



Geoenvironmental Appraisal

Land at Lee Lane, Royston

For Barratt Homes & David Wilson
Homes Yorkshire West

Report no: 2366/1

Date: August 2016



SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2366	Site area/ha	5.3 Ha
Client:	Barratt Homes & David Wilson Homes Yorkshire West	NGR:	SE 349 115
Site:	Lee Lane, Royston	Nearest postcode:	S71 4RT

The site is located off Lee Lane, approximately 1km west of Royston Village, and currently comprises a disused grazing field and paddocks totalling 5.3 Ha in area.

Lithos were commissioned by Barratt to provide a geoenvironmental appraisal of the site. It is understood that the site is to be redeveloped with a number of low rise residential dwellings with gardens, adoptable highways and services. Lithos' investigation included a review of two 3rd party reports, the site's history and environmental setting, and a ground investigation comprising 12 trial pits.

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

Issue	Remarks
Made ground	Localised made ground of up to around 1m thickness was present, identified in TPs 102 and 104. The material comprised re-worked natural soils.
Natural ground	Most of the site is underlain by granular glacial deposits, mainly gravels, with occasional thin clay layers sporadically present across the area. Bedrock of Oaks Rock (sandstone and siltstone) strata were encountered in the west of the site only, at typical depths of around 2m.
Contamination	No significant contamination has been identified. Testing of topsoil suggests it is chemically suitable for re-use.
Hazardous gas	No hazardous ground gas sources have been identified. Less than 1% of homes in the site area are above the radon action level; as such, no radon protective measures are necessary in new dwellings.
Preparatory works	The site will require a full topsoil strip and stockpile prior to development commencing.
Foundations	The entire site should be suited to shallow strip / trench fill footings for the proposed low-rise residential development.
Groundwater & excavations	Shallow groundwater was present at around 2mbgl in a number of locations on-site within the granular glacial deposits; this caused localised instability when excavations were left open.
Flooding & drainage	The site lies within an EA-defined Flood Zone 1, and as such flood protection measures are not necessary.
Highways	The natural deposits on-site should yield a CBR of at least 3%, this should be verified by in-situ testing.

Significant developer abnormalities relating to geoenvironmental issues at the site have been identified:

- Instability within natural granular glacial deposits at shallow depth due to shallow groundwater
- Potential need for localised dewatering of shallow excavations
- Potential Yorkshire Water soakaway field in the southeast of the site.

CONTENTS

1	INTRODUCTION	1
1.1	THE COMMISSION AND BRIEF.....	1
1.2	THE PROPOSED DEVELOPMENT	1
1.3	REPORT FORMAT AND LIMITATIONS	1
2	SITE DESCRIPTION.....	2
2.1	GENERAL	2
2.2	SITE FEATURES	2
3	SITE HISTORY	3
4	ENVIRONMENTAL SETTING.....	4
4.1	GENERAL	4
5	PREVIOUS INVESTIGATION FINDINGS	5
5.1	GENERAL	5
5.2	SUMMARY OF RSK'S FINDINGS	5
5.3	SUMMARY OF REC'S FINDINGS	5
5.4	LITHOS COMMENTS	7
6	GROUND INVESTIGATION DESIGN.....	8
6.1	ANTICIPATED GROUND CONDITIONS & POTENTIAL ISSUES.....	8
6.2	PRELIMINARY CONCEPTUAL SITE MODEL.....	8
6.3	GROUND INVESTIGATION DESIGN & STRATEGY.....	9
7	FIELDWORK.....	9
7.1	SCOPE OF WORKS.....	9
8	GROUND CONDITIONS.....	10
8.1	GENERAL	10
8.2	MADE GROUND	10
8.3	NATURAL GROUND	10
8.4	GROUNDWATER	10
8.5	STABILITY	10
8.6	REVISED CONCEPTUAL GROUND MODEL (GROUND CONDITIONS).....	11
9	CONTAMINATION (ANALYSIS).....	11
9.1	GENERAL	11
10	CONTAMINATION (ANALYSIS)	13
10.1	GENERAL	13
10.2	TESTING SCHEDULED.....	13
10.3	SOIL CONTAMINATION RESULTS	13
11	CONTAMINATION (QUALITATIVE RISK ASSESSMENT)	16
11.1	TOPSOIL	16
11.2	WASTE CLASSIFICATION.....	16
12	HAZARDOUS GAS	16
12.1	METHANE & CARBON DIOXIDE	16
12.2	RADON.....	17
13	GEOTECHNICAL TESTING	17
13.1	GENERAL	17
13.2	ATTERBERG LIMITS	17
13.3	SOLUBLE SULPHATE AND PH	17

