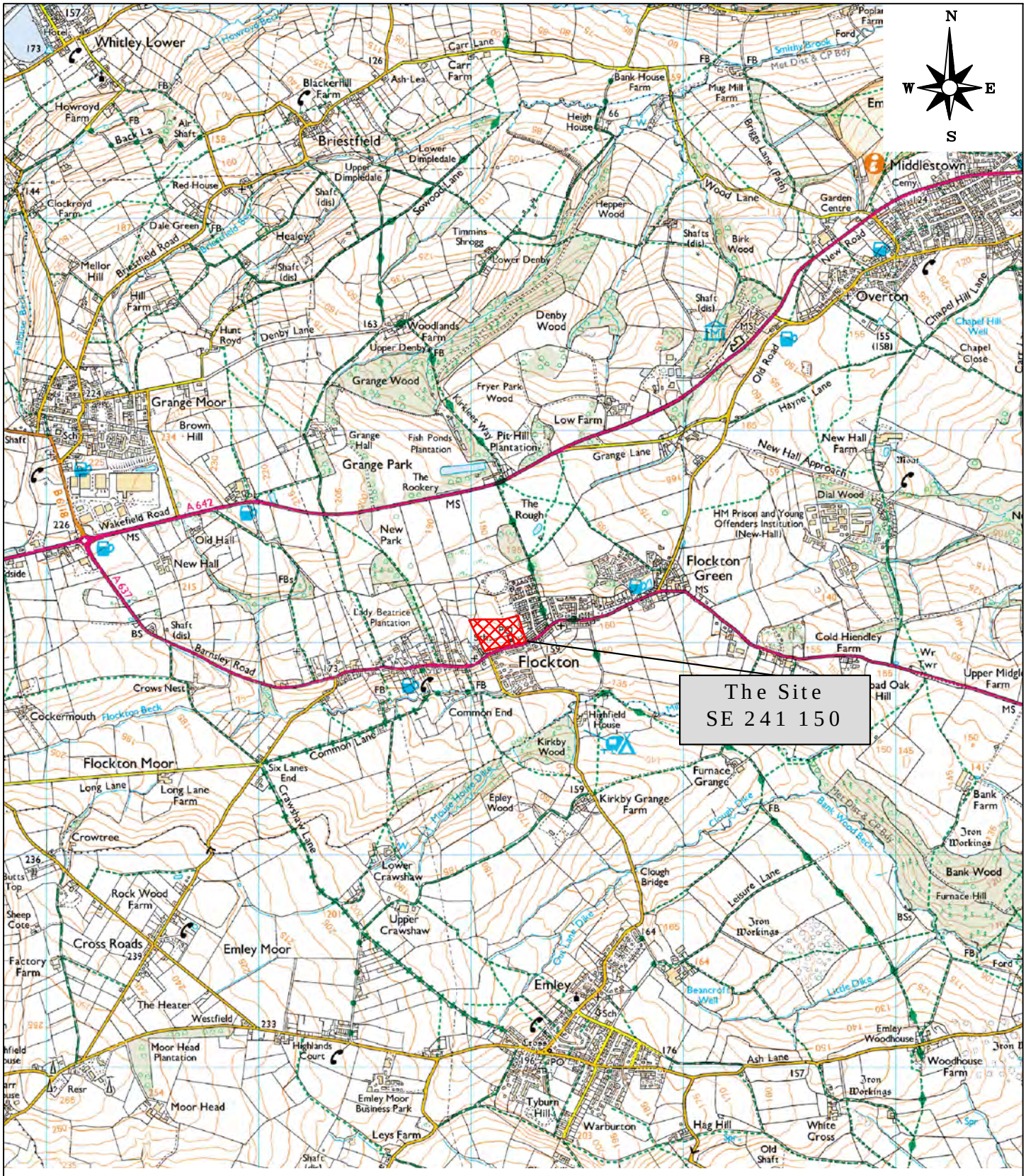
Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

- Standing groundwater level
- Depth to base of permeable strata
- Cost of excavation

Soakaway percolation in some rock types is predominately via the vertical joints within the rock mass. The relatively small-scale soakaway test pits may not intercept such joints and this can result in variable test results. However, it is likely that the larger surface area of a completed soakaway within the development will intercept such joints.

Appendix B

Drawings



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

CLIENT	BARRATT & DAVID WILSON HOMES YORKSHIRE WEST
JOB TITLE	FLOCKTON GREEN WORKING MEN'S CLUB
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	MJT
DATE	20/10/2015
CHECKED	REG
DATE	21/10/2015
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
SCALE	1:25,000
SHEET	A4
DRAWING NO.	2211/1
REVISION	

NOTES

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM BARRATT & DWH HOMES DRAWING REFERENCE KSL-01, DATED APRIL 2015

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

info@lithos.co.uk
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Tel 01937 545330

CLIENT

BARRATT & DAVID WILSON HOMES YORKSHIRE WEST

JOB TITLE

FLOCKTON GREEN WORKING MEN'S CLUB

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
MJT	19/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	20/10/2105	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2211/2	

NOTES

- GRASS & OVERGROWN AREAS
- BUILDING
- TARMAC SURFACING
- APPROXIMATE MINE ENTRY LOCATION
- FORMER OPENCAST
- APPROXIMATE COAL SEAM OUTCROP
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

BARRATT & DAVID WILSON HOMES YORKSHIRE WEST

JOB TITLE

FLOCKTON GREEN WORKING MEN'S CLUB

DRAWING TITLE

SITE FEATURES & GEOLOGICAL FEATURES

DRAWN	DATE	STATUS
MJT	19/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	20/10/2015	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1,000	A3	2211/3	

NOTES

- LOCATION & ORIENTATION OF PHOTOGRAPH
- GRASS & OVERGROWN AREAS
- BUILDING
- TARMAC SURFACING
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

BARRATT DAVID WILSON HOMES

JOB TITLE

FLOCKTON GREEN WORKING MENS CLUB

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
MJT	19/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	20/10/2015	DRAFT ☐
		FINAL ☑

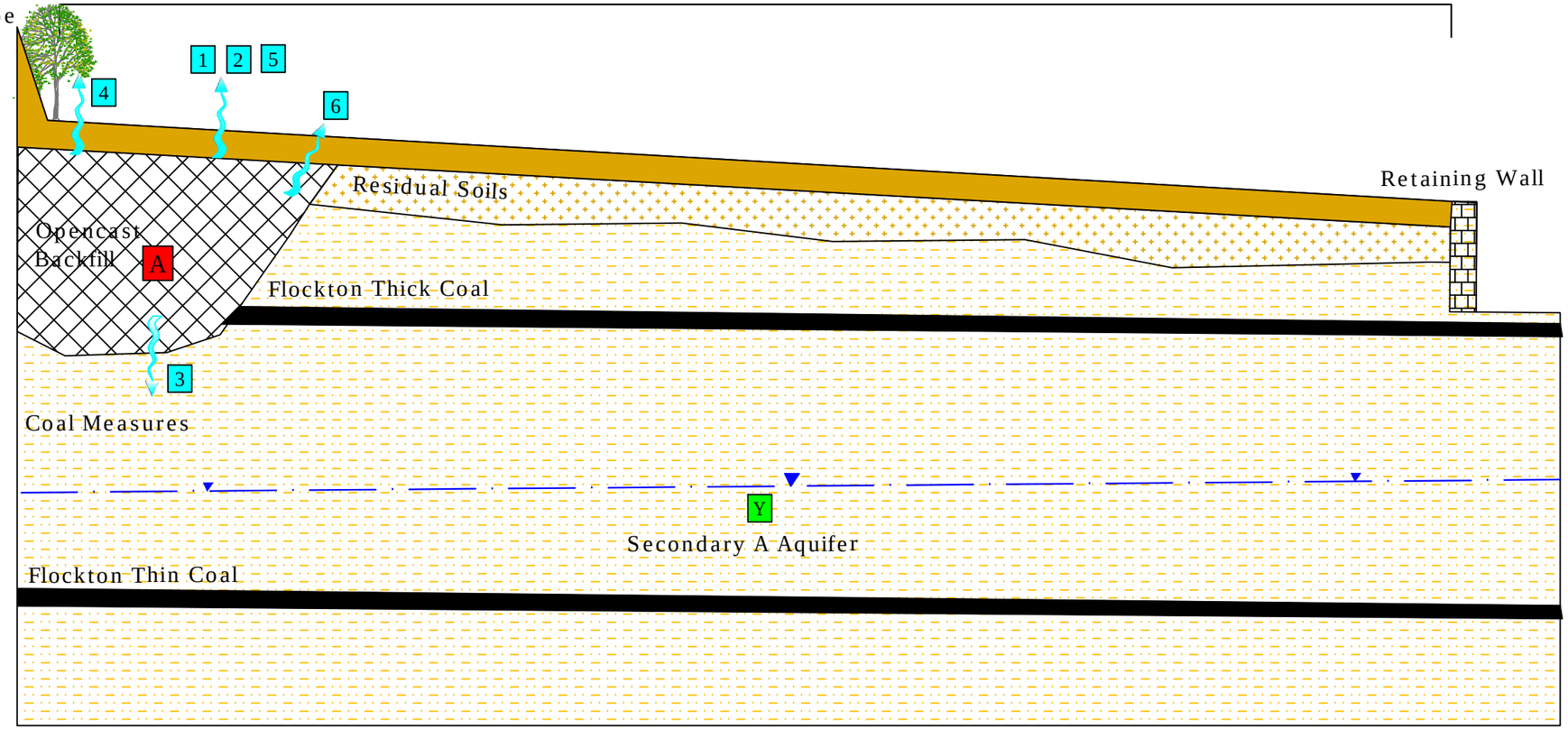
SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2211/4	

North

Site Extents

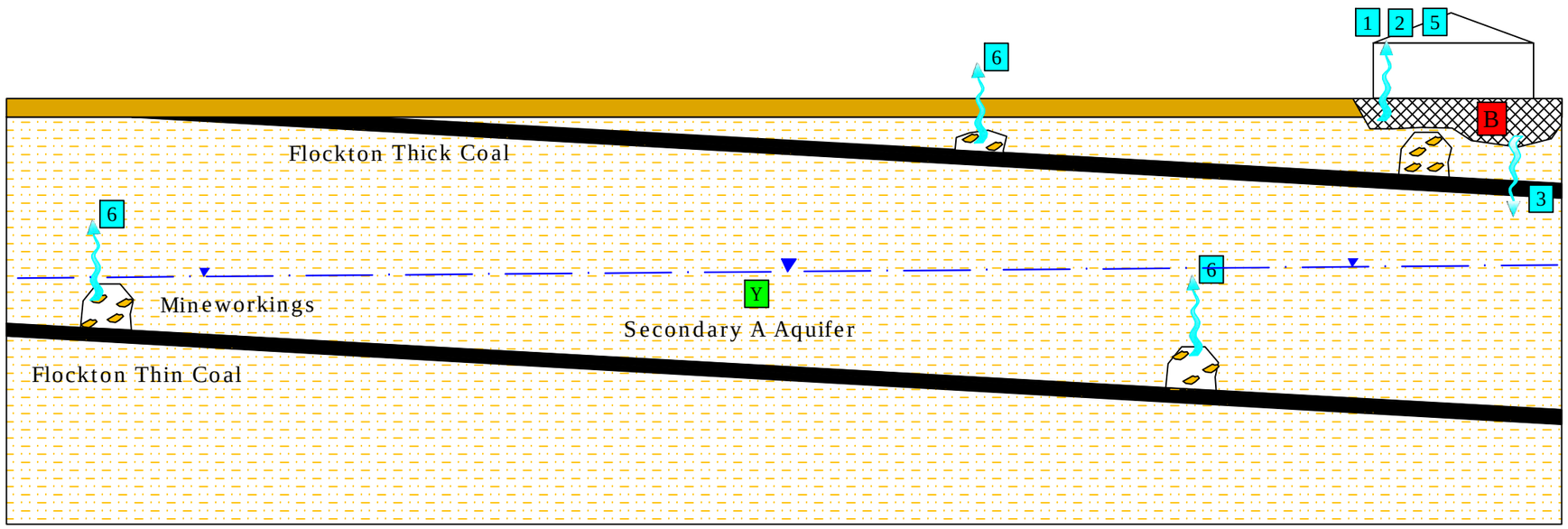
South

Slope



West

East



NOTES

SOURCES	
A	OPENCAST BACKFILL
B	MADE GROUND

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION\INHALATION
3	LEACHING OF CONTAMINANTS
4	UPTAKE BY PLANTS
5	VOLATILISATION
6	MIGRATION OF GAS

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

REV.	DESCRIPTION	DATE

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CLIENT

BARRATT DAVID WILSON HOMES

JOB TITLE

FLOCKTON GREEN WORKING MEN'S CLUB

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
MJT	19/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	20/10/2015	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2211/5	

NOTES

- APPROXIMATE MINE ENTRY LOCATION
- SOAKAWAY PIT LOCATION
- TRIAL PIT LOCATION
- TRIAL TRENCH LOCATION
- PROBEHOLE LOCATION
- FORMER OPENCAST
- APPROXIMATE COAL SEAM OUTCROP
- APPROXIMATE SITE BOUNDARY
- NO ACCESS FOR INTRUSIVE SI
- TRIAL TRENCHED AREA

REV.	DESCRIPTION	DATE
A	SITE FEATURES UPDATED (MJT)	19/10/15

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CLIENT

BARRATT DAVID WILSON HOMES

JOB TITLE

FLOCKTON GREEN WMC

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
MAR	02/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	02/10/2105	DRAFT ☐
		FINAL ☑

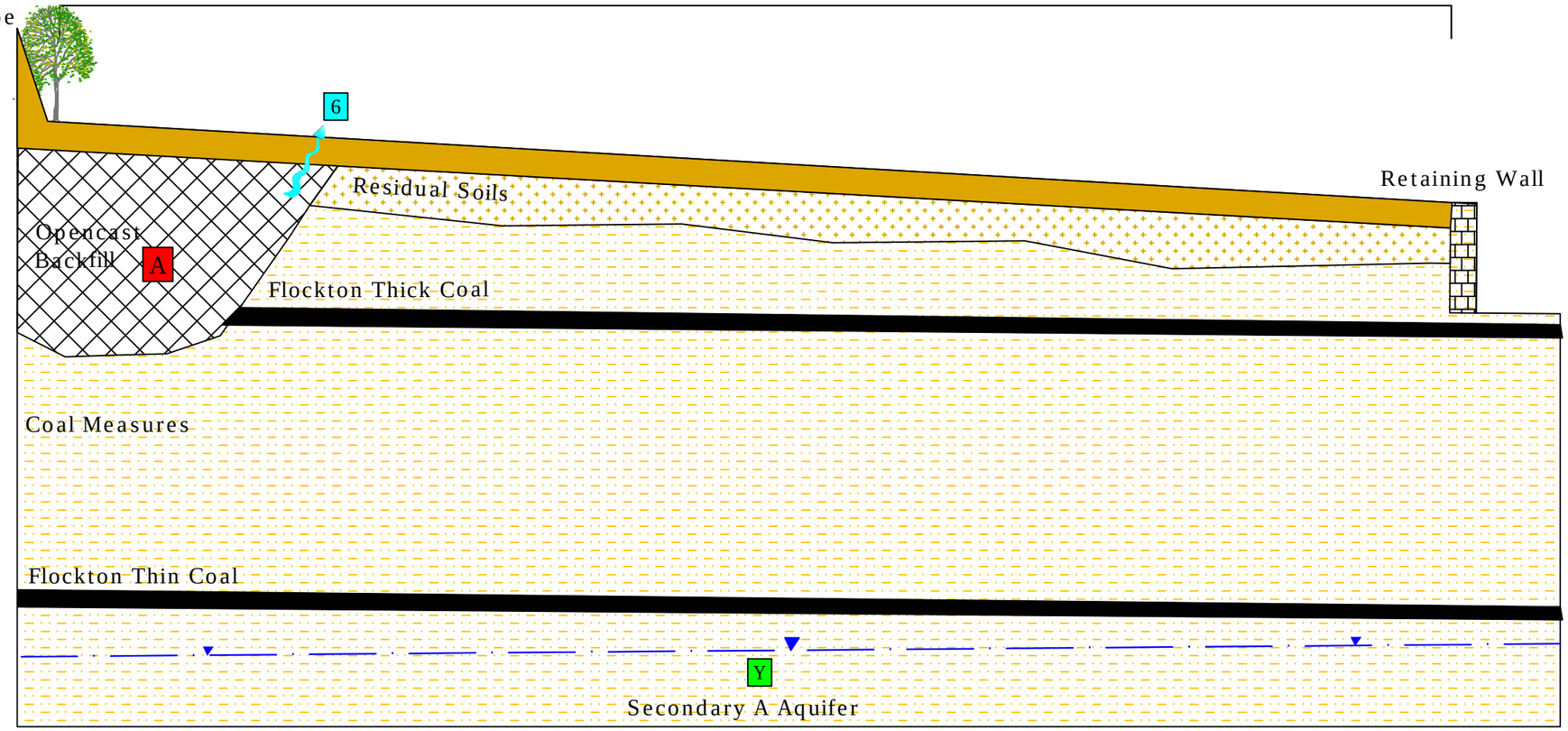
SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	2211/6	A

North

Site Extents

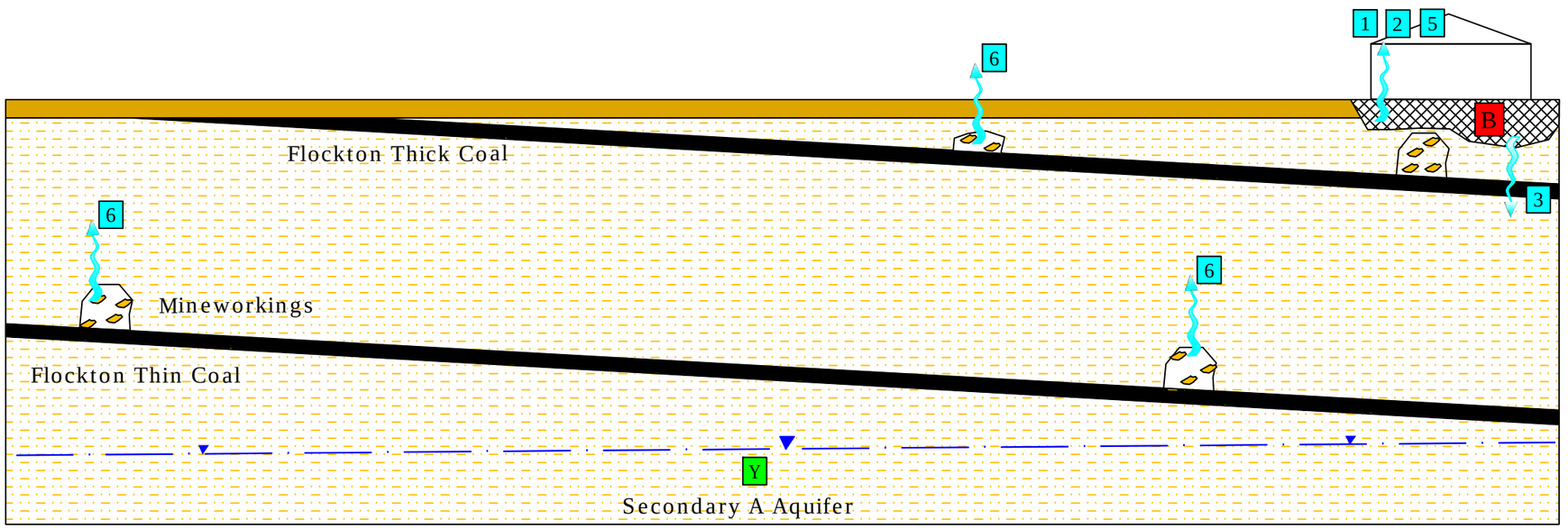
South

Slope



West

East



NOTES

SOURCES

- B MADE GROUND

PATHWAYS

- 1 DERMAL CONTACT
- 2 INGESTION\INHALATION
- 3 LEACHING OF CONTAMINANTS
- 4 UPTAKE BY PLANTS
- 5 VOLATILISATION
- 6 MIGRATION OF GAS

RECEPTORS

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

REV.	DESCRIPTION	DATE

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CLIENT

BARRATT DAVID WILSON HOMES

JOB TITLE

FLOCKTON GREEN WORKING MEN'S CLUB

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
MJT	19/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	20/10/2015	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2211/7	

NOTES

- PROBEHOLE LOCATION
- AREA LIKELY TO REQUIRE MITIGATION MEASURES FOR WORKINGS IN FLOCKTON THICK SEAM
- FORMER OPENCAST
- APPROXIMATE COAL SEAM OUTCROP
- CROSS SECTION LINE
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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CLIENT

BARRATT DAVID WILSON HOMES

JOB TITLE

FLOCKTON GREEN WMC

DRAWING TITLE

MINING MITIGATION MEASURES

DRAWN	DATE	STATUS
MJT	20/10/2015	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	21/10/2015	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	2211/8	A

Appendix C

Commission

004/2211/MJT

25th August 2015

Mr G Rhodes
Barratt David Wilson Homes Yorkshire West
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LITHOS CONSULTING

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Wetherby
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Dear Graham

Flockton Working Men's Club, Barnsley Road, Flockton

Further to your recent invitation, please find attached our proposal for undertaking a site investigation on the above land. We understand that your proposed development will include 92 traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers.