14	GEOTECHNICAL ISSUES	18
14.1	CONCEPTUAL SITE MODEL	18
14.2	FOUNDATION RECOMMENDATIONS.....	18
14.3	FLOOR SLABS.....	22
14.4	DESIGNATED CONCRETE MIXES	22
14.5	EXCAVATIONS.....	23
14.6	DRAINAGE.....	23
14.7	HIGHWAYS.....	24
14.8	EXTERNAL WORKS	24
15	REDEVELOPMENT ISSUES.....	24
15.1	GENERAL	24
15.2	GOOD PRACTICE GUIDANCE	24
15.3	NEW UTILITIES.....	25
15.4	HEALTH & SAFETY ISSUES - CONSTRUCTION WORKERS.....	25
15.5	POTENTIAL DEVELOPMENT CONSTRAINTS.....	25
16	SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.....	25
16.1	GENERAL	25
16.2	HAZARDOUS GAS	25
16.3	MINING AND QUARRYING	26
16.4	CONTAMINATION	26
16.5	FOUNDATIONS.....	26
16.6	FLOODING	26
16.7	DRAINAGE.....	26
16.8	HIGHWAYS.....	26

APPENDICES

Appendix A - General notes

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

Appendix B - Drawings

Drawing	Revision	Title
2366/1	-	Site location plan
2366/2	-	Proposed site layout
2366/3	-	Site features
2366/4	-	Site photographs
2366/5	-	Preliminary conceptual site model
2366/6	-	Exploratory hole locations
2366/7	-	Revised conceptual site model
2366/8	-	Indicative foundation types & depths

Appendix C - Commission

Appendix D - Historical OS plans

Appendix E - Search responses

From	Date	Content
Landmark	August 2016	Environmental search data
Coal Authority	June 2012	Mining report

Appendix F - Exploratory records

Appendix F	TP101 to TP112
------------	----------------

Appendix G - Chemical test results

Appendix H - Geotechnical 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

LEE LANE, ROYSTON

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Barratt Homes & David Wilson Homes Yorkshire West to carry out a geoenvironmental appraisal of land at Lee Lane, Royston.

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 review of third party reports
- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- An intrusive ground investigation comprising 12 trial pits
- 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 exploratory phase of investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable Barratt 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 a number of low-rise domestic dwellings, associated gardens, POS and adoptable roads and sewers. A sketch site layout has been prepared by Barratt Homes (reference KSL-01), a copy is included in Appendix 2 as Drawing 2366/2. The drawing shows 154 single story residential dwellings.

1.2.2 Barratt have recently indicated that the small area of land in the far north-east is not going to be developed for housing but possibly for an attenuation pond.

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

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 2366/1 presented in Appendix B to this report. Site details are summarised in the Table below.

Detail	Remarks
Location	1km west of Royston Village
NGR	SE 349 115
Approximate area	5.3 ha
Known services	None; but potential for YWS soakaway in the south-east of the site

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on 23rd July 2016. Very few features exist on the site, which appears largely abandoned.

2.2.2 The entire site is overgrown with thistles / nettles etc and appears not to be in use. Vegetation is particularly dense and overgrown in the south-west of the site area close to Lee Lane; an old horse feeder and domestic garden incinerator were noted in that location.

2.2.3 Occasional disused electric stock fences or timber post and wire fences remained in-situ, dividing parts of the western side of the site into individual paddocks. The rear of an old box van was present in this area, presumably used as a makeshift stable.

2.2.4 A few semi-mature trees were present on-site, notably three trees located on the northern boundary line. Some semi mature trees were noted along the outside of the eastern boundary at the rear of the residential properties. Mature trees lined the outside of the southern boundary where the site meets Lee Lane.

2.2.5 The land adjacent to the site to the west was in use as paddocks / grazing for horses at the time of the visit, with three horses in residence.

2.2.6 A small 'additional' parcel of land to the north-east forms part of the proposed development site; this comprises an enclosed grassed paddock to the rear of Parkhead Close, adjacent to the former railway. The un-named surface water drain runs along the south-eastern side of that area.

2.2.7 Existing salient features, at the time of the walkover are presented on Drawing 2366/3 in Appendix B to this report, and summarised in the Table below.

Feature	Remarks
Current Access	Off Lee Lane
Topography	Relatively flat / level
Nature of boundaries	South, west & east – wire fences North – no physical boundary
Surrounding land uses	North – woodland East – residential dwellings South – Lee Lane, with agricultural fields beyond West – Paddocks / grazing land

2.2.8 A selection of site photographs is included on Drawing 2366/4.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to the mid-1800s 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 – 1855	Site is shown as open fields	Stream shown running along the north-western boundary flowing to the east.
1894		Barnsley Coal Railway Extension has been constructed along the northern boundary.
1948		Residential development within 50m east of the site.
1980 - 1984		Lee Lane Farm shown around 50m west of the site.
1990 - 1993		Substantial expansion of residential development adjacent to the east of the site.

3.3 In summary, the site itself has seen little or no development over the period covered by the Ordnance Survey. No significant land uses have occurred in the surrounding area either.

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 response received from Landmark, and responses from 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 SE31SW)	Drift – Granular Glacial Deposits (centre of site) and Cohesive Glacial Deposits (remainder of site). Solid – Oaks Rock (fine grained sandstone unit of the Middle Coal Measures). Shallowest coal seam - Swinton Pottery Coal Seam, c. 0.20 m thick at 4m below the Oaks Rock. The seam is so thin it is unlikely to have been worked, plus based on the dip of the bedrock in the area (~4°) and a distance of approximately 300m to the sub-crop of the Oaks Rock, the Swinton Coal is likely to be at >20m depth. Strata dip – approximately 4° to the north-east Faults – None.
Mining	Coal Authority	This site is located within a Coal Mining Development Low Risk Area (within the defined coalfield, but no known defined risks have been recorded by the Authority; there may still be unrecorded issues). Past and present workings – shallowest recorded workings at 180mbgl. Opencast – None on-site or within 250m. Mine entries – None on or within 20m of the site.
Quarrying	Historical OS plans	No features identified.
Landfills	Envirocheck Report	No known landfills within 250m.
Radon	Landmark Report	The site is in an area where less than 1% of properties are above the action levels, therefore radon protection measures are not required.
Hydrogeology	Environment Agency	Source Protection Zone? No. Aquifers: Secondary 'A' (Granular Glacial Deposits); Secondary 'A' (Oaks Rock). Groundwater abstractions? None relevant to site. Soil leaching potential – Minor Aquifer Low. Pollution incidents? None relevant to site
Hydrology	Environment Agency Envirocheck Report	Nearest watercourse(s) – Un-named surface water stream along northern boundary of main site area. Water quality – No data available. Pollution incidents? None relevant to site. Abstractions? None relevant to site. Discharge consents? None relevant to site.
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. In accordance with Chapter 10 of the National Planning Policy Framework, a site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1.

5 PREVIOUS INVESTIGATION FINDINGS

5.1 General

5.1.1 Barratt have provided Lithos with a copies of the following reports:

- Preliminary Risk Assessment; Land at Lee Lane, Royston (ref 301049 R01 (00)), issued by RSK in June 2012.
- Geo-Environmental Site Investigation; Lee Lane, Royston (Ref. 4553784P1R0), Issued by REC in April 2014.

5.1.2 These reports have been reviewed by Lithos and are discussed in turn below.

5.2 Summary of RSK's findings

5.2.1 The report includes a review of data from an Envirocheck report and historical OS maps dating back to the 1800s. A site walkover was also undertaken on the 7th June 2012. Sections 1 to 4 of this Report include similar content to the RSK report, but with further detail.

5.2.2 It is noted that the RSK report covers a far wider area than the subject site covered by this report. As such, items raised in the RSK report which are considered to be irrelevant have not been included in this review.

5.2.3 With respect to the site considered by Barratt, the report states that the use of the land for agriculture is unlikely to have resulted in any significant contamination.

5.2.4 The presence of the former railway along the north-western boundary is, however highlighted as a potential contamination source.

5.2.5 The site conceptual model developed by RSK concludes that the risks posed by the majority of relevant pollutant linkages are 'low' and 'very low', therefore they do not warrant further assessment.

5.2.6 However, the exception to this is that RSK rated the risks posed by hazardous ground gases are 'moderate'. In Lithos' opinion, this is unjustified as no sources of hazardous ground gas have been identified.