Review of the drawing supplied suggests that the site consists of a single parcel of land of approximately 2.5 hectares off Barnsley Road, Flockton. Review of Google Maps suggests the south-east of the site is currently occupied by Flockton Working Men's Club, the south-west by allotments/overgrown areas, and the north is occupied by a single open field.

Brief review of Old Maps and Environment Agency data suggests the site:

- appears to have remained undeveloped throughout its history, with the exception of the working men's club building, first shown in the 1960s
- is not located within 250m of a known landfill site
- is not within a groundwater source protection zone

Brief examination of the relevant geological map suggests the site is underlain by Lower Coal Measures bedrock (undifferentiated sandstone, siltstone and mudstone). The Flockton Thick seam is shown to outcrop in the west, and an area of 'infilled ground' associated with the Flockton thick seam is shown in the north-west (almost certainly a former opencast mine).

Brief review of the Coal Authority's online Interactive Map Viewer suggests there are numerous mine entries (adits and shafts) located along the southern and eastern site boundary. This will be confirmed by the Coal Authority mining report and any available abandonment plans; our proposal allows for obtaining abandonment plans.

This site is located within a Coal Mining Development High Risk Area (an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc) therefore a mining report is will be obtained.

Due to the presence of shallow coal the Local Authority may consider the site to lie within a Mineral Safeguarding Area. As a consequence of this and the NPPF, the Local Authority may require you to consider the opportunity to recover (extract) the coal. Our report will include an assessment of the feasibility of coal extraction.

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, CLR11 etc), and allows for the following works:

Desk study: Environmental search data and historical maps (obtained from Landmark or Groundsure as well as any available abandonment plans from the Coal Authority), will be reviewed in order to determine whether any past land uses have had any effect on the proposed development. In addition, published geological plans of the area will be examined. We will also visit site to undertake a walkover survey.

Fieldwork: We have allowed for two day's trial pitting and the drilling of around 6 rotary probeholes. All trial pits and probeholes will be supervised and logged by an experienced geoenvironmental engineer.

Soakaway testing will also be carried out in at least 5 pits in order to assess suitability of the ground for house and highway surface water drainage.

In line with current UK guidance, (most notably BRE365 and CIRIA C697:2007) soakaways should not be advocated where the seasonally high groundwater table lies within 1m of the soakaway base. Consequently, assuming the initial soakaway tests yield satisfactory results the wells installed within rotary probeholes would need to monitored for ground water levels on at least 6 occasions.

No allowance has been made for investigation within the immediate vicinity of the existing working men's club as it is understood that this building is still in use and therefore the disturbance caused by trial pitting would be unacceptable at this stage. It would be possible to investigate this are with a more 'subtle' technique (window sampling); however it would be more economical to return to the site and carry out additional trial pitting at a later date once the building has been demolished, or is no longer in use. The additional fee for this would be around £*** inclusive of chemical testing.

Representative soil samples of natural and man-made ground, including any contaminated samples, will be taken during the works. In-situ shear strengths of any cohesive soils encountered will be determined by the use of a hand-held shear vane.

We will make every effort to compact arisings and 'sweep' them over each pit. However, you should be aware that on completion of the investigation, "graves" of spoil (each about 3m long by 1m wide) unsuitable for trafficking, will be left up to 400mm proud at each trial pit location. At this stage, no allowance has been made for any further reinstatement such as removal of excess arisings, replacement of turf etc.

If the pitting encounters significant thicknesses of very soft/loose deposits (unlikely) or deep made ground (possible within the former opencast), boreholes may be required to obtain geotechnical data from greater depth. We will advise you of any need for boreholes within 2 days of completion of the pitting.

This investigation should yield sufficient data to enable a foundation zoning plan, and possibly a detailed Foundation Schedule. However, if ground conditions are found to be more variable than anticipated, a 'tighter' grid of pits will be necessary prior to preparation of a detailed Foundation Schedule. This proposal does not allow for the preparation of a detailed Foundation Schedule, but we will provide a quote on completion of the site investigation if requested.

The site is underlain by The Flockton Thick and Flockton Thin coal seams, and therefore we have allowed for the drilling of around 6 rotary probeholes to check for the presence of mineworkings, and also determine the depth to bedrock within the former opencast. This drilling should be sufficient to determine whether old mineworkings are present and pose a significant risk to surface stability of the site. However, if a potential risk is perceived to exist, further probeholes may be required to delineate the extent of workings in order to obtain fixed price quotations for the necessary consolidation works.

It will be necessary to submit an application (with the associated fee) to the Coal Authority (CA) for 'Permission to enter CA mining interests'; and we have allowed for this. Given the proximity of surrounding housing (within 50m of much of the general site area), and in accordance with CA requirements we have had to assume some of the probeholes will need to be advanced using water as the flushing medium (as reinforced by recent CA guidance on managing the risk of

hazardous gas). Our drilling sub-contractor will need to locate the wash outs close to the site, and procure a standpipe and licence from Yorkshire Water; our proposal allows for this.

With reference to the control, management and disposal of surplus water and flush arising from the works, (and in order to avoid additional costs associated with the provision of a telehandler to transfer a weir tank between boreholes, and the provision of a pump to transfer surplus water from the weir tank to an approved disposal point), we have made provision for a sand bag bund at the foot of the drilling mast, at each borehole to contain the majority of the drill cuttings. However, we have assumed that potentially discoloured surplus water will be allowed to flow and settle into the field.

Given the likely presence of a former opencast on site, as well as the potential for shallow mineworkings, we have allowed for the installation of wells in 6 holes and monitoring for hazardous gas (and any shallow groundwater).

The generation potential of this gas source is considered likely to be Low. Therefore, in accordance with CIRIA Report C665, we have initially allowed for 6 visits over a 3 month period. A hazardous gas risk assessment will be issued on completion of monitoring.

This proposal has been put together without a visit to the site and it has been assumed that access is available for a JCB-type excavator along with a tractor-towed water bowser and a track mounted drilling rig.

Soils testing: This will comprise routine geotechnical soils analysis, including 10 moisture content & Atterberg limits, and 10 pH & water soluble sulphate.

This site is brownfield and therefore likely to be underlain by made ground which in turn is likely to be subject to re-engineering prior to the construction of new estate roads. Consequently, there is no merit in obtaining CBR values at this stage. We will simply estimate CBR values from strata descriptions and classification test results.

The site is understood to be essentially Greenfield however made ground is likely to exist within the vicinity of the former opencast. Consequently, we have allowed for analysis of topsoil (6 samples) to confirm its suitability for re-use and a further 6 samples of made ground. The test suite will include heavy metals and speciated PAH.

Within in our proposal we have allowed for the screening (ID) of 12 samples for asbestos. In the event that positive IDs are reported, it is likely that we will need to schedule further analysis (asbestos quantification), in order to determine the significance of the results. Asbestos quantification is currently a relatively expensive test and consequently we have not allowed for it at this stage. We will inform you immediately after receipt of results if we consider asbestos quantification is required.

Reporting & timescales: In order to provide you with sufficient information to enable assessment of abnormal costs at the earliest opportunity we will issue a concise overview report within 5 days of fieldwork completion.

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

The report will also provide technically feasible options for redevelopment of the site with housing, including consideration of foundation types and treatment\removal of contamination.

Fieldwork could be commenced within 4 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion. This report will comment on issues associated with hazardous gas, but the gas risk assessment will not be issued until monitoring is completed.

Invoicing: The attached proposal provides a breakdown of the costs associated with this project. This breakdown is for information only and the proposal can be regarded as a lump sum price of £*** plus VAT. Variation will only occur in the event that a given item is not undertaken or that substantial additional works are recommended, in which case we will inform you immediately, provide costs for the required works, and seek your prior consent.

Our proposal allows for submission of the report to the Local Authority and NHBC, and for submission of a single piece of subsequent correspondence with each regulator to address any queries they may have. Any further meetings, correspondence etc, would be chargeable.

We will submit invoices for this project at the milestones defined below:

- 1st milestone invoice (Items A to D) within 5 days of fieldwork completion, with exploratory hole logs and an interim letter report outlining our initial findings and preliminary recommendations report
- 2nd milestone invoice (Items E, F & G) on issue of the final SI report
- 3rd and final invoice (Item G) after completion of the gas monitoring/issue of the supplementary letter report

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

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

Utility plans are required in order to protect operatives from the hazards associated with striking buried services and avoid potentially substantial disruption\repair costs. We will make every effort not to damage any services (including review of utility plans and use of a CAT detector). Most developers have copies of the necessary utility plans (including electricity, gas, water, drainage & telecom), and it would be appreciated if you could forward these prior to the proposed fieldworks. However, if you do not have the necessary plans, Lithos will obtain them direct from each of the utility companies.

Terms & conditions: Barratt & David Wilson Homes and Lithos have an agreed Appointment document, and this work will be undertaken in accordance with that.

You will note that in the last two columns of our costed proposal we have included an estimate of the proportion of the total cost of the works that could be eligible for Land Remediation Tax Relief (LRR). It is hoped the above is sufficient for your present needs. However, should you require any further information, please contact the undersigned.

Yours sincerely

Matt Thompson
Senior Engineer
for and on behalf of
LITHOS CONSULTING LIMITED

BDW TRADING LIMITED Region – Barratt & David Wilson Homes Yorkshire West ("the Client")	**TO:** **Lithos Consulting** ..... ("the Consultant")

This Project Order is issued pursuant to the Agreement dated 17th June 2015

Order: The Client requires and instructs the Consultant to carry out the Services in connection with the Project in accordance with and subject to the Terms and Conditions set out in the Agreement and the special conditions (if any) set out in this Project Order.

The Project: Flockton Working Mens Club

Project No: FLOC-Lithos-01
Project Start Date: **26/08/2015**
Project Finish Date: **4weeks to start on fieldwork**
1week initial report from fieldwork
4 weeks to issue full report from field work
TOTAL WEEK 8 – 21/10/2015 (latest)

Site: Flockton Working Mens Club, Barnsley Road, Flockton, WF4 4AA

Works:
To complete stage 1 and 2 site investigation, obtain service provider information and obtain coal authority licence

Client Contact:
Graham Rhodes
0113 279 0099
graham.rhodes@barratthomes.co.uk

Scope of Services:
The Services of **Lithos Consulting** as attached to this Project Order as Schedule 1 subject to the following amendments if any:

Fee: the sum of £[redacted] (exclusive of VAT) payable as follows:

Month/Work Stage *	**%/Amount of fee due**	**Cumulative Fee**
Stages as set out on Quote (Schedule 1)	100% at each stage	....

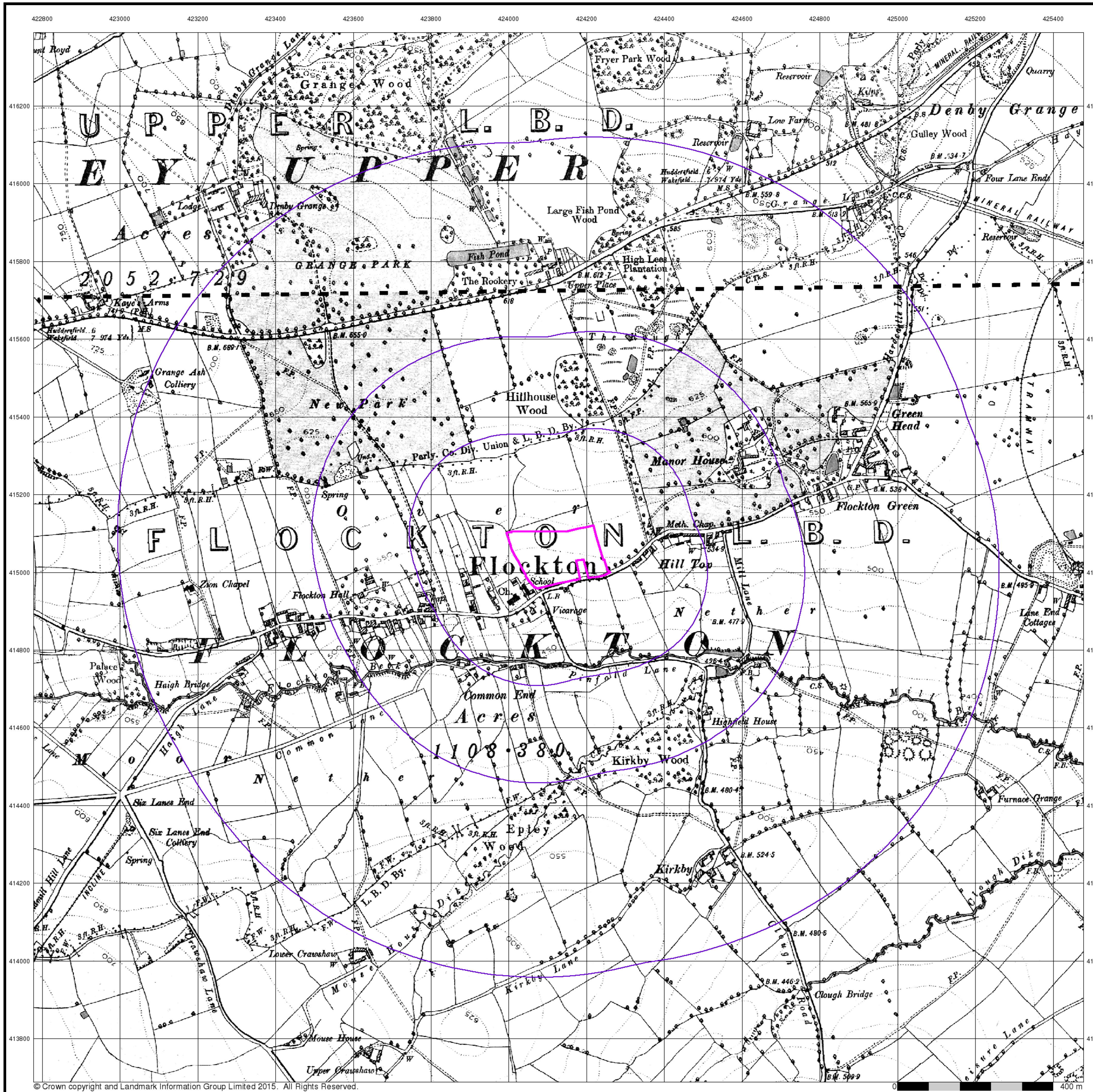
Expenses to be paid in addition to the Fee:
Additional £[redacted] for SI work within working mens club area post demolition (should site progress & timescales will be advised at that time)

Special Conditions (if any)

Signed for and on behalf of BDW Trading Limited Dated 26/08/2014	Signed for and on behalf of Dated .....28/8/15.....