5.3 Summary of REC's findings

5.3.1 REC's ground investigation works comprised:

- 13 Window sample holes (WS01 to 13) advanced to maximum depths of 3.45m.
- Monitoring wells were installed in WS holes, with response zones sealed in the granular glacial deposits.
- 5 hand-dug soakaways.
- 2 falling head tests in window samples holes.
- 9 TRL probe (Dynamic Cone Penetrometer) tests to assess CBRs of natural soils.
- Geotechnical classification tests (Atterberg Limits, pH, soluble sulphate etc).
- Chemical soil laboratory tests (including metals, pH, total sulphate, water soluble sulphate (2:1 extract), sulphide, cyanide, phenols, total and speciated poly-aromatic hydrocarbons (PAHs), asbestos and banded total petroleum hydrocarbons (TPH)).
- Chemical testing of groundwater (pH, sulphate, metals, phenols, speciated PAH and banded TPH)

5.3.2 Ground conditions encountered by REC are summarised in the Table below:

Hole ID	Final depth (m)	Depth to base of (m)					Groundwater level (m)	Remarks
		Topsoil	Cohesive Glacial Deposits	Granular Glacial Deposits	Cohesive Glacial Deposits	Rockhead		
WS101	2.90	0.20	-	>2.90	-	-	Damp 1.4; Strike 2.0	-
WS102	3.40	0.20	0.60	>3.40	-	-	Strike 2.0	-
WS103	2.45	0.20	1.70	-	-	>2.45	-	-
WS104	2.00	0.25	1.50	-	-	>2.00	-	-
WS105	2.30	0.20	1.40	-	-	>2.30	Strike 0.9	Well installed
WS106	3.45	0.30	-	2.80	>3.45	-	Strike 2.0	Well installed
WS107	2.40	0.50	-	>2.40	-	-	Damp 1.5	-
WS108	3.45	0.30	1.70	>3.45	-	-	Damp 1.7; Strike 2.0	Well installed
WS109	3.15	0.20	0.60	>3.15	-	-	Damp 1.8; Strike 2.0	Clay band 1.1 to 1.5m
WS110	2.25	0.30	0.60	>2.25	-	-	Strike 1.0	-
WS111	3.15	0.40	-	>3.15	-	-	Damp 1.5; Strike 2.0	Well installed
WS112	3.15	0.20	-	>3.15	-	-	Strike 2.0	-
WS113	2.45	0.30	-	1.90	-	>2.45	-	-
SA101	0.50	0.20	-	>0.50	-	-	-	Falling head tests undertaken
SA102	0.45	0.20	>0.45	-	-	-	-	
SA103	0.60	0.25	>0.60	-	-	-	-	
SA104	0.60	0.30	-	>0.60	-	-	-	
SA105	0.50	0.30	>0.50	-	-	-	-	

- 5.3.3 All granular glacial deposits yielded SPT results which indicated the materials are at least medium dense throughout the site at the depths tested.
- 5.3.4 The cohesive glacial deposits (clays) were all found to be at least firm, with SPT 'N' values upwards of N=12 and hand vane results upwards of 85 kPa being reported across the site.
- 5.3.5 The cohesive materials subjected to laboratory testing were found to be low to medium plasticity and low to medium shrinkability clays.
- 5.3.6 CBRs undertaken onsite using a TRL probe have yielded results typically between 3% & 9% (cohesive deposits) and between 6% & 9% (granular deposits). This is in line with what could be typically expected for such glacial deposits in their natural state. Groundwater was encountered at depths of around 2.00m bgl throughout the granular deposits. Groundwater was not encountered within the cohesive deposits.
- 5.3.7 However, in WS105 groundwater was shallower at 0.90m bgl due to a water-bearing sand lens. Groundwater was also found to be elevated to a depth of 1.0m bgl in WS110.
- 5.3.8 The lowest recorded pH was pH5.5 and highest sulphate reading was 100mg/l; suggesting that Sulphate Design Class DS-1 and Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s applies in accordance with BRE Special Digest 1 (2005).

- 5.3.9 Six samples of topsoil and 4 samples of underlying natural soil were submitted for a range of chemical analysis comprising, metals, pH, total sulphate, water soluble sulphate (2:1 extract), sulphide, cyanide, phenols, total and speciated poly-aromatic hydrocarbons (PAHs), asbestos and banded total petroleum hydrocarbons (TPH).
- 5.3.10 A Tier 1 Risk assessment was undertaken on the resultant chemical test data using commercially available screening values published by CIEH / LQM. The assessment assumed a 'residential with plant uptake' end use scenario and concluded that no contaminants of concern were present in the soils.
- 5.3.11 Limited sampling and testing of shallow perched groundwater was undertaken by REC from a window sample well installation; their assessment utilised Tier 1 Screening criteria including UK DWS and EQS standards. The assessment found no Tier 1 exceedances and therefore no evidence for contamination in the perched groundwater on-site.

5.4 Lithos comments

- 5.4.1 Although a window sample investigation is useful in that SPTs have been undertaken, the visual assessment of the soil can be affected due to compression of the recovered sample in the window sample tubes. Furthermore, stability of future excavations cannot be reliably assessed from window sample holes; this would be better assessed by trial pitting.
- 5.4.2 Hand dug falling head tests were undertaken in hand dug pits and window sample holes. These were not, in Lithos' opinion, accordance with best practice for soakaway design (BRE SD365) and as such, the results are of very limited use. However, Lithos concurs that the cohesive glacial deposits are highly unlikely to be suitable for soakaway drainage.
- 5.4.3 The TRL probe is a good indicator of CBRs, but it is best undertaken in conjunction with plate or plunger tests to provide the most confidence.
- 5.4.4 Notwithstanding the above comments, in summary, the investigation works undertaken by REC provides a useful dataset which can help inform the design of the proposed development. However, the ground investigation still requires some supplementing.

6 GROUND INVESTIGATION DESIGN

6.1 Anticipated ground conditions & potential issues

6.1.1 Based on the data reviewed in Sections 4 (Environmental Setting) and 5 (Previous Investigation Findings), anticipated ground conditions are expected to comprise:

Anticipated condition	Remarks
Made ground	None anticipated.
Natural soils	Predominantly granular glacial deposits (sands and gravels). Glacial clay is anticipated along some of the western boundary and in the south-eastern quarter of the site.
Bedrock	In the west of the site, likely to be encountered within 1.5 to 2.0mbgl.
Groundwater	Perched, shallow groundwater within granular glacial deposits.

6.1.2 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. agricultural chemicals	1. pesticides applied to fields historically
Potential off-site contamination sources	1. rail embankment (made ground)	1. unknown materials at site boundary
Potential geotechnical hazards	1. running sands 2. shallow groundwater 3. trees	1. sand and gravel deposits have only been observed in window holes 2. shallow groundwater may destabilise excavations, especially in granular soils 3. some trees are present on-site and around the site perimeter which may affect shrinkable soils
Other potential constraints	1. possible Yorkshire Water soakaway field in south-east corner	1. Yorkshire Water unable to confirm existence / nature of the feature

6.2 Preliminary conceptual site model

6.2.1 A preliminary conceptual site model, presented as Drawing 2366/5 in Appendix B, has been prepared after consideration of the data presented in Sections 2 to 6.1 of this report.

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

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

6.2.3 An assessment of potential contaminants associated with the former uses has been undertaken based on professional judgement. As a consequence of this assessment, anticipated potential contaminants, within soil and/or groundwater include:

- PAHs
- Metals
- Organophosphorous and organochlorine pesticides

6.2.4 Potential pollutant linkages are shown on the preliminary conceptual site model. In summary, the only pollutant linkage identified is tenuous and involves agricultural chemicals in the site soil as a source, inhalation / ingestion of soil particles by future site users (residents) as pathway and receptors respectively.

6.3 Ground investigation design & strategy

6.3.1 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 12	To determine the general nature of soils underlying the site, including the: <ul style="list-style-type: none"> • Nature, distribution and thickness of shallow soils, including any made ground • Suitability of the ground for founding structures and highways • To complement existing exploratory hole data and reduce uncertainty between holes

6.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site whilst above. Taking into account the existing exploratory holes, the proposed Lithos trial pits would provide a roughly 50m grid spacing, which improves on, and reduces the uncertainty between positions on the previous 80m grid spacing. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

6.3.3 The number of representative samples taken will be reflective of the geological complexity actually encountered. However, 3 samples will be taken from most trial pits.