Appendix D

Historical OS Plans



LITHOS CONSULTING

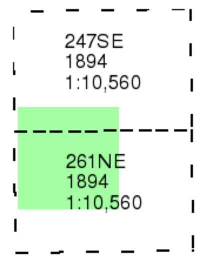
Yorkshire

Published 1894

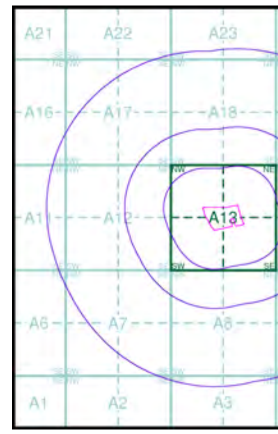
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



N

Order Details

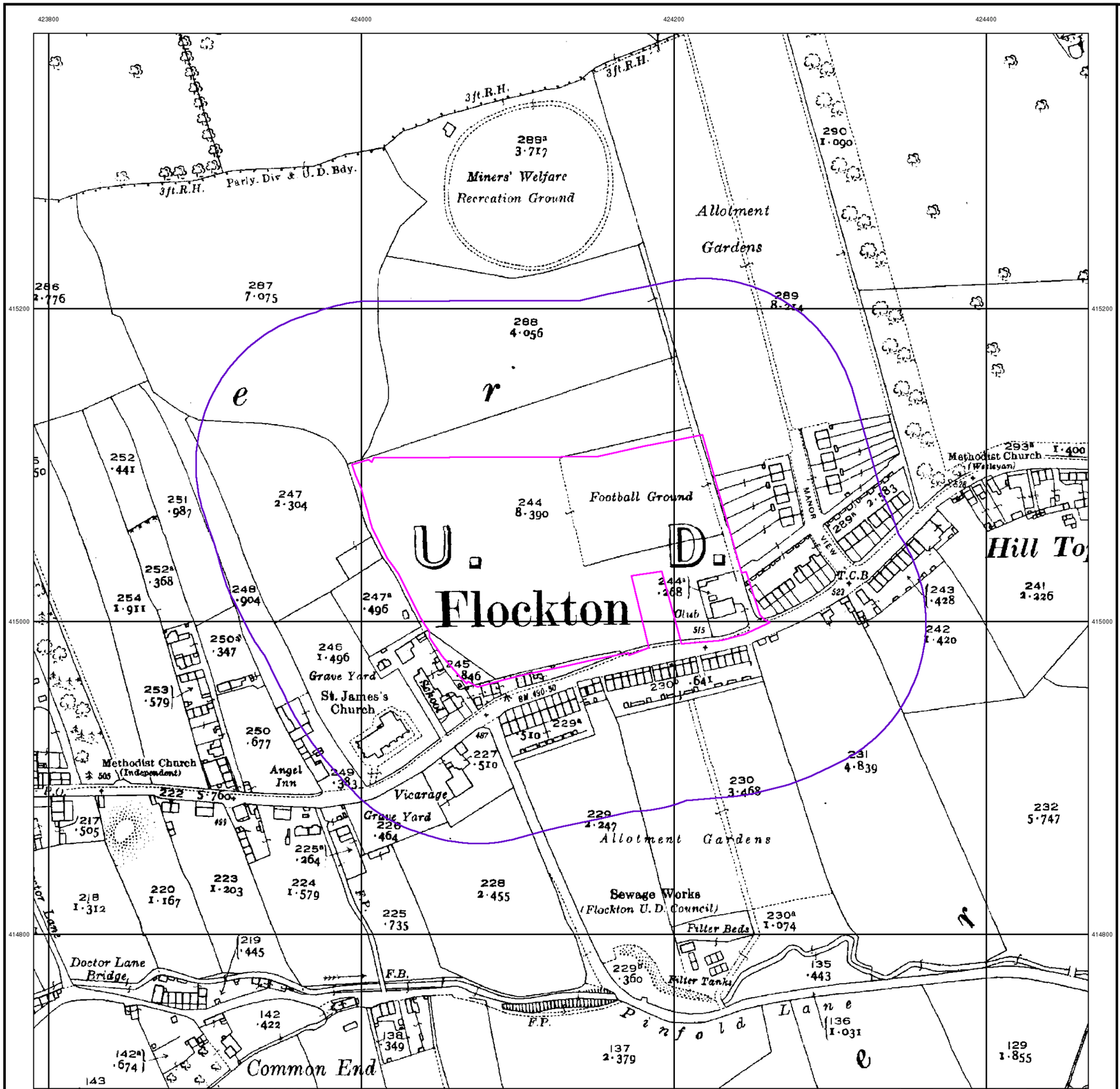
Order Number:	72890244_1_1
Customer Ref:	2211
National Grid Reference:	424130, 415050
Slice:	A
Site Area (Ha):	2.82
Search Buffer (m):	1000

Site Details

Flockton Green Working Mens Club, 157 Barnsley Road, Flockton, WAKEFIELD, West Yorkshire, WF4 4AA

Landmark Information Group

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



LITHOS CONSULTING

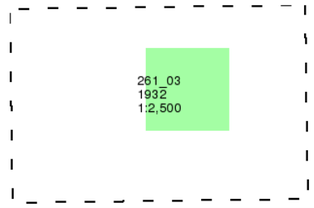
Yorkshire

Published 1932

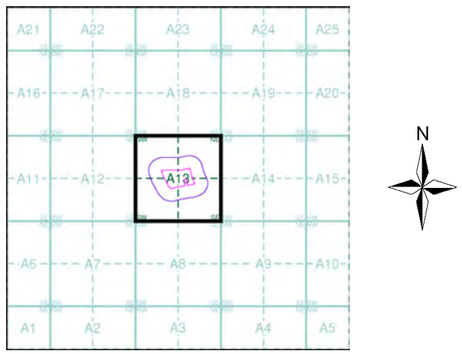
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

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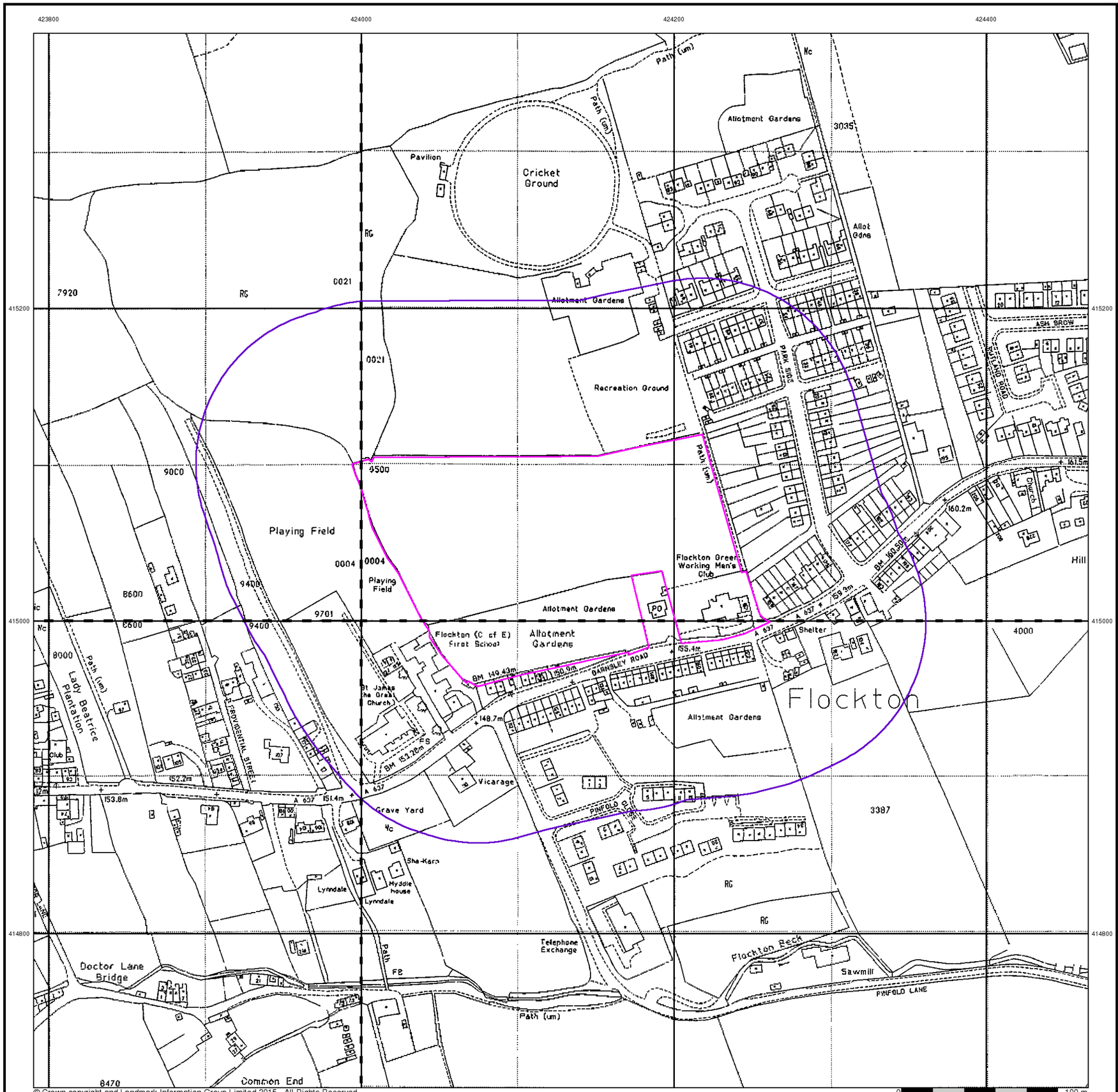


LITHOS CONSULTING

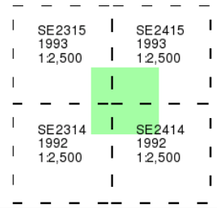
Large-Scale National Grid Data

Published 1992 - 1993

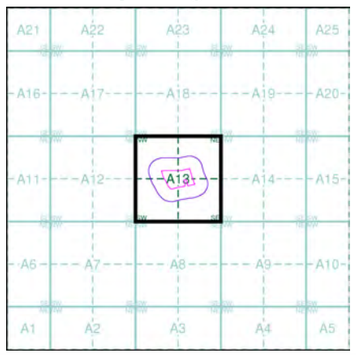
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

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Customer Ref:	2211
National Grid Reference:	424130, 415050
Slice:	A
Site Area (Ha):	2.82
Search Buffer (m):	100

Site Details

Flockton Green Working Mens Club, 157 Barnsley Road, Flockton, WAKEFIELD, West Yorkshire, WF4 4AA

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

Appendix E

Search Responses

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
72890244_1_1

Customer Reference:
2211

National Grid Reference:
424130, 415050

Slice:
A

Site Area (Ha):
2.82

Search Buffer (m):
1000

Site Details:

Flockton Green Working Mens Club
157 Barnsley Road, Flockton
WAKEFIELD
West Yorkshire
WF4 4AA

Client Details:

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

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 1		3	4	3
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 3				3
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 3		Yes		
Pollution Incidents to Controlled Waters	pg 4		2	2	1
Prosecutions Relating to Authorised Processes					
Prosecutions Relating to Controlled Waters					
Registered Radioactive Substances					
River Quality	pg 4		1		
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register					
Water Abstractions	pg 5				(*1)
Water Industry Act Referrals					
Groundwater Vulnerability	pg 5	Yes	n/a	n/a	n/a
Bedrock Aquifer Designations	pg 5	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences	pg 5		Yes	n/a	n/a
Flooding from Rivers or Sea without Defences	pg 5		Yes	n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
Detailed River Network Lines	pg 5		Yes	Yes	n/a
Detailed River Network Offline Drainage	pg 8			Yes	n/a

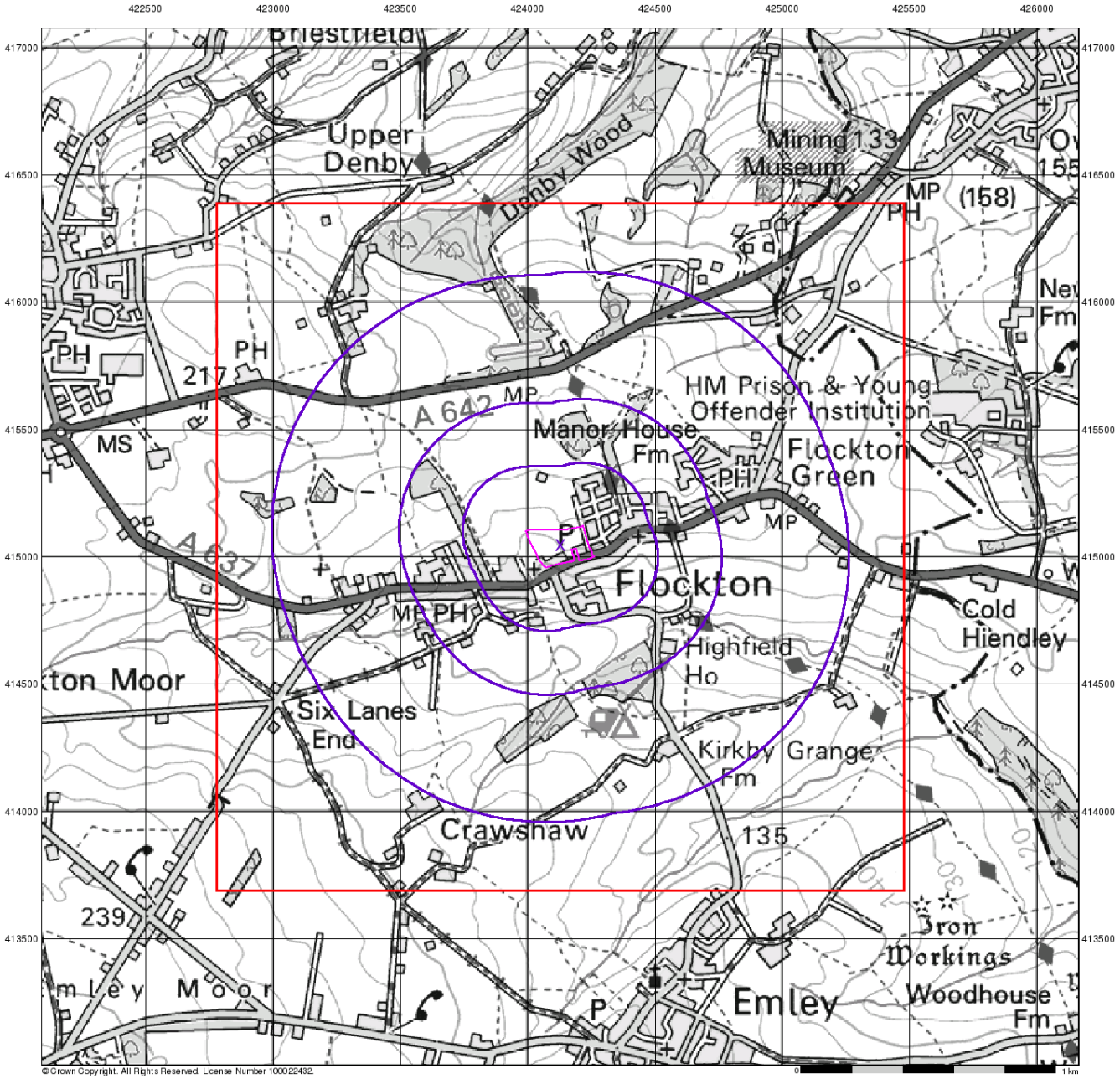
LITHOS CONSULTING

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites					
Historical Landfill Sites					
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)					
Local Authority Recorded Landfill Sites					
Registered Landfill Sites					
Registered Waste Transfer Sites					
Registered Waste Treatment or Disposal Sites					
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					
Geological					
BGS 1:625,000 Solid Geology	pg 10	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 10	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 27			5	26
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
Brine Compensation Area			n/a	n/a	n/a
Coal Mining Affected Areas	pg 32	Yes	n/a	n/a	n/a
Mining Instability	pg 33	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 33	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 33	Yes	Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 33	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 34	Yes	Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 34	Yes		n/a	n/a
Radon Potential - Radon Affected Areas	pg 35	Yes	n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Industrial Land Use					
Contemporary Trade Directory Entries	pg 36			1	2
Fuel Station Entries					
Sensitive Land Use					
Areas of Adopted Green Belt	pg 37	1			
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 37	1			
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					



LITHOS CONSULTING

Source Protection Zones

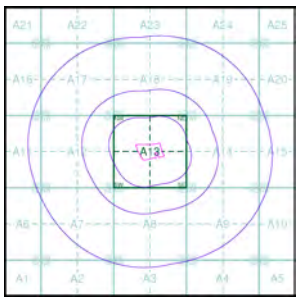
General

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

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)
- Source Protection Zone Borehole

Site Sensitivity Context Map - Slice A



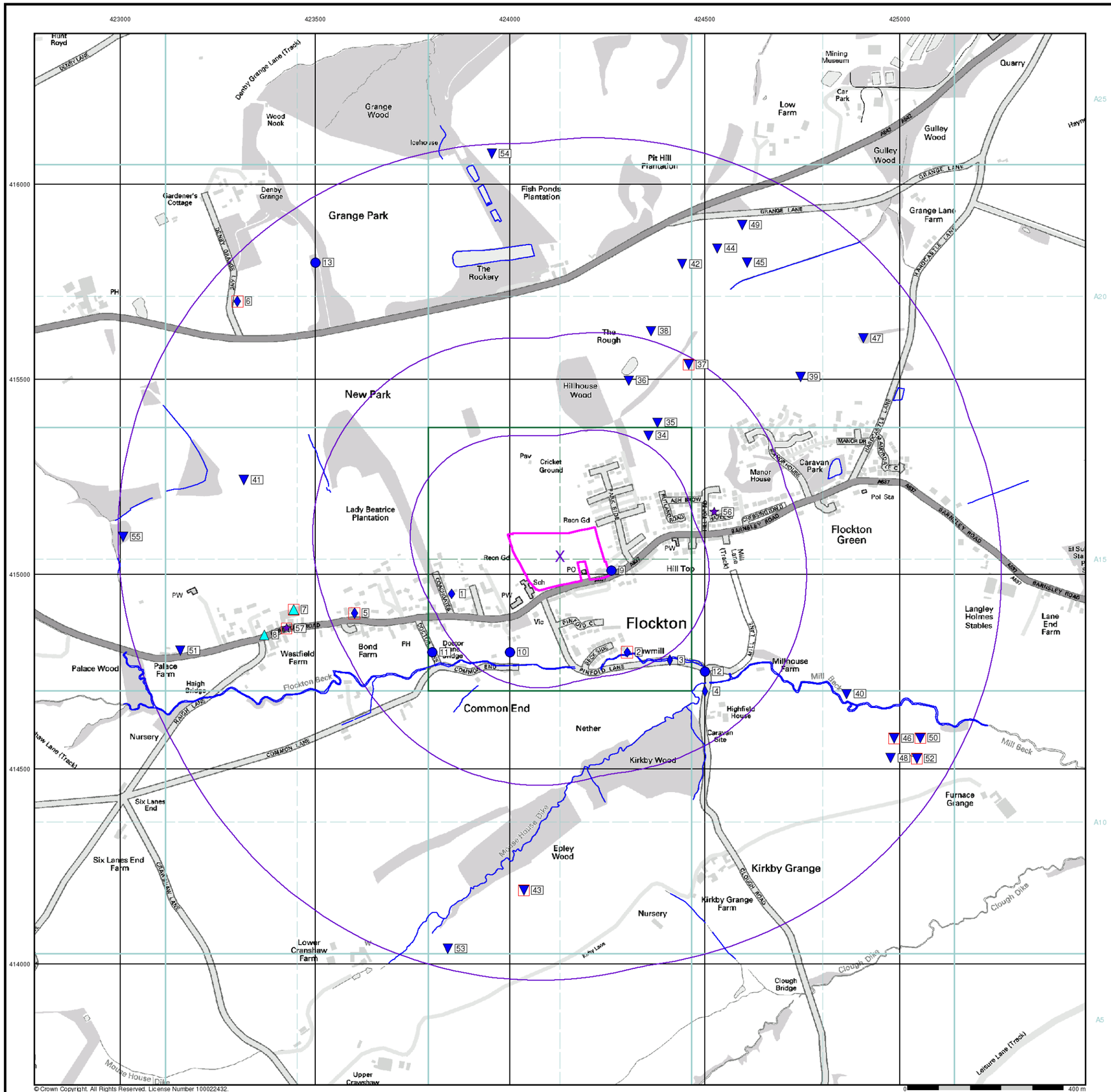
Order Details

Order Number:	72890244_1_1
Customer Ref:	2211
National Grid Reference:	424130, 415050
Slice:	A
Site Area (Ha):	2.82
Search Buffer (m):	1000

Site Details

Flockton Green Working Mens Club, 157 Barnsley Road, Flockton, WAKEFIELD, West Yorkshire, WF4 4AA

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



LITHOS CONSULTING

General

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

Agency and Hydrological

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

Geological

- BGS Recorded Mineral Site

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry

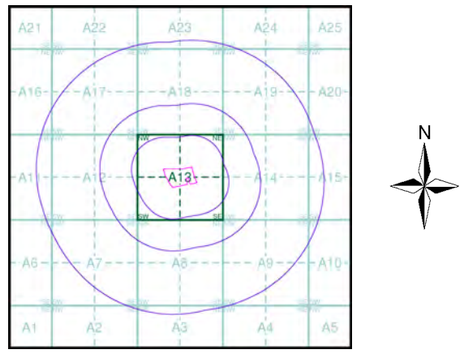
Waste

- BGS Recorded Landfill Site (Location)
- BGS Recorded Landfill Site
- EA Historic Landfill (Buffered Point)
- EA Historic Landfill (Polygon)
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facility (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Local Authority Recorded Landfill Site (Location)
- Local Authority Recorded Landfill Site
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

Site Sensitivity Map - Slice A



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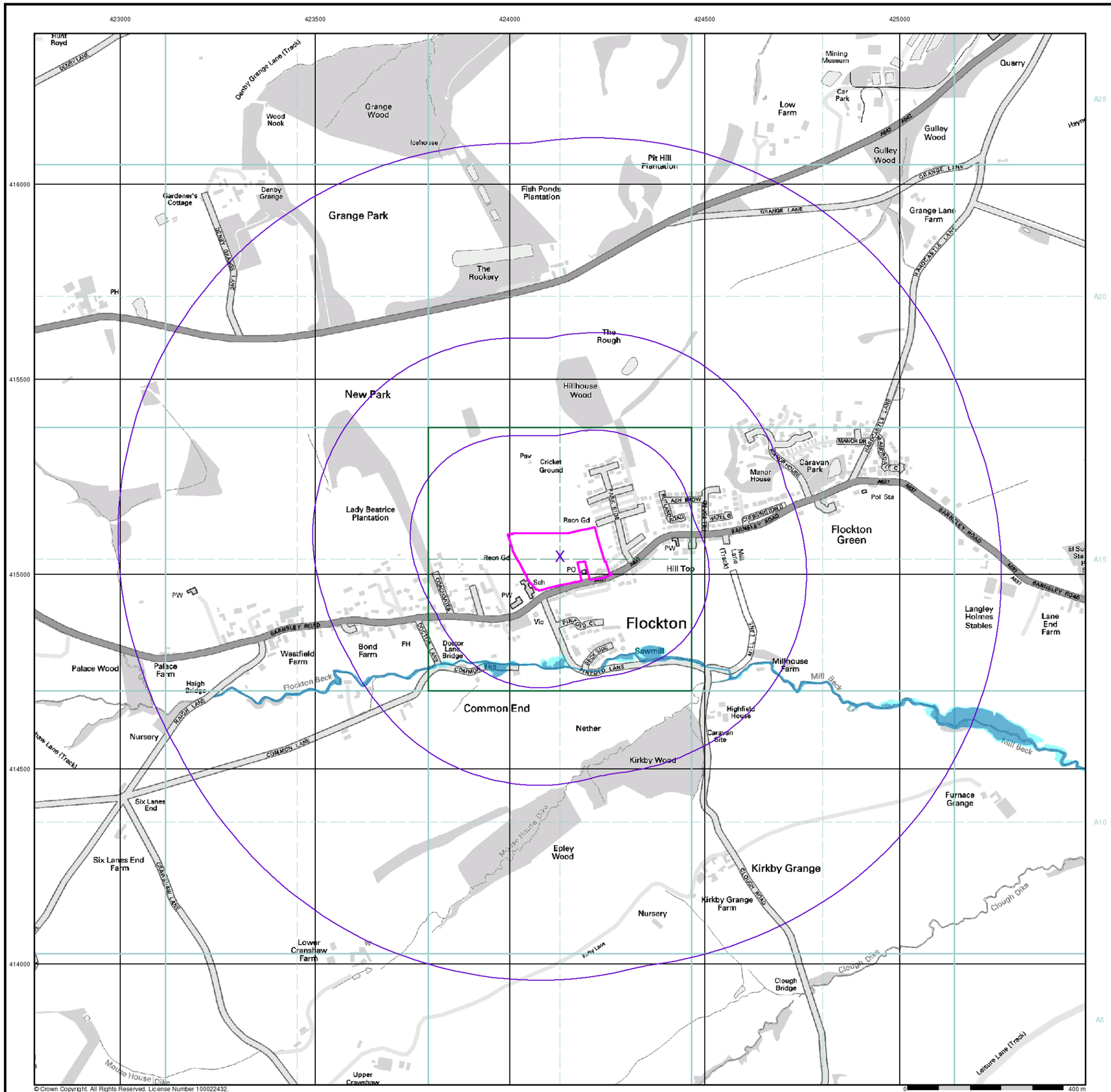


LITHOS CONSULTING

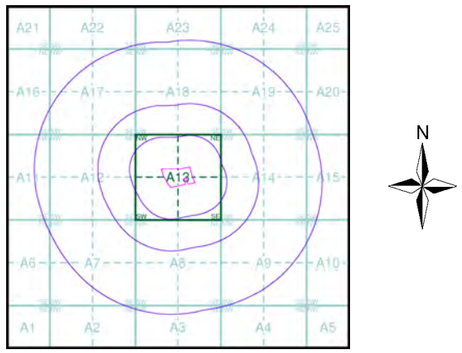
General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



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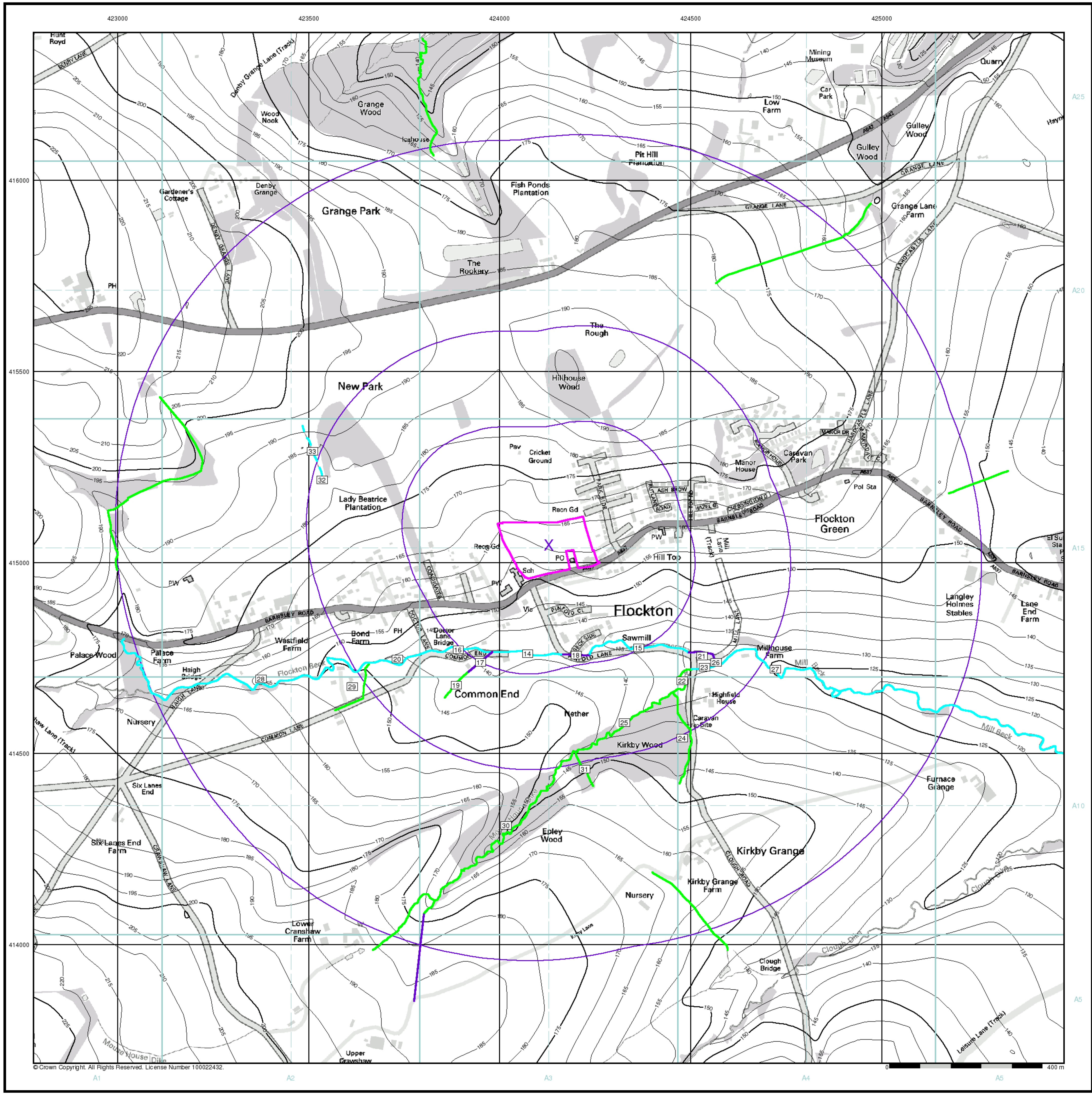


General

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

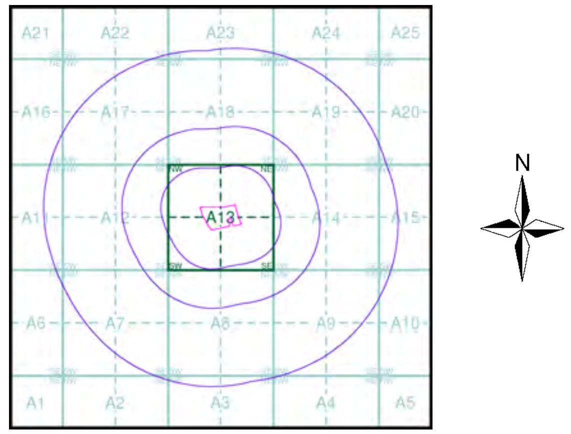
Detailed River Network Data

Primary River	Extended Culvert (greater than 50m)
Secondary River	Underground River (inferred)
Tertiary River	Underground River (local knowledge)
Canal	Downstream of High Water Mark
Canal Tunnel	Downstream of Seaward Extension
Undefined River	Not assigned River feature
Lake/Reservoir	
Offline Drainage Feature	

Contours (height in metres)

Standard Contour	105	MLW Mean Low Water
Master Contour	100 95	MHW Mean High Water
Spot Height	167.3	

EA/NRW Detailed River Network Map - Slice A



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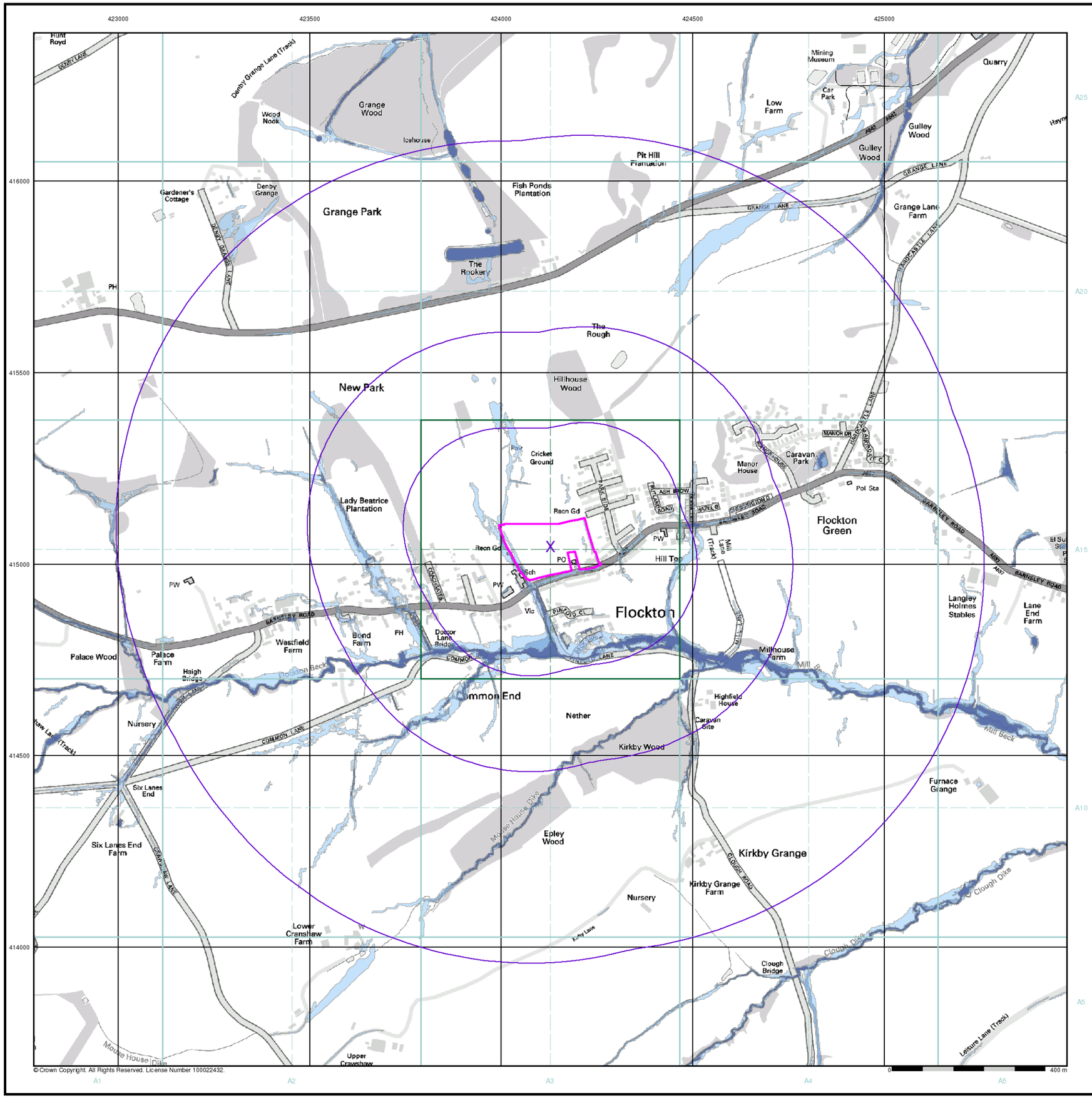


LITHOS CONSULTING

General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

Risk of Flooding from Surface Water

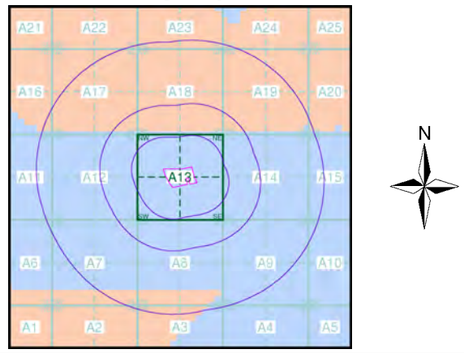
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

EA/NRW Suitability Map - Slice A



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Tel: 0844 844 9952
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The Coal Authority

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

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

Our reference:	**51001006684001**
Your reference:	**72890244_2|**
Date of your enquiry:	**23 September 2015**
Date we received your enquiry:	**23 September 2015**
Date of issue:	**23 September 2015**

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

Non-Residential Coal Authority Mining Report

FLOCKTON GREEN WORKING MENS CLUB, FLOCKTON, 157 BARNSLEY ROAD WAKEFIELD, WEST YORKSHIRE,

This report is based on and limited to the records held by, the Coal Authority, and the Cheshire Brine Subsidence Compensation Board's records, at the time we answer the search.

Coal mining	See comments below
Brine Compensation District	No

Information from the Coal Authority

Underground coal mining

Past

The property is in the likely zone of influence from workings in 5 seams of coal at shallow to 210m depth, and last worked in 1975.

Present

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

Future

The property is not in an area for which the Coal Authority is determining whether to grant a licence to remove coal using underground methods.

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

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

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

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

Mine entries

Within, or within 20 metres of, the boundary of the property there are 4 mine entries, the approximate positions of which are shown on the attached plan.

There is no record of what steps, if any, have been taken to treat the mine entries.

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

For an additional fee, the Coal Authority will provide a supplementary Mine Entry Interpretive Report. The report will provide a separate assessment for the mine entry (entries) referred to in this report. It will give details based on information in the Coal Authority's possession, together with an opinion on the likelihood of mining subsidence damage arising from ground movement as a consequence of the existence of the mine entry/entries. It will also give details of the remedies available for subsidence damage where the mine entry was sunk in connection with coal mining.

Please note that it may not be possible to produce a report if the main building to the property cannot be identified from Coal Authority plans (ie. for development sites and new build).

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

Coal mining geology

The Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining.

Opencast coal mining

Past

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

Present

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

Future

The property is not within 800 metres of the boundary of an opencast site for which the Coal Authority is determining whether to grant a licence to remove coal by opencast methods.

The property is not within 800 metres of the boundary of an opencast site for which a licence to remove coal by opencast methods has been granted.

Coal mining subsidence

A damage notice or claim for alleged subsidence damage was made in November 2011 for 1 PARKSIDE, FLOCKTON, WAKEFIELD, WEST YORKSHIRE, WF4 4AD. However, the claim was rejected.

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

There are a further 1 claim(s) within 50 metres of the property boundary that do not match the property address. These are shown on the attached plan.

The Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

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

Mine gas

There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the property.

Hazards related to coal mining

The property has not been subject to remedial works, by or on behalf of the Authority, under its Emergency Surface Hazard Call Out procedures.

Withdrawal of support

The property is in an area for which notices of entitlement to withdraw support were published in 1972.

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

Working facilities orders

The property is not in an area for which an Order has been made under the provisions of the Mines (Working Facilities and Support) Acts 1923 and 1966 or any statutory modification or amendment thereof.

Payments to owners of former copyhold land

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

Comments on Coal Authority information

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

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

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

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

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

In view of the mining circumstances a prudent developer would seek appropriate technical advice before any works are undertaken.

Therefore if development proposals are being considered, technical advice relating to both the investigation of coal and former coal mines and their treatment should be obtained before beginning work on site. All proposals should apply good engineering practice developed for mining areas. No development should be undertaken that intersects, disturbs or interferes with any coal or mines of coal without the permission of the Coal Authority. Developers should be aware that the investigation of coal seams/former mines of coal may have the potential to

generate and/or displace underground gases and these risks both under and adjacent to the development should be fully considered in developing any proposals. The need for effective measures to prevent gases entering into public properties either during investigation or after development also needs to be assessed and properly addressed. This is necessary due to the public safety implications of any development in these circumstances.