7 FIELDWORK

7.1 Scope of works

7.1.1 Fieldwork was supervised by Lithos on 28th July 2016 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine excavated)	TPs 01 to 12	2.1 to 3.0m	Vane tests undertaken in cohesive soils

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

7.1.3 Exploratory hole logs are presented in Appendix F to this Report and include details of:

- Samples taken
- Descriptions of the strata, and any groundwater encountered
- Results of the in-situ testing

7.1.4 Exploratory hole locations are shown on Drawing 2366/6 presented in Appendix B.

8 GROUND CONDITIONS

8.1 General

- 8.1.1 A complete record of strata encountered beneath the proposed development site is given on the various exploratory hole records, presented in Appendix F.
- 8.1.2 Typical ground conditions encountered onsite are described below in Sections 8.2 (made ground) and 8.4 (natural ground), with a summary provided in the Table on page 10.

8.2 Made ground

- 8.2.1 Made ground on site was tentatively identified on-site in two locations (TP02 and TP04) as re-worked natural ground, i.e. topsoil and natural sand, extending no more than 1.1mbgl.
- 8.2.2 The made ground material identified may be associated with minor localised works, e.g. installing drainage etc. and is not thought to be widespread.

8.3 Natural ground

- 8.3.1 Natural ground was encountered in all exploratory holes, and typically comprised granular glacial deposits (sands / gravels) or cohesive glacial deposits (clays).
- Topsoil: friable organic topsoil was present site-wide to a typical depth of 250mm.
 - Granular Glacial (Sand & Gravel): Medium dense sandy gravels and sand.
 - Cohesive Glacial (Clays): Firm and stiff slightly sandy or gravelly clay.
 - Weathered Oaks Rock (Sandstone and Siltstone): Grey fine grained sandstone interbedded with grey siltstone.
- 8.3.2 The granular glacial materials are prevalent across the central, southern and northern areas of the site. The glacial clays are present along the western edge of the site and in the south-eastern corner.

8.4 Groundwater

- 8.4.1 Inflows of groundwater were encountered in 7 of the 12 trial pits during the investigation, summarised in the table below:

Hole ID	Groundwater body	Water level (m bgl)
TP01	Perched groundwater in granular glacial deposits	2.0 (rising to 1.9m after 5 minutes)
TP02		1.8 (rising to 1.7m after 5 minutes)
TP03		2.0 (rising to 1.9m after 5 minutes)
TP04		2.1 (rising to 2.0m after 15 minutes)
TP08		2.0 (no rise after 5 minutes)
TP11		2.2 (no rise after 5 minutes)
TP12		2.6 (rise to 2.5 after 5 minutes)

8.5 Stability

- 8.5.1 Stability of excavations within soils above the groundwater level i.e. <2.0mbgl was generally good. Slumping in of gravels occurred where waterlogged.

8.6 Revised conceptual ground model (ground conditions)

- 8.6.1 No significant revisions to the preliminary conceptual site model have been made following the findings of the trial pitting; the ground conditions are much the same as was expected after review of search information and third party reports.
- 8.6.2 The revised Conceptual Site Model and geological cross-sections are presented in Appendix B, as Drawings 2366/7.

9 CONTAMINATION (ANALYSIS)

9.1 General

- 9.1.1 The site's former usage is considered unlikely to have given rise to any significant ground contamination. Furthermore, no significant made ground was encountered during the ground investigation. However, samples of topsoil have been recovered in order to confirm its suitability for re-use.
- 9.1.2 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 6.2.
- 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.

Summary of Ground Conditions

Hole ID	Final depth (m)	Depth to base of (m)								Remarks
		Topsoil	Made Ground	Glacial Deposits				Bedrock		
			Reworked natural soils	Cohesive Glacial deposits (firm and stiff clay)	Cohesive Glacial deposits (soft damp clay)	Granular Glacial Deposits (medium dense sandy gravels or gravelly sand)	Cohesive Glacial deposits (firm and stiff clay)	Completely Weathered Oak Rock (stiff gravelly clay)	Weak Oak Rock (sandstone/siltstone)	
TP01	2.7	0.4	-	0.8	-	>2.7	-	-	-	Groundwater at 2.0m
TP02	2.3	0.5 ¹	0.8	1.6	-	>2.3 ²	-	-	-	Groundwater at 1.8m
TP03	2.3	0.3	-	-	-	>2.3	-	-	-	Groundwater at 2.0m
TP04	2.1	0.4 ¹	1.1	>2.1	-	-	-	-	-	Groundwater at 2.1m (seepage)
TP05	2.2	0.3	-	-	-	1.0	1.3	2.0	>2.2	Located near western boundary.
TP06	2.5	0.25	-	-	-	1.5	-	2.2	>2.5	
TP07	2.2	0.4	-	0.8	-	>2.2	-	-	-	
TP08	2.6	0.25	-	-	-	>2.6	-	-	-	Groundwater at 2.0m
TP09	3.0	0.25	-	-	-	>3.0	-	-	-	
TP10	2.3	0.3	-	-	-	1.0	1.3	2.0	>2.3	Located near western boundary
TP11	2.5	0.4	-	-	-	>2.5	-	-	-	Groundwater at 2.2m.
TP12	2.8	0.3	-	-	1.5	>2.8	-	-	-	Pit excavated in parcel of land to north-east. Groundwater at 2.5m.