Information from the Cheshire Brine Subsidence Compensation Board

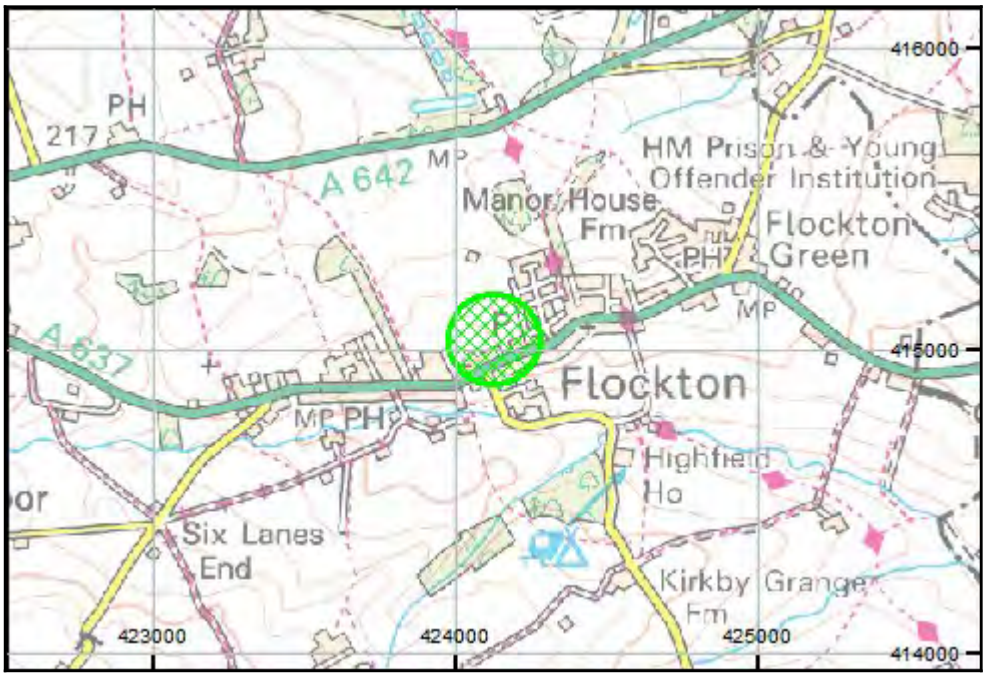
The property lies outside the Cheshire Brine Compensation District.

Additional Remarks

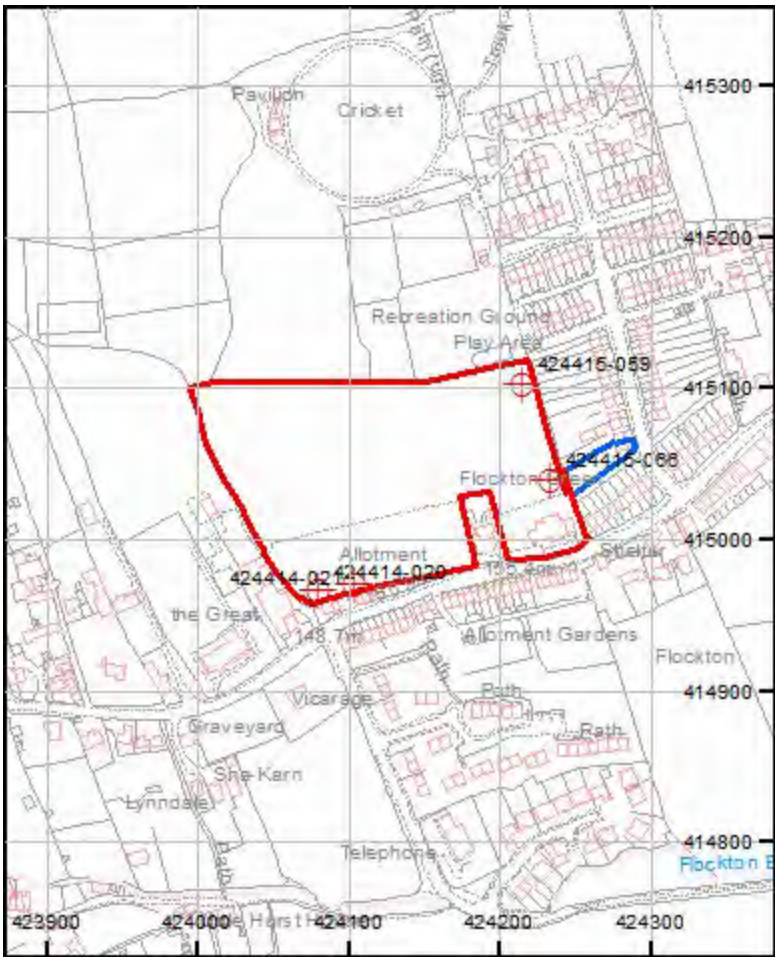
Information provided by the Coal Authority in this report is compiled in response to the Law Society's Con29M Coal Mining and Brine Subsidence Claim enquiries. The said enquiries are protected by copyright owned by the Law Society of 113 Chancery Lane, London WC2A 1PL. Please note that Brine Subsidence Claim enquiries are only relevant for England and Wales. This report is prepared in accordance with the Law Society's Guidance Notes 2006, the User Guide 2006 and the Coal Authority and Cheshire Brine Board's Terms and Conditions applicable at the time the report was produced.

Location map

Approximate position of property



Enquiry boundary



Key

Approximate position of enquiry boundary shown

Disused Adit or Mineshaft

Coal Claims

Mapping sourced from Ordnance Survey

The Coal Authority

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

LITHOS CONSULTING
PARKHILL
WALTON ROAD
WETHERBY
LS22 5DZ

Our reference:	**51000997071001**
Your reference:	**PO 9778/2211/MJT**
Date of your enquiry:	**24 September 2015**
Date we received your enquiry:	**24 September 2015**
Date of issue:	**25 September 2015**

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

Shaft Plan and Data Sheets

FLOCKTON POST OFFICE, FLOCKTON GREEN WORKING MENS CLUB, BARNSLEY ROAD, WAKEFIELD, WF4 4AA

I refer to the enquiry dated 24 September 2015, received 24 September 2015, in connection with the above.

As requested I enclose the mine entry data sheet(s) held for the mine entry/entries referred to.

Mine Entry Data

Shaft/adit:	Shaft
Reference:	424415-059
Source:	Former British Coal Records (Colliery Surface Overlay)
Colliery name:	Unknown
Entry name:	Unknown
Date abandoned:	Unknown
Depth of superficial deposits (m):	Unknown
Depth of shaft (m):	Unknown
Diameter of shaft (m):	Unknown
Probable adit azimuth:	Not Applicable
Treatment details:	Unknown
Conveyance:	Not Applicable
Easting:	424216
Northing:	415102
Other information:	None

Mine Entry Data (continued)

Shaft/adit:	Shaft
Reference:	424415-066
Source:	Former British Coal Records (Colliery Flockton Thick 6" Plan)
Colliery name:	Unknown
Entry name:	Unknown
Date abandoned:	Unknown
Depth of superficial deposits (m):	Unknown
Depth of shaft (m):	Unknown
Diameter of shaft (m):	Unknown
Probable adit azimuth:	Not Applicable
Treatment details:	Unknown
Conveyance:	Not Applicable
Easting:	424234
Northing:	415039
Other information:	None

Mine Entry Data (continued)

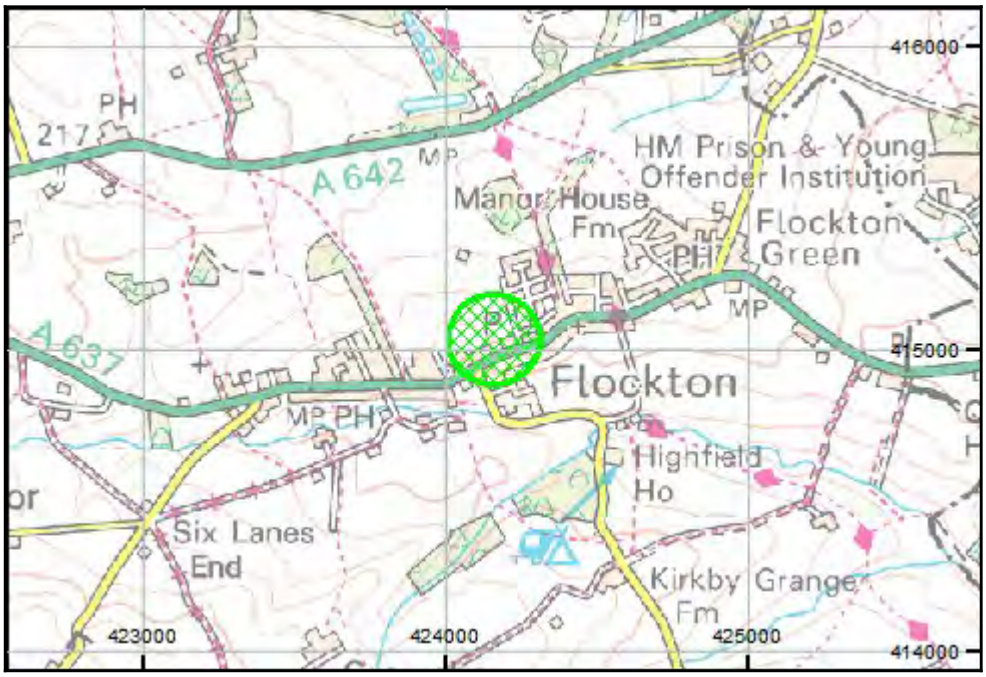
Shaft/adit:	Shaft
Reference:	424414-020
Source:	Former British Coal Records (Colliery Flockton Thick 6" Plan)
Colliery name:	Unknown
Entry name:	Unknown
Date abandoned:	Unknown
Depth of superficial deposits (m):	Unknown
Depth of shaft (m):	Unknown
Diameter of shaft (m):	Unknown
Probable adit azimuth:	Not Applicable
Treatment details:	Unknown
Conveyance:	Not Applicable
Easting:	424081
Northing:	414966
Other information:	None

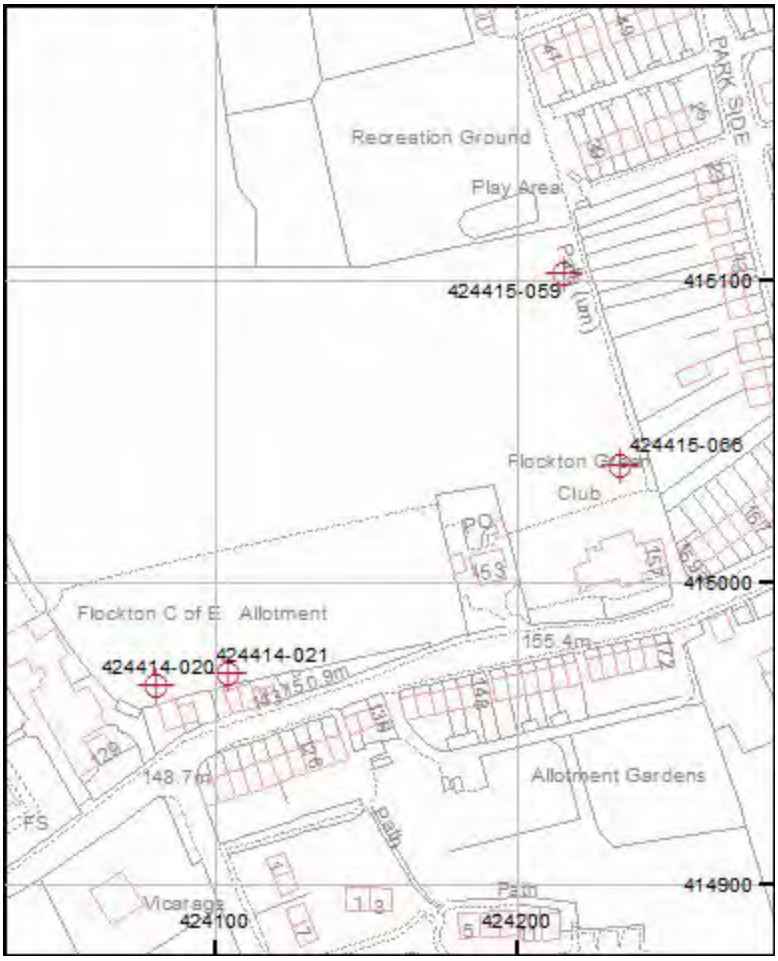
Mine Entry Data (continued)

Shaft/adit:	Shaft
Reference:	424414-021
Source:	Former British Coal Records (Colliery Flockton Thick 6" Plan)
Colliery name:	Unknown
Entry name:	Unknown
Date abandoned:	Unknown
Depth of superficial deposits (m):	Unknown
Depth of shaft (m):	Unknown
Diameter of shaft (m):	Unknown
Probable adit azimuth:	Not Applicable
Treatment details:	Unknown
Conveyance:	Not Applicable
Easting:	424105
Northing:	414970
Other information:	None

Location map

Approximate position of enquiry





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

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

Our emergency telephone number at all times is 01623 646333.

Key

Disused Adit or Mineshaft

Mapping sourced from Ordnance Survey

17778

FLOCKTON THIN SEAM SCALE:- 1/10560

THIS PLAN HAS BEEN CONSTRUCTED FROM INFORMATION FORMERLY HELD BY THE NATIONAL COAL BOARD. THE COAL AUTHORITY CANNOT VOUCH FOR ITS ACCURACY OR COMPLETENESS.

Appendix F

Trial Pit Logs

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP01** Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424053.00 - 414994.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 3.10	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown, slightly gravelly, sandy clay. Gravel is sub-angular to angular, fine to medium of mudstone and brick. (TOPSOIL)
				0.30			Firm, orange-brown, slightly gravelly CLAY. Gravel is sub-angular to angular, fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
	0.80	D					
				1.60			Soft, wet, light grey CLAY. (COHESIVE RESIDUAL SOIL)
	2.00	D					
			HVP=25				*At 2.5m, water inflow.*
▼				3.00			?Medium dense, light grey, clayey, sub-angular to angular, fine to coarse, horizontally oriented GRAVEL of mudstone. (GRANULAR RESIDUAL SOIL)
				3.10			End of pit at 3.10 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflows were encountered at 2.8m. 3. The sides of the trial pit began to collapse beyond 2m depth. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP02** Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424066.00 - 415032.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 2.30	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown, slightly gravelly, sandy clay. Gravel is sub-angular to angular, fine to medium of mudstone. (TOPSOIL)
			HVP=60	0.40			Firm, dark brown, gravelly CLAY. Gravel is sub-angular to angular, fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)
				1.00			?Medium dense, light orangish brown, clayey GRAVEL. Gravel is sub-angular to angular, fine to coarse of sandstone. (GRANULAR RESIDUAL SOIL)
	1.50	D		1.40			Black, weathered COAL. Recovered as sub-angular to sub-rounded, fine to coarse, clayey gravel of coal and dark mudstone. (WEATHERED FLOCKTON THICK COAL SEAM)
				1.80			?Medium dense, yellowish brown, slightly clayey, sub-angular to angular, fine to coarse sized GRAVEL of sandstone. Some cobble. (GRANULAR RESIDUAL SOIL)
				2.30			End of pit at 2.30 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP03**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424030.00 - 415056.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 1.70	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown, clayey sand with common rootlets. (TOPSOIL)
				0.30			?Medium dense, yellowish brown, slightly clayey, sub-angular to angular, fine to coarse sized GRAVEL of sandstone. Some cobble. (GRANULAR RESIDUAL SOIL)
	1.00	D					
				1.70			End of pit at 1.70 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP04** Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424055.00 - 415095.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 3.40	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20			TOPSOIL: Dark brown, sandy clay. (TOPSOIL)
							MADE GROUND: Dark grey, clayey, sub-angular to angular, fine to cobble sized, randomly oriented gravel of mudstone. (OPENCAST BACKFILL)
							At and below 1.0m, sidewalls collapsing.
	1.20	J&T					
				2.80			MADE GROUND: Firm, light grey, clay. (OPENCAST BACKFILL)
			HVP=66				
	3.20	J&T					
				3.40			*At 3.4m, unable to dig further due to sidewall collapse.* End of pit at 3.40 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Sidewall collapse occurred below 1m. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP05**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424086.00 - 415064.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 3.20	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.20			TOPSOIL: Dark brown, slightly gravelly, sandy clay. Gravel is of sub-angular, fine to medium brick and concrete. (TOPSOIL)
							MADE GROUND: Grey, slightly clayey, sub-angular to angular, fine to cobble-sized, gravel of mudstone. (OPENCAST BACKFILL)
							At and below 1.0m, sidewalls collapsing.
			HVP=56	2.00			MADE GROUND: Firm, grey, brown mottled, slightly gravelly clay. Gravel is sub-angular, fine, of mudstone. (OPENCAST BACKFILL)
				3.20			End of pit at 3.20 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Sidewall collapse occurred below 1m. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP06** Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424100.00 - 415056.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 2.80	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20			TOPSOIL: Dark brown, slightly gravelly, sandy clay with common rootlets. Gravel is fine to cobble sized of sandstone, coal, brick and mudstone. (TOPSOIL)
							MADE GROUND: ?Medium dense, grey, clayey, sub angular to angular, fine to coarse gravel of predominantly mudstone with coal traces. (OPENCAST BACKFILL)
	1.00	J&T					*At and below 1.0m, spalling.*
				2.80			*At 2.8m, unable to dig further due to sidewall collapse.* End of pit at 2.80 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Some spalling occurred beyond 1m depth. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP07**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424104.00 - 415086.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 3.20	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20			TOPSOIL: Dark brown, sandy clay. (TOPSOIL)
	0.80	J		1.00			MADE GROUND: Brown, gravelly CLAY. (COHESIVE MADE GROUND)
	1.50	J&T		3.20			MADE GROUND: Light grey, clayey, sub-angular to angular, fine to cobble sized GRAVEL of mudstone. (GRANULAR MADE GROUND) *At and below 1.5m, sidewalls collapsing.* End of pit at 3.20 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Pit sides were unstable below 1.5m depth. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP08
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424125.00 - 415070.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 1.80	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown, clayey sand with common rootlets. (TOPSOIL)
				0.30			MADE GROUND: ?Medium dense, greyish brown, slightly clayey, sub-angular to angular, fine to coarse gravel of mudstone, sandstone and coal. (OPENCAST BACKFILL)
	0.60	J&T					
	0.80	J&T					
				1.60			Firm, orangish brown, slightly gravelly CLAY. Gravel is sub-angular to sub-rounded, fine to medium of coal and mudstone. (COHESIVE RESIDUAL SOIL)
				1.80			End of pit at 1.80 m

1
2
3
4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP09**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424163.00 - 415054.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 1.80	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown, clayey sand. (TOPSOIL)
				0.30			
				0.40			?Medium dense, light grey, clayey, tabular, fine to medium GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
	1.00	D					?Medium dense, yellow, slightly clayey, sub-angular to angular, fine to coarse sized GRAVEL of sandstone. Some cobble. (GRANULAR RESIDUAL SOIL)
				1.50			?Moderately strong, orange brown, SANDSTONE. Recovered as tabular, coarse gravel and cobble. (COAL MEASURES)
				1.80			*At 1.8m, unable to dig further due to refusal.* End of pit at 1.80 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP10**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424161.00 - 415087.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 1.20	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown, clayey sand with common rootlets. Rare angular, tabular, fine to medium gravel of mudstone. (TOPSOIL)
				0.30			?Medium dense, yellowish brown, slightly clayey, angular, tabular, fine to cobble sized GRAVEL of sandstone. (WEATHERED COAL MEASURES)
				1.20			*At 1.2m, unable to dig further due to refusal.* End of pit at 1.20 m

1
2
3
4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP11
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424207.00 - 415109.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 2.50	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown, slightly gravelly, sandy clay. Gravel is of sub rounded, fine to medium sandstone, mudstone and tile. (TOPSOIL)
				0.30			Firm, light grey, slightly gravelly CLAY. Gravel is of sub-angular, medium to coarse mudstone and coal. (COHESIVE RESIDUAL SOIL)
				0.70			Firm, yellow, grey gleyed CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=75				
			HVP=75				
				2.10			?Medium dense, clayey, angular, tabular, fine to medium GRAVEL of mudstone. (GRANULAR RESIDUAL SOIL)
				2.50			End of pit at 2.50 m

1
2
3
4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

Trialpit No **TP12**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424218.00 - 415046.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 1.80	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown, slightly gravelly, sandy clay. Gravel is sub rounded to angular, fine to medium of sandstone, mudstone and tile. (TOPSOIL)
				0.35			Firm, orange-brown clay. (COHESIVE RESIDUAL SOIL)
	1.00	D					
			HVP=75	1.40			Firm, yellow, grey mottled CLAY. (COHESIVE RESIDUAL SOIL)
				1.60			?Moderately strong, yellow, SANDSTONE. (COAL MEASURES)
				1.80			*At 1.8m, unable to dig further due to refusal.* End of pit at 1.80 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP13
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424219.00 - 415070.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 2.10	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown, sandy, slightly gravelly clay with common rootlets. Gravel is sub-angular to angular, fine to medium of brick and mudstone. (TOPSOIL)
				0.35			Firm, orange brown, grey gleyed CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=65				
	1.10	D					
			HVP=90				*At 1.5m, becoming stiff.*
				1.90			?Medium dense, grey, slightly clayey, angular, tabular, fine to medium GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				2.10			*At 2.1m, unable to dig further due to refusal.* End of pit at 2.10 m

1
2
3
4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP14**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424150.00 - 415013.00 Level:	Date 28/09/2015
Location:		Dimensions (m): Depth 1.70	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown, clayey SAND with common rootlets. (TOPSOIL)
				0.30			Firm, yellow, grey gleyed CLAY. (COHESIVE RESIDUAL SOIL)
	1.20	D					
				1.50			?Moderately strong, fine to medium grained SANDSTONE, recovered as sub-angular to angular, fine to coarse gravel. (COAL MEASURES)
	1.60	D					
				1.70			*At 1.7m, unable to dig further due to refusal.* End of pit at 1.70 m

1
2
3
4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP15
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424224.00 - 415053.00 Level:	Date 29/09/2015
Location:		Dimensions (m): Depth 2.20	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			TOPSOIL: Dark brown, clayey sand with brick and tile fragments. (TOPSOIL)
				0.90			Firm, grey CLAY. (COHESIVE RESIDUAL SOIL)
				1.60			Firm, yellow, grey mottled CLAY. (COHESIVE RESIDUAL SOIL)
				2.20			Very weak thinly bedded reddish-black MUDSTONE with cobble-sized siderite nodules. Recovered as angular, tabular, medium to coarse slightly clayey gravel of ironstone and mudstone. (COAL MEASURES) End of pit at 2.20 m

1
2
3
4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TT16**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: - Level:	Date 29/09/2015
Location:		Dimensions (m): Depth 2.90	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown, sandy clay with rare brick and tile fragments. (TOPSOIL)
				0.20			Firm, grey or yellow CLAY. (COHESIVE RESIDUAL SOIL)
				0.90			Very weak thinly bedded reddish-black MUDSTONE with cobble-sized siderite nodules. Recovered as angular, tabular, medium to coarse slightly clayey gravel of ironstone and mudstone. (COAL MEASURES)
				2.90			*At 2.9m, unable to dig further due to refusal on underlying sandstone.* End of pit at 2.90 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial trenches mostly remained stable during excavation, although some collapse beyond 1.5m was apparent. 5. Not all the area trenched was excavated to 2.9m. 4. Backfilled with materials arising upon completion.

Stability:

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TT17
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: - Level:	Date 29/09/2015
Location:		Dimensions (m): Depth 2.20	Scale 1:20
Client: Barratt David Wilson Homes Yorkshire West			Logged MAR

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown, sandy clay with rare brick and tile fragments. (TOPSOIL)
				0.20			Firm, grey or yellow CLAY. (COHESIVE RESIDUAL SOIL)
				0.90			Very weak thinly bedded reddish-black MUDSTONE with cobble-sized siderite nodules. Recovered as angular, tabular, medium to coarse slightly clayey gravel of ironstone and mudstone. (COAL MEASURES)
				2.20			*At 2.2m, unable to dig further due to refusal on underlying sandstone.* End of pit at 2.20 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. The sides of the trial trenches mostly remained stable during excavation, although some collapse beyond 1.5m was apparent. 5. Not all the area trenched was excavated to 2.2m. 4. Backfilled with materials arising upon completion.

Stability:

AGS

Appendix G

Probehole Logs

LITHOS CONSULTING

Borehole Log

Borehole No.
PH01
Sheet 1 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424201.00 - 415101.00	Hole Type PH
Location:			Level:	164.80	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.30	163.50		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					8.00	156.80		Broken ground - loss of returns (MINEWORKINGS)
					9.50	155.30		Solid rock (COAL MEASURES)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in broken soft ground from 8.0m to 9.5m.

AGS

Borehole Log

Borehole No. **PH01**

Sheet 2 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424201.00 - 415101.00	Hole Type PH
Location:			Level:	164.80	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					18.00	146.80		End of borehole at 18.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in broken soft ground from 8.0m to 9.5m.

Borehole Log

Borehole No. **PH01A**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: -	Hole Type PH
Location:		Level:	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.30			Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					4.00			End of borehole at 4.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH02**

Sheet 1 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424165.00 - 415067.00	Hole Type PH
Location:			Level:	162.80	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.30	161.50		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					8.00	154.80		Void - loss of returns (MINEWORKINGS)
					9.50	153.30		Solid rock (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in void from 8.0m to 9.5m.

Borehole Log

Borehole No. **PH02**

Sheet 2 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424165.00 - 415067.00	Hole Type PH
Location:			Level:	162.80	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					15.00	147.80		End of borehole at 15.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in void from 8.0m to 9.5m.

Borehole Log

Borehole No.
PH02A
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: -	Hole Type PH
Location:		Level:	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.30			Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					4.00			End of borehole at 4.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH03**

Sheet 1 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424213.00 - 415038.00	Hole Type PH
Location:			Level:	160.20	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.00	159.20		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					6.50	153.70		Broken ground - loss of returns (MINEWORKINGS)
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in broken soft ground from 6.50m to 11.5m.

Borehole Log

Borehole No. **PH03**

Sheet 2 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424213.00 - 415038.00	Hole Type PH
Location:			Level:	160.20	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					11.50	148.70		Solid rock (COAL MEASURES)
					15.00	145.20		End of borehole at 15.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in broken soft ground from 6.50m to 11.5m.

Borehole Log

Borehole No. **PH03A**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: -	Hole Type PH
Location:		Level:	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.00			Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					4.00			End of borehole at 4.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH04**

Sheet 1 of 3

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424110.00 - 415068.00	Hole Type PH
Location:			Level:	161.50	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Brown and grey clayey GRAVEL (OPENCAST BACKFILL)
					6.70	154.80		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH04**

Sheet 2 of 3

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424110.00 - 415068.00	Hole Type PH
Location:			Level:	161.50	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				

11
12
13
14
15
16
17
18
19
20

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH04**

Sheet 3 of 3

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424110.00 - 415068.00	Hole Type PH
Location:			Level:	161.50	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					21.00	140.50		FLOCKTON THIN COAL (COAL MEASURES)
					21.70	139.80		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					27.00	134.50		End of borehole at 27.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No.
PH04A
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: -	Hole Type PH
Location:		Level:	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Brown and grey clayey GRAVEL (OPENCAST BACKFILL)
					4.00			End of borehole at 4.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH05**

Sheet 1 of 4

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424148.00 - 415022.00	Hole Type PH
Location:			Level:	159.05	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.40	157.65		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					6.30	152.75		FLOCKTON THICK COAL (COAL MEASURES)
					7.80	151.25		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. All coal seams encountered were intact.

Borehole Log

Borehole No. **PH05**

Sheet 2 of 4

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424148.00 - 415022.00	Hole Type PH
Location:			Level:	159.05	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				

11
12
13
14
15
16
17
18
19
20

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. All coal seams encountered were intact.

Borehole Log

Borehole No. **PH05**

Sheet 3 of 4

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424148.00 - 415022.00	Hole Type PH
Location:			Level:	159.05	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					23.00	136.05		FLOCKTON THIN COAL (COAL MEASURES)
					23.70	135.35		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
								Continued on next sheet

21 22 23 24 25 26 27 28 29 30

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. All coal seams encountered were intact.

Borehole Log

Borehole No. **PH05**

Sheet 4 of 4

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424148.00 - 415022.00	Hole Type PH
Location:			Level:	159.05	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					33.00	126.05		End of borehole at 33.00 m

31 32 33 34 35 36 37 38 39 40

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. All coal seams encountered were intact.

Borehole Log

Borehole No. **PH05A**

Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: -	Hole Type PH
Location:		Level:	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.40			Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					4.00			End of borehole at 4.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

Borehole No. **PH06**

Sheet 1 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424051.00 - 415052.00	Hole Type PH
Location:			Level:	158.25	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.50	156.75		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in broken soft ground from 15.1m to 15.6m.

Borehole Log

Borehole No. **PH06**

Sheet 2 of 2

Project Name:	Flockton Green Working Men's Club	Project No. 2211	Co-ords:	424051.00 - 415052.00	Hole Type PH
Location:			Level:	158.25	Scale 1:50
Client:	Barratt David Wilson Homes Yorkshire West		Dates:	29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					15.10	143.15		Broken ground - loss of returns (MINEWORKINGS)
					15.60	142.65		Solid rock (COAL MEASURES)
					18.00	140.25		End of borehole at 18.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost in broken soft ground from 15.1m to 15.6m.

Borehole Log

Borehole No.
PH06A
Sheet 1 of 1

Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: -	Hole Type PH
Location:		Level:	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.50			Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					4.00			End of borehole at 4.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flcokton Thin coal seam as encountered was intact.

Borehole Log

			Borehole No. **PH07** Sheet 1 of 1
Project Name: Flockton Green Working Men's Club	Project No. 2211	Co-ords: 424046.00 - 415046.00	Hole Type PH
Location:		Level: 157.60	Scale 1:50
Client: Barratt David Wilson Homes Yorkshire West		Dates: 29/09/2015 - 29/09/2015	Logged By IMC / DRILLER

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								CLAY (COHESIVE RESIDUAL SOIL)
					1.30	156.30		FLOCKTON THICK COAL (COAL MEASURES)
					1.50	156.10		Interbedded MUDSTONE and SANDSTONE (COAL MEASURES)
					3.00	154.60		End of borehole at 3.00 m

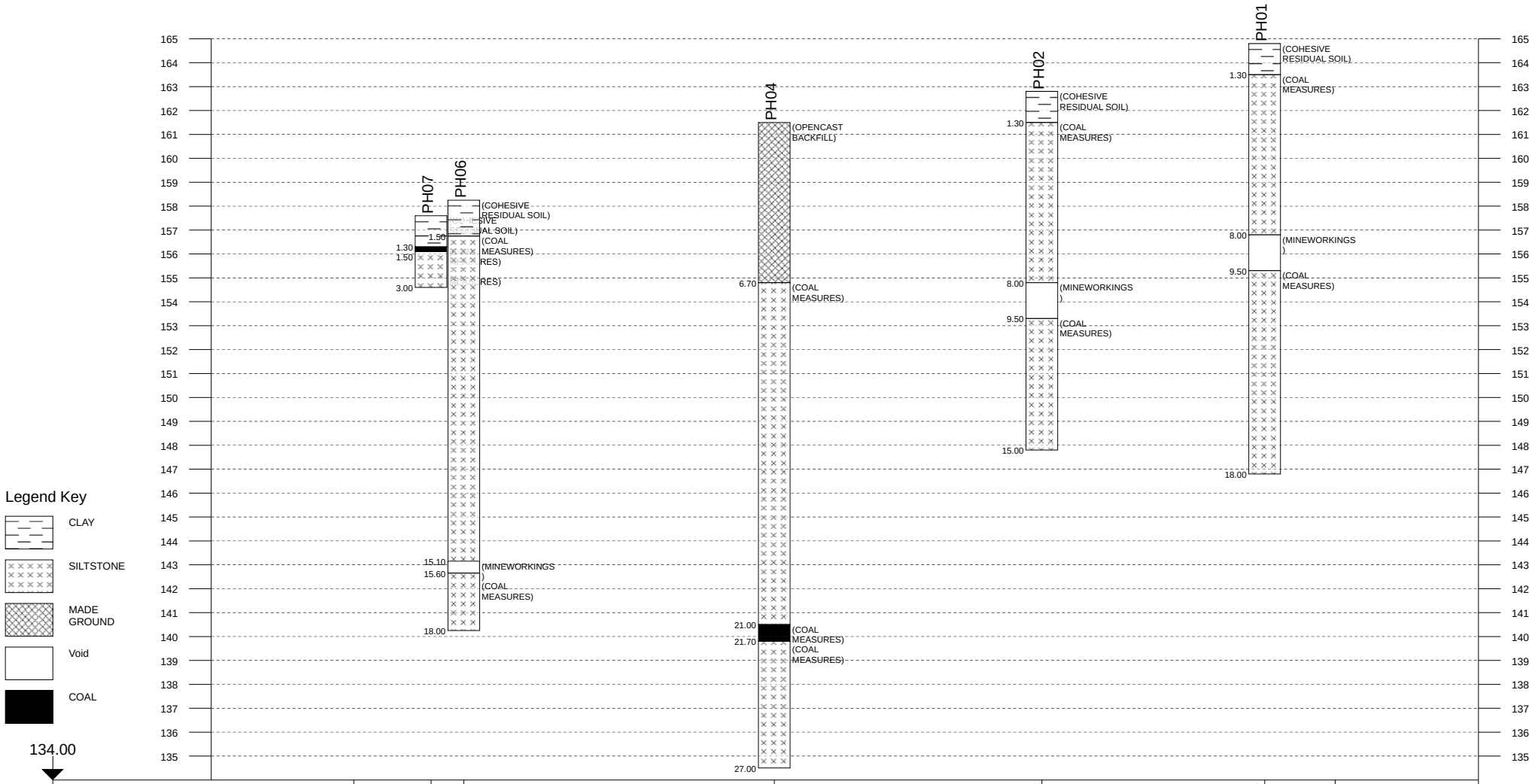
Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Probehole terminated on proving outcrop of the Flockton Thick coal seam.

Appendix H

Geological Cross Section

Project Id: 2211	Title: Section line 1
Project Title: Flockton Green Working Men's Club	Vertical Scale: 1:238
Location:	Horizontal Scale: 1:1120
Client: Barratt David Wilson Homes Yorkshire West	Engineer: MJT



Chainage (m)	0.00	15.21	21.64	82.77	135.45	179.30	193.18
Offset (m)	2.26	2.17	1.61	14.24	8.76		
Elevation (mAOD)	157.60	158.25	161.50	162.80	164.80		

Appendix I

Chemical Test Results

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Report Number: 513744-1

Date of Report: 06-Oct-2015

Customer: Lithos Consulting Ltd.
Parkhill
Walton Road
Wetherby
West Yorkshire
LS22 5DZ

Customer Contact: Mr Matt Thompson

Customer Job Reference: 001/2211/SAL
Customer Purchase Order: PO9809/2211/MAR
Customer Site Reference: Flockton Working Men's Club
Date Job Received at SAL: 29-Sep-2015
Date Analysis Started: 02-Oct-2015
Date Analysis Completed: 06-Oct-2015

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING 1549

Report checked and authorised by :
Emma Spear
Project Manager

Issued by :
Emma Spear
Project Manager

SAL Reference: 513744
Project Site: Flockton Working Men's Club
Customer Reference: 001/2211/SAL

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**513744 001**	**513744 002**	**513744 003**	**513744 004**	**513744 005**
				Customer Sample Reference	**TP01**	**TP03**	**TP05**	**TP11**	**TP12**
				Bottom Depth	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
				Sample Description	**TOPSOIL**	**TOPSOIL**	**TOPSOIL**	**TOPSOIL**	**TOPSOIL**
				Date Sampled	**28-SEP-2015**	**28-SEP-2015**	**28-SEP-2015**	**28-SEP-2015**	**28-SEP-2015**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @ 105 C	T162	AR	0.1	%	**23**	**24**	**26**	**24**	**17**
pH	T7	AR			**6.8**	**6.0**	**6.2**	**6.4**	**6.9**
Arsenic	T6	M40	2	mg/kg	**36**	**25**	**22**	**46**	**49**
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**23**	**23**	**23**	**25**	**25**
Chromium (trivalent)	T85	AR	2	mg/kg	**23**	**23**	**23**	**25**	**25**
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	M40	1	mg/kg	**49**	**37**	**33**	**60**	**73**
Lead	T6	M40	1	mg/kg	**74**	**65**	**56**	**110**	**110**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**27**	**25**	**29**	**39**	**34**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**150**	**110**	**100**	**130**	**180**
Asbestos ID	T27	AR			N.D.	N.D.	N.D.	N.D.	N.D.
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**0.2**	<0.1	<0.1	<0.1	<0.1
Pyrene	T207	M105	0.1	mg/kg	**0.2**	<0.1	<0.1	<0.1	<0.1
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/kg	**0.5**	<0.1	<0.1	<0.1	<0.1
Total Organic Carbon	T21	M40	0.1	%	**4.3**	**3.8**	**3.8**	**9.0**	**6.5**

SAL Reference: 513744
Project Site: Flockton Working Men's Club
Customer Reference: 001/2211/SAL

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**513744 006**	**513744 007**	**513744 008**	**513744 009**	**513744 010**
				Customer Sample Reference	**TP14**	**TP04**	**TP04**	**TP06**	**TP07**
				Bottom Depth	**0.1**	**1.2**	**3.2**	**1.0**	**1.5**
				Sample Description	**TOPSOIL**	**OPENCAST BACKFILL**	**OPENCAST BACKFILL**	**OPENCAST BACKFILL**	**OPENCAST BACKFILL**
				Date Sampled	**28-SEP-2015**	**28-SEP-2015**	**28-SEP-2015**	**28-SEP-2015**	**28-SEP-2015**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @ 105 C	T162	AR	0.1	%	**17**	**12**	**20**	**13**	**11**
pH	T7	AR			**5.6**	**7.5**	**6.7**	**7.5**	**7.1**
Arsenic	T6	M40	2	mg/kg	**13**	**29**	**6**	**12**	**21**
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**18**	**16**	**24**	**23**	**17**
Chromium (trivalent)	T85	AR	2	mg/kg	**18**	**16**	**24**	**23**	**17**
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	M40	1	mg/kg	**24**	**72**	**38**	**50**	**57**
Lead	T6	M40	1	mg/kg	**32**	**65**	**33**	**59**	**24**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**21**	**90**	**45**	**58**	**42**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**110**	**210**	**120**	**130**	**49**
Asbestos ID	T27	AR			N.D.	N.D.	N.D.	N.D.	N.D.
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total Organic Carbon	T21	M40	0.1	%	**1.8**	**6.3**	**0.4**	**1.7**	**5.7**

SAL Reference: 513744
Project Site: Flockton Working Men's Club
Customer Reference: 001/2211/SAL

Soil Analysed as Soil
Miscellaneous

SAL Reference	**513744 011**	**513744 012**
Customer Sample Reference	**TP08**	**TP08**
Bottom Depth	**0.6**	**0.8**
Sample Description	**OPENCAST BACKFILL**	**OPENCAST BACKFILL**
Date Sampled	**28-SEP-2015**	**28-SEP-2015**

Determinand	Method	Test Sample	LOD	Units		
Moisture @ 105 C	T162	AR	0.1	%	**18**	**14**
pH	T7	AR			**6.9**	**7.1**
Arsenic	T6	M40	2	mg/kg	**16**	**18**
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1
Cadmium	T6	M40	1	mg/kg	<1	<1
Chromium	T6	M40	1	mg/kg	**22**	**19**
Chromium (trivalent)	T85	AR	2	mg/kg	**22**	**19**
Chromium VI	T6	AR	1	mg/kg	<1	<1
Copper	T6	M40	1	mg/kg	**42**	**39**
Lead	T6	M40	1	mg/kg	**33**	**32**
Mercury	T6	M40	1	mg/kg	<1	<1
Nickel	T6	M40	1	mg/kg	**45**	**46**
Selenium	T6	M40	3	mg/kg	<3	<3
Zinc	T6	M40	1	mg/kg	**110**	**110**
Asbestos ID	T27	AR			N.D.	N.D.
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	<0.1
Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1
Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	<0.1	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/kg	<0.1	<0.1
Total Organic Carbon	T21	M40	0.1	%	**2.5**	**3.2**

Index to symbols used in 513744-1

Value	Description
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
AR	As Received
N.D.	Not Detected
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was sub-contracted to REC Asbestos.