Notes: ¹ Made Ground Topsoil
² Loose (slight spalling/collapse)

10 CONTAMINATION (ANALYSIS)

10.1 General

- 10.1.1 The site's former usage is considered unlikely to have given rise to any significant ground contamination. Furthermore, no significant made ground was encountered during the ground investigation. However, samples of topsoil have been recovered in order to confirm its suitability for re-use.
- 10.1.2 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 6.2.
- 10.1.3 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.
- 10.1.4 Where available, Category 4 Screening Levels (C4SL) have also been referenced.
- 10.1.5 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).
- 10.1.6 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

10.2 Testing scheduled

- 10.2.1 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	2	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc)
		Leachable metals: arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc
		Water soluble sulphate
		Asbestos ID
		TOC
Topsoil	6	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc)
		Leachable metals: arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc
		Water soluble sulphate
		Asbestos ID
		TOC
	2	Organophosphorous and organochlorine pesticides

10.3 Soil contamination results

- 10.3.1 The soil contamination test results are summarised in the Table on page 16.
- 10.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix G to this report.

Inorganic determinands

- 10.3.3 Of the two samples of made ground and 6 samples of topsoil analysed for inorganic parameters, all can be classified as uncontaminated.
- 10.3.4 These samples have been classified by comparison with Tier 1 Soil Screening Values for an end use including domestic gardens and any area where plants are to be grown (the most sensitive of the proposed end-uses).

Asbestos

- 10.3.5 No asbestos fibres were identified in the two samples of made ground and 6 samples of topsoil screened. As such, asbestos in site soils does not warrant further assessment.

Organic determinands

- 10.3.6 Samples have been classified by comparison with Tier 1 Soil Screening Values. These screening values assume a Soil Organic Matter (SOM) of 6% (equivalent to a TOC of 3.5%). Many organic contaminants are more mobile when the SOM is lower, and consequently lower screening values are then more appropriate for many organic contaminants.
- 10.3.7 In order to check the validity of Tier 1 Soil Screening Values, the average TOC for each common fill type (beyond any areas of obvious hydrocarbon impact) have been determined.

Soil type	Typical TOC (%)	Comparison with revised screening value necessary?
Made Ground	1.5%	Yes, revised screening values adopted.
Natural topsoil	1.5%	

Polycyclic Aromatic Hydrocarbons (PAH)

- 10.3.8 There are numerous PAH compounds. The USEPA identified 16 PAHs that are considered to represent the most problematic in terms of toxicology, fate and behaviour. The UK have also focused on these 16 and these are included in the laboratory report where speciated PAH analysis has been scheduled.
- 10.3.9 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).
- 10.3.10 Speciated analysis has confirmed the absence of significant concentrations of both benzo(a)pyrene and naphthalene in made ground and topsoil beneath the site.

Insecticides

- 10.3.11 Both of the topsoil samples scheduled for insecticide analysis (organo-chlorine and organo-phosphorous Insecticides) yielded results below the laboratory limit of detection (0.01 mg/kg).