Method Index

Value	Description
T6	ICP/OES
T27	PLM
T207	GC/MS (MCERTS)
T21	OX/IR
T7	Probe
T2	Grav
T85	Calc
T162	Grav (1 Dec) (105 C)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Moisture @ 105 C	T162	AR	0.1	%	N	001-012
pH	T7	AR			M	001-012
Arsenic	T6	M40	2	mg/kg	M	001-012
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-012
Cadmium	T6	M40	1	mg/kg	M	001-012
Chromium	T6	M40	1	mg/kg	M	001-012
Chromium (trivalent)	T85	AR	2	mg/kg	N	001-012
Chromium VI	T6	AR	1	mg/kg	N	001-012
Copper	T6	M40	1	mg/kg	M	001-012
Lead	T6	M40	1	mg/kg	M	001-012
Mercury	T6	M40	1	mg/kg	M	001-012
Nickel	T6	M40	1	mg/kg	M	001-012
Selenium	T6	M40	3	mg/kg	M	001-012
Zinc	T6	M40	1	mg/kg	M	001-012
Asbestos ID	T27	AR			SU	001-012
Retained on 10mm sieve	T2	M40	0.1	%	N	001-012
Naphthalene	T207	M105	0.1	mg/kg	M	001-012
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-012
Acenaphthene	T207	M105	0.1	mg/kg	M	001-012
Fluorene	T207	M105	0.1	mg/kg	M	001-012
Phenanthrene	T207	M105	0.1	mg/kg	M	001-012
Anthracene	T207	M105	0.1	mg/kg	U	001-012
Fluoranthene	T207	M105	0.1	mg/kg	M	001-012
Pyrene	T207	M105	0.1	mg/kg	M	001-012
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-012
Chrysene	T207	M105	0.1	mg/kg	M	001-012
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-012
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-012
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-012
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-012
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-012
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-012
PAH(total)	T207	M105	0.1	mg/kg	U	001-012
Total Organic Carbon	T21	M40	0.1	%	N	001-012

Appendix J

Geotechnical Test Results

PSL
Professional Soils Laboratory

LABORATORY REPORT

UKAS TESTING
4043

Contract Number: PSL15/4837

Client's Reference: Report Date: 08 October 2015

Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Matt Thompson

Contract Title: Flockton Working Mens Club

Date Received: 1/10/2015
Date Commenced: 1/10/2015
Date Completed: 8/10/2015

Notes: Opinions and Interpretations are outside the UKAS Accreditation

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

Checked and Approved Signatories:

R Gunson (Director)
A Watkins (Director)
M Beastall (Laboratory Manager)

D Lambe (Senior Technician)
S Royle (Senior Technician)

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

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Depth m	Description of Sample
TP01	2	D	0.80	Brown slightly gravelly sandy CLAY.
TP01	3	D	2.00	Brown mottled grey slightly sandy very silty CLAY.
TP12	2	D	1.00	Brown slightly gravelly slightly sandy CLAY.
TP13	2	D	1.10	Brown mottled grey slightly sandy CLAY.
TP14	2	D	1.20	Brown mottled grey sandy CLAY.

PSL
Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	08/10/15		08/10/15		08/10/15

FLOCKTON WORKING MEN'S CLUB.

Contract No: PSL15/4837

Client Ref: 2211

SUMMARY OF SOIL CLASSIFICATION TESTS

(B.S. 1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Depth m	Moisture Content % Clause 3.2	Bulk Density Mg/m^3 Clause 7.2	Dry Density Mg/m^3 Clause 7.2	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4.4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	% Passing .425mm	Remarks
TP01	2	D	0.80	25				46	24	22	96	Intermediate plasticity CI.
TP01	3	D	2.00	33				55	28	27	100	High plasticity CH.
TP12	2	D	1.00	27				64	25	39	99	High plasticity CH.
TP13	2	D	1.10	28				56	28	28	100	High plasticity CH.
TP14	2	D	1.20	17				48	24	24	100	Intermediate plasticity CI.

SYMBOLS : NP : Non Plastic *** : Liquid Limit and Plastic Limit Wet Sieved.**

PSL
Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	08/10/15		08/10/15		08/10/15

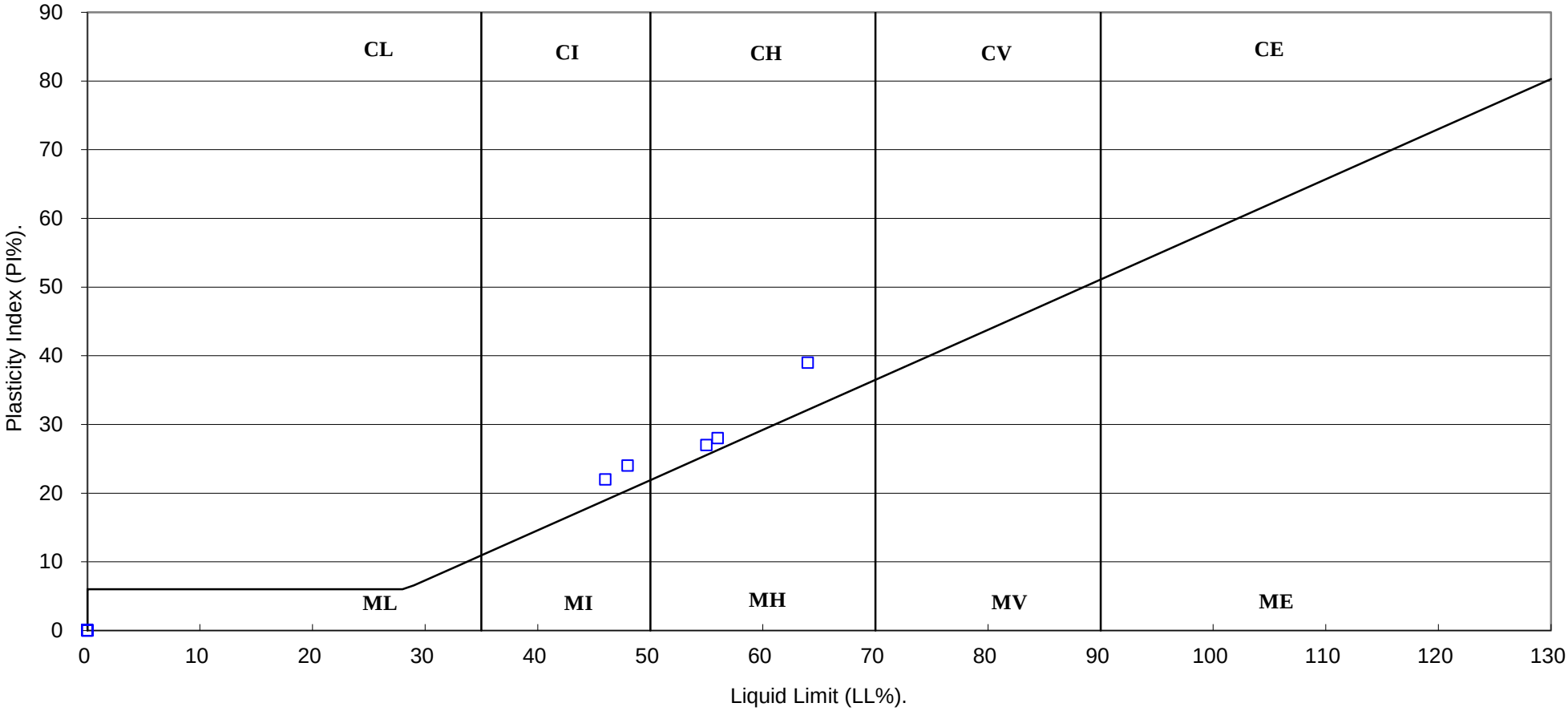
FLOCKTON WORKING MEN'S CLUB.

Contract No: **PSL15/4837**

Client Ref: **2211**

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)



PSL Professional Soils Laboratory	Compiled by	Date	Checked by	Date	Approved by	Date
		08/10/15		08/10/15		08/10/15
	FLOCKTON WORKING MEN'S CLUB.				Contract No:	PSL15/4837
					Client Ref:	2211

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING
2183

Final Report

Report No.:	15-23379-1
Initial Date of Issue:	12-Oct-2015
Client	Professional Soils Laboratory
Client Address:	5/7 Hexthorpe Road Doncaster South Yorkshire DN4 0AR
Contact(s):	Anthony Watkins Mark Beastall Russell Gunson Sean Royle
Project	PS45/4837 - Flockton Working Men's Club

Quotation No.:		**Date Received:**	06-Oct-2015
Order No.:	PO9808/2211/MAR (002/2211/PSL)	**Date Instructed:**	06-Oct-2015
No. of Samples:	9	**Target Date:**	12-Oct-2015
Turnaround (Wkdays):	5	**Results Due:**	12-Oct-2015

Date Approved: 12-Oct-2015

Approved By:

Details: Keith Jones, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Soil

Project: PS45/4837 - Flockton Working Men's Club

Client: Professional Soils Laboratory												
				Chemtest Job No.:	15-23379	15-23379	15-23379	15-23379	15-23379	15-23379	15-23379	15-23379
Quotation No.:				Chemtest Sample ID.:	202095	202096	202097	202098	202099	202100	202101	202102
Order No.: PO9808/2211/MAR (002/2211/PSL)				Client Sample Ref.:	2	3	2	2	2	2	2	3
				Client Sample ID.:	TP01	TP01	TP12	TP13	TP14	TP03	TP09	TP14
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.8	2.0	1.0	1.1	1.2	1.0	1.0	1.6
				Bottom Depth (m):								
				Date Sampled:	28-Sep-2015	28-Sep-2015	28-Sep-2015	28-Sep-2015	28-Sep-2015	28-Sep-2015	28-Sep-2015	28-Sep-2015
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
Moisture	N	2030	%	0.020	17	24	12	11	12	8.2	6.5	8.3
pH	U	2010		N/A	7.7	7.5	8.3	7.8	6.4	8.0	8.2	8.1
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.049	0.017	0.013	0.023	0.025	0.012	< 0.010	0.012

Chemtest
The right chemistry to deliver results

Results - Soil

Project: PS45/4837 - Flockton Working Men's Club

Client: Professional Soils Laboratory			Chemtest Job No.:		15-23379
Quotation No.:			Chemtest Sample ID.:		202103
Order No.: PO9808/2211/MAR (002/2211/PSL)			Client Sample Ref.:		2
			Client Sample ID.:		TP02
			Sample Type:		SOIL
			Top Depth (m):		1.5
			Bottom Depth (m):		
			Date Sampled:		28-Sep-2015
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Moisture	N	2030	%	0.020	6.7
pH	U	2010		N/A	7.9
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.053

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

Appendix K

Gas Monitoring Results

Job Title:				Job No:
Flockton Green, WMC				2211
Client:				Sheet :
Barratt David Wilson Homes				1 of 1
Date:	Arrival Time:	Depart Time:	Operator:	
19/10/2015	07:40	08:20	J Jones	

LITHOS CONSULTING

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	0.0	CO_2:	0.0	O_2:	20.5

Monitoring Point	Groundwater level	Concentrations: Initial / Highest CH_4	Initial / Highest CO_2	Steady concentrations CH_4	Steady concentrations CO_2	Lowest concn O_2	Gas Flow Rates: Initial / Maximum	Gas Flow Rates: Steady	Time to fall from highest to steady	Bottom of well	Remarks
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01a	3.62	ND	2.0	ND	2.0	18.2	ND	ND	ND	3.67	
PH02a	ND	ND	2.6	ND	2.6	18.1	ND	ND	ND	3.71	
PH03a	ND	0.2	0.6	0.0	0.6	19.8	ND	ND	ND	3.91	
PH04a	ND	ND	2.1	ND	2.1	18.4	ND	ND	ND	3.64	5 ppm CO
PH05a	3.62	ND	4.3	ND	4.3	**14.1**	ND	ND	ND	3.77	
PH06a	ND	0.1	3.3	0.0	3.3	16.4	ND	ND	ND	3.64	

Notes

Equipment Used:
Gas Data GFM430 Infrared Gas Analyser
Geotechnical Instruments Dipmeter

Next Calibration Date
29/07/2016

Key

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

	Site Data:			Weather Station Data (Emley Village Station)							CH_4	CO_2	O_2
	Temp (°C):	8		Barometric Pressure Trend:			Fluctuating						
Time:	07:45	08:01	08:17	00:04	04:05	08:01	13:22	17:22	21:03	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1005	1003	1005	1023.9	1024.6	1024.9	1025.3	1024.3	1025.6	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:	Sunny											
	Surface Ground Conditions:	Damp											

Remarks:

Appendix L

Soakaway Test Calculations

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Barratt David Wilson
Job Name:	Flockton Green WMC
Job No.:	2211

Trial Pit No.	**2**
Test No.	**1**

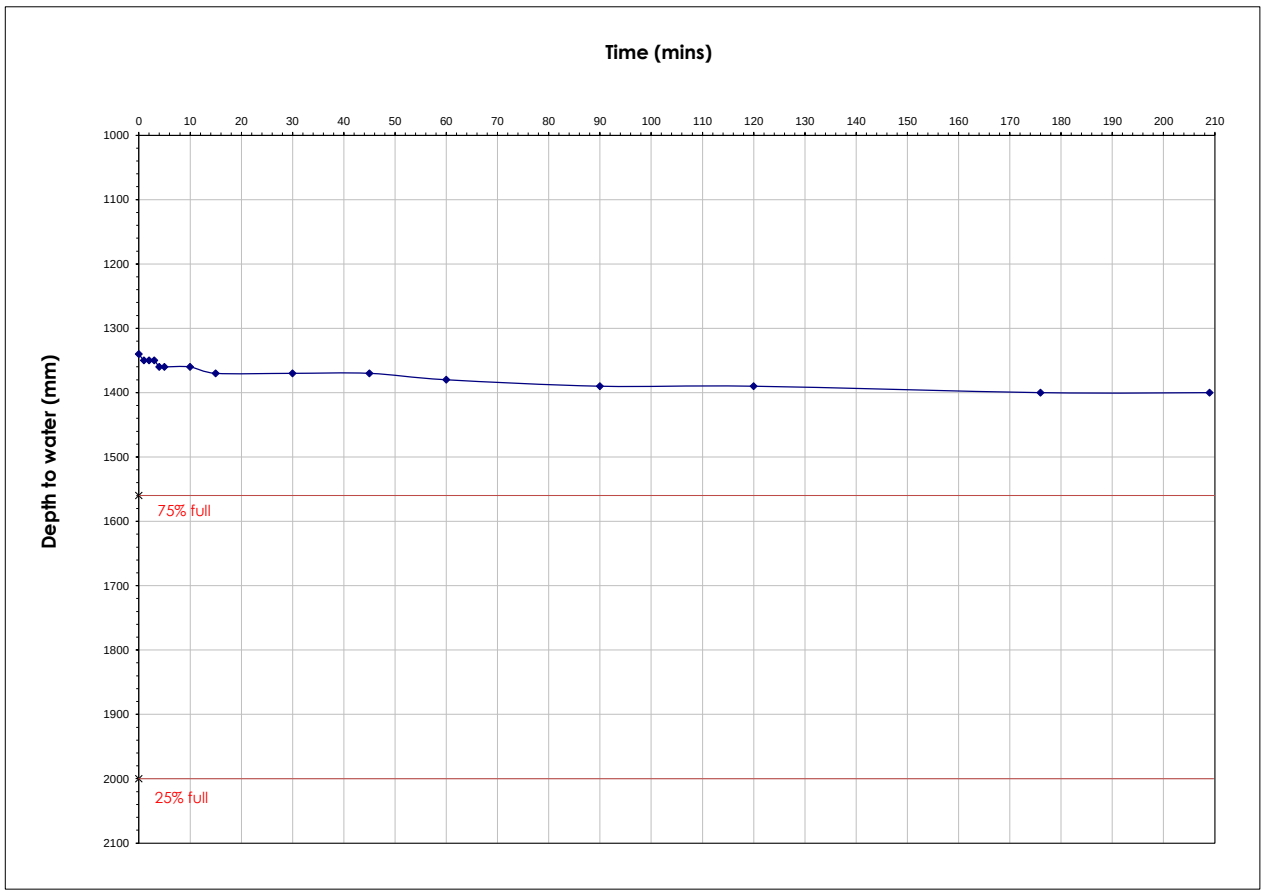
Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:48	0	1.34	1340
10:49	1	1.35	1350
10:50	2	1.35	1350
10:51	3	1.35	1350
10:52	4	1.36	1360
10:53	5	1.36	1360
10:58	10	1.36	1360
11:03	15	1.37	1370
11:18	30	1.37	1370
11:33	45	1.37	1370
11:48	60	1.38	1380
12:18	90	1.39	1390
12:48	120	1.39	1390
13:44	176	1.40	1400
14:17	209	1.40	1400

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.05	2050
Width	=	0.70	700
Depth	=	2.22	2220

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2000	2.00
0.50	=	1780	1.78
0.75	=	1560	1.56

Depth at start of test (mm)	=	1340
Depth at end of test (mm)	=	1400
Base area of pit	=	1.435
a_{p50} - 50% internal surface area inc. base	=	3.855
V_{p75-25} - Volume 75 - 25%	=	0.6314

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Barratt David Wilson
Job Name:	Flockton Green WMC
Job No.:	2211

Trial Pit No.	**3**
Test No.	**1**

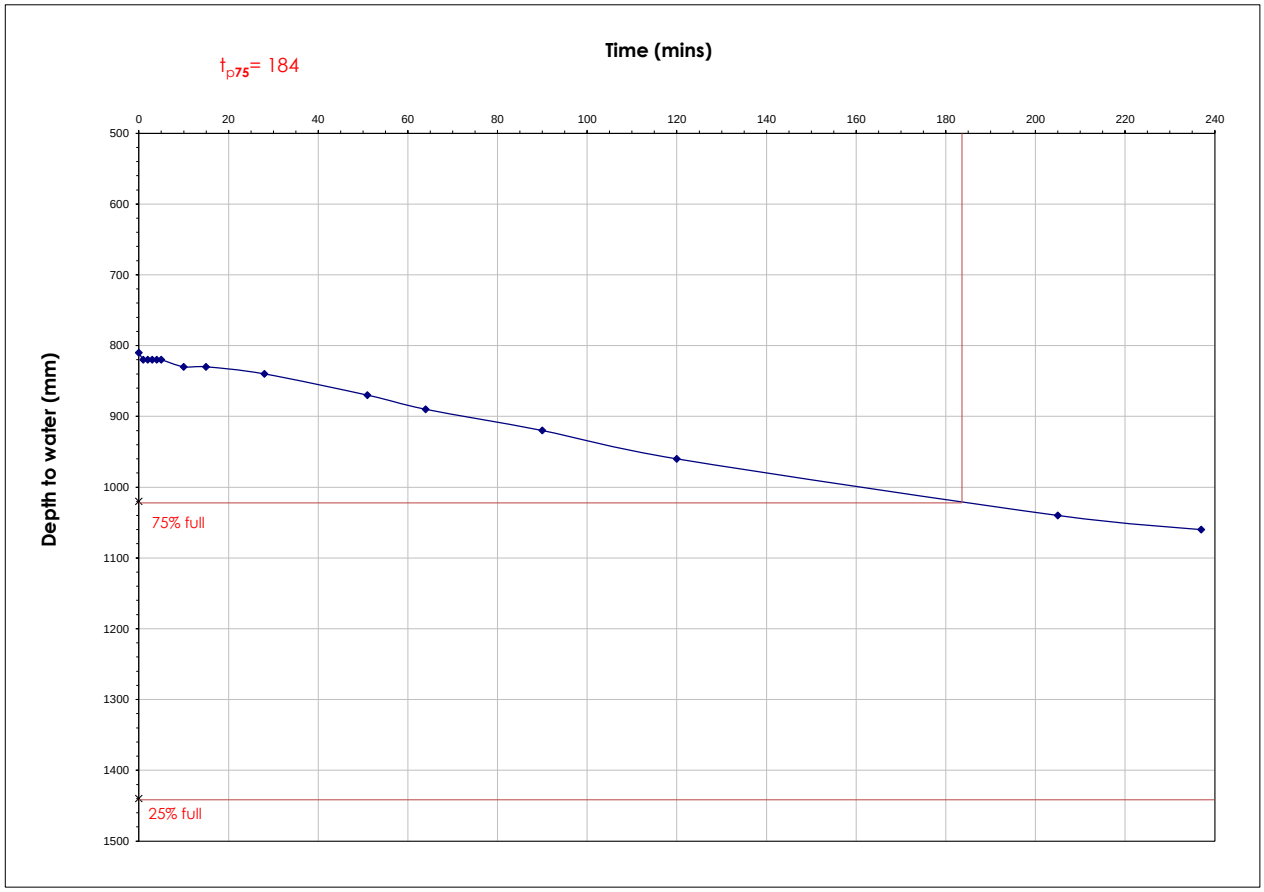
Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:16	0	0.81	810
10:17	1	0.82	820
10:18	2	0.82	820
10:19	3	0.82	820
10:20	4	0.82	820
10:21	5	0.82	820
10:26	10	0.83	830
10:31	15	0.83	830
10:44	28	0.84	840
11:07	51	0.87	870
11:20	64	0.89	890
11:46	90	0.92	920
12:16	120	0.96	960
13:41	205	1.04	1040
14:13	237	1.06	1060

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.17	2170
Width	=	0.71	710
Depth	=	1.65	1650

Effective Depth (% full)		(mm)	(m)
0.25	=	1440	1.44
0.50	=	1230	1.23
0.75	=	1020	1.02

Depth at start of test (mm)	=	810
Depth at end of test (mm)	=	1060
Base area of pit	=	1.5407
a_{p50} - 50% internal surface area inc. base	=	3.9599
V_{p75-25} - Volume 75 - 25%	=	0.647094

Read from the graph:		
$t_{p\,75}$ (min)	=	184.00
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Barratt David Wilson
Job Name:	Flockton Green WMC
Job No.:	2211

Trial Pit No.	**9**
Test No.	**1**

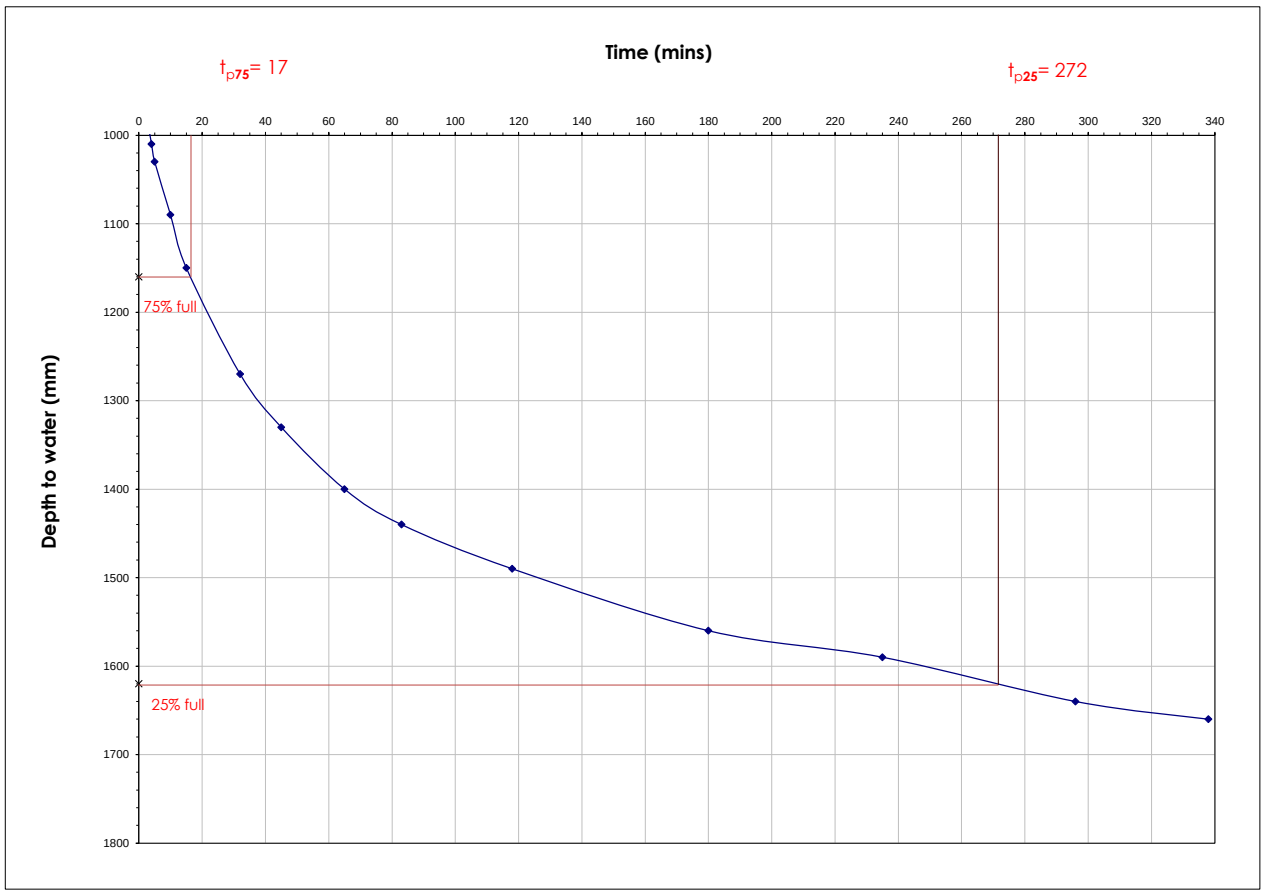
Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:52	0	0.93	930
09:53	1	0.96	960
09:54	2	0.97	970
09:55	3	0.99	990
09:56	4	1.01	1010
09:57	5	1.03	1030
10:02	10	1.09	1090
10:07	15	1.15	1150
10:24	32	1.27	1270
10:27	45	1.33	1330
10:57	65	1.40	1400
11:16	83	1.44	1440
11:50	118	1.49	1490
12:52	180	1.56	1560
13:47	235	1.59	1590
14:48	296	1.64	1640
15:30	338	1.66	1660

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.36	2360
Width	=	0.71	710
Depth	=	1.85	1850

Effective Depth (% full)		(mm)	(m)
0.25	=	1620	1.62
0.50	=	1390	1.39
0.75	=	1160	1.16

Depth at start of test (mm)	=	930
Depth at end of test (mm)	=	1660
Base area of pit	=	1.6756
a_{p50} - 50% internal surface area inc. base	=	4.5
V_{p75-25} - Volume 75 - 25%	=	0.770776

Read from the graph:		
$t_{p\,75}$ (min)	=	17.00
$t_{p\,25}$ (min)	=	272.00



Soil infiltration rate, f, (m/s) = 1.12E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Barratt David Wilson
Job Name:	Flockton Green WMC
Job No.:	2211

Trial Pit No.	**11**
Test No.	**1**

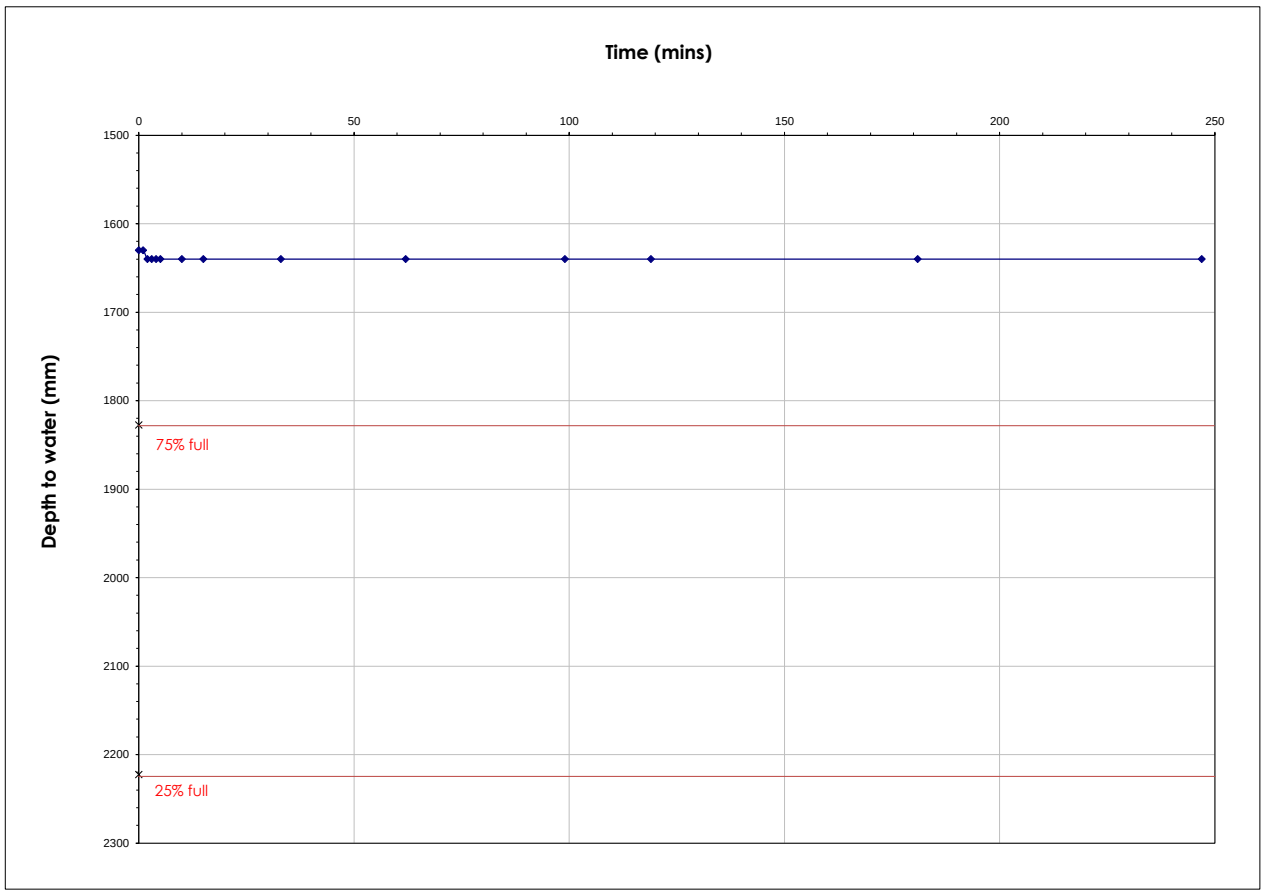
Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:31	0	1.63	1630
09:32	1	1.63	1630
09:33	2	1.64	1640
09:34	3	1.64	1640
09:35	4	1.64	1640
09:36	5	1.64	1640
09:41	10	1.64	1640
09:46	15	1.64	1640
10:04	33	1.64	1640
10:34	62	1.64	1640
11:10	99	1.64	1640
11:30	119	1.64	1640
12:32	181	1.64	1640
13:38	247	1.64	1640

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.23	2230
Width	=	0.67	670
Depth	=	2.42	2420

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2222.5	2.22
0.50	=	2025	2.03
0.75	=	1827.5	1.83

Depth at start of test (mm)	=	1630
Depth at end of test (mm)	=	1640
Base area of pit	=	1.4941
a_{p50} - 50% internal surface area inc. base	=	3.7851
V_{p75-25} - Volume 75 - 25%	=	0.5901695

Read from the graph:		
$t_{p\ 75}$ (min)	=	
$t_{p\ 25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Barratt David Wilson
Job Name:	Flockton Green WMC
Job No.:	2211

Trial Pit No.	**12**
Test No.	**1**

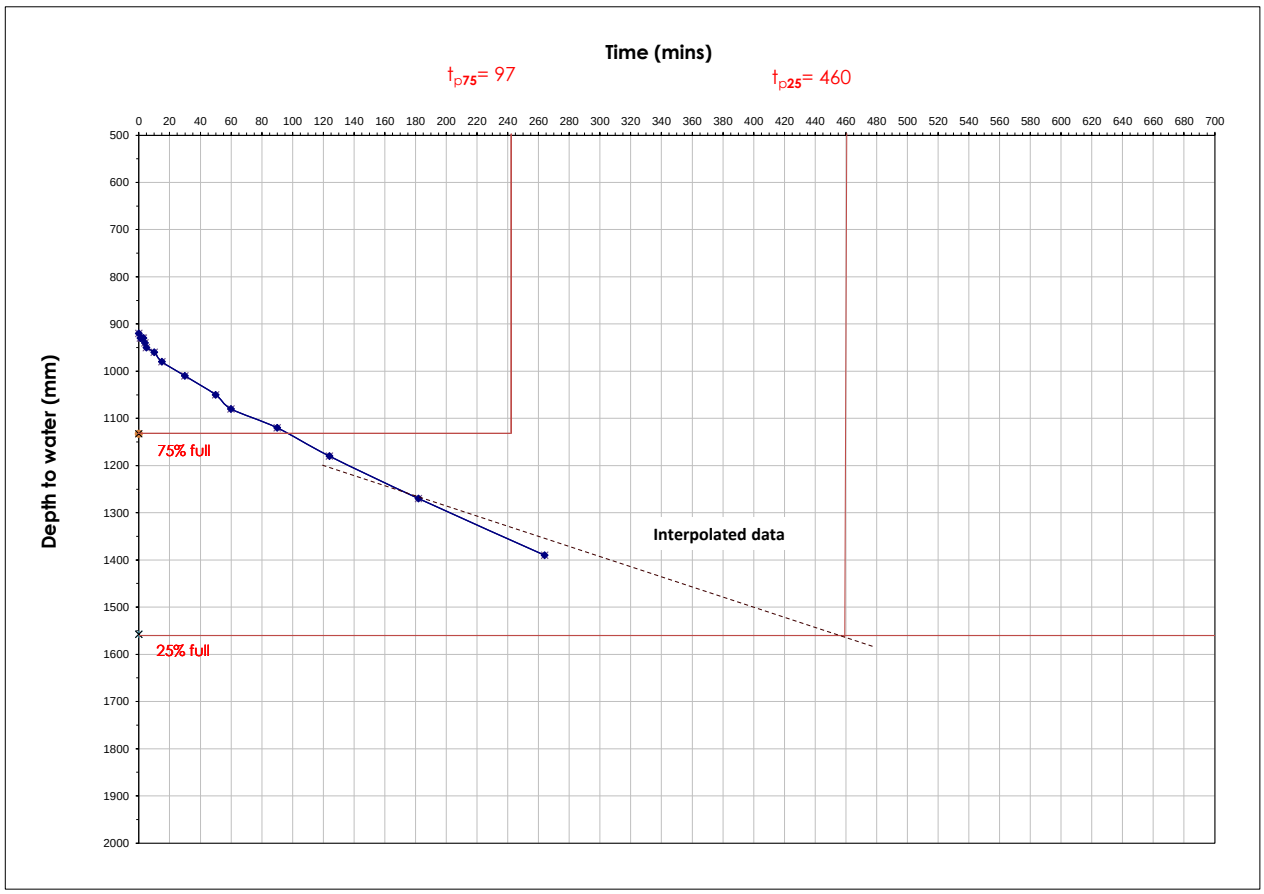
Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:09	0	0.92	920
09:10	1	0.93	930
09:11	2	0.93	930
09:12	3	0.93	930
09:13	4	0.94	940
09:14	5	0.95	950
09:19	10	0.96	960
09:24	15	0.98	980
09:39	30	1.01	1010
09:59	50	1.05	1050
10:09	60	1.08	1080
10:39	90	1.12	1120
11:13	124	1.18	1180
12:11	182	1.27	1270
13:35	264	1.39	1390

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.31	2310
Width	=	0.72	720
Depth	=	1.77	1770

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1557.5	1.56
0.50	=	1345	1.35
0.75	=	1132.5	1.13

Depth at start of test (mm)	=	920
Depth at end of test (mm)	=	1390
Base area of pit	=	1.6632
a_{p50} - 50% internal surface area inc. base	=	4.2387
V_{p75-25} - Volume 75 - 25%	=	0.70686

Read from the graph:		
$t_{p\,75}$ (min)	=	97
$t_{p\,25}$ (min)	=	460



Soil infiltration rate, f, (m/s) = 7.66E-06