Summary of degree of soils contamination

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 gardens end-use.													Asbestos I.D.	
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣\$	Pb ∞	Hg *	Ni	Se	Zn \$	PAH			
				37	5	26	3000	200	200	169	127	350	200	5	B(a)P ∞≠		Naphthalene≠
TP02	0.80	Made Ground	7.7	16	1.2	0.2	18	28	50	< 0.05	15	< 0.5	70	1.6	< 0.03	< 0.03	N.D.
TP04	0.50	Made Ground	8.5	8.6	1.1	< 0.1	14	16	17	< 0.05	16	< 0.5	52	0.5	< 0.03	< 0.03	N.D.
TP01	0.10	Topsoil	7.9	17	1.4	0.1	13	24	46	0.06	16	1.3	57	1.5	< 0.03	< 0.03	N.D.
TP05	0.10	Topsoil	6.7	15	1.0	0.2	15	21	41	< 0.05	18	0.8	73	1.1	< 0.03	< 0.03	N.D.
TP11	0.10	Topsoil	7	13	1.0	0.2	17	22	39	< 0.05	16	0.7	64	1.6	< 0.03	< 0.03	N.D.
TP12	0.10	Topsoil	6.4	12	1.1	0.2	14	19	37	0.06	15	< 0.5	66	1.8	< 0.03	< 0.03	N.D.
TP04	0.10	Topsoil	7.4	15	1.2	0.2	19	26	40	0.05	15	1.0	66	1.8	< 0.03	< 0.03	N.D.
TP10	0.10	Topsoil	6.6	15	1.0	0.2	17	22	39	< 0.05	17	< 0.5	67	1.2	< 0.03	< 0.03	N.D.

Key		Source of guidance trigger level	
12	Parameter tested for but not found to be in excess of Tier 1 concentration.	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.	
≠	Revision of tier 1 value dependent on TOC of soil. See Section 10.3.		
♣	Tier 1 Value is pH dependent.	∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.	\$	Ministry of Agriculture, Fisheries & Food. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.	~	Engineering judgement (Lithos). Boron is a phytotoxic. Plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.
N.D.	None Detected (applicable to asbestos ID only)		

11 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

11.1 Topsoil

- 11.1 Topsoil, typically 250mm thick underlies the entire site. Testing suggests this material is chemically suitable for re-use.
- 11.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth. However, no testing in accordance with BS3882:2015 Specification for Topsoil (N-P-K, clay content etc) has been undertaken to date.
- 11.1.2 Two localised patches of made ground have been found on-site; these are up to 1.1m thick and comprise re-worked natural soils. Testing suggests this material is not contaminated.

11.2 Waste classification

- 11.2.1 Some excess arisings may be generated by excavations for foundations, sewers etc.
- 11.2.2 Classification of soils as inert, non-hazardous or hazardous should be undertaken in accordance with the Environment Agency's Technical Guidance WM3¹, 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.
- 11.2.3 Off-site disposal to landfill is not recommended. In accordance with the CL:AIRE Code of Practice² 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.
- 11.2.4 Contractors exporting waste from the site should be asked to review the site investigation data and make their own assessment. Alternatively Lithos could undertake this assessment once exported waste streams have been identified.

12 HAZARDOUS GAS

12.1 Methane & carbon dioxide

- 12.1.1 The site is not believed to be affected by sources of hazardous gas generation as it is:
- Not located within 250m of a known former or current landfill site or backfilled feature (eg quarry, pond, canal etc)
 - Neither underlain by shallow mineworkings nor located in an area considered susceptible to mines gas emissions
 - Not underlain by a significant thickness of made ground
 - Not underlain by peat or shallow chalk deposits
- 12.1.2 As stated in Section 5, contrary to REC's report, Lithos do not consider gas monitoring to be necessary for this site due to the lack of any potential sources. Furthermore, REC's reported suggests that, after two monitoring rounds indications were that no gas protection measures would be required.

¹ Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015

² The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

12.2 Radon

12.2.1 The Envirocheck report obtained by Lithos in August 2016 utilised the same development site boundary as shown in Drawing 2366/3 in Appendix B. The report states that the site is in an area where less than 1% of properties are at risk, and therefore radon protection measures are not required.

13 GEOTECHNICAL TESTING

13.1 General

13.1.1 A total of 10 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

13.1.2 The geotechnical laboratory test results are presented in Appendix H to this report.

13.2 Atterberg limits

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

Soil type	Moisture content range (average)	Range of Plasticity Indices* (average)	Shrinkability
Cohesive Glacial Deposits	16 to 29 (21)	15 to 24 (20)	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.

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

13.3 Soluble sulphate and pH

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

13.3.2 It is envisaged foundations will extend to depths of about 1m through made ground and natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).

13.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 10 samples were determined. In addition, two samples of made ground were tested as part of the contamination suite. The pH value of each sample has also been determined.

13.3.4 The highest water-soluble sulphate concentration and the lowest pH value for each soil type analysed are shown in the table below.

Soil type	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Made Ground	6.4	22
Granular Glacial Deposits	7.1	15
Cohesive Glacial Deposits	6.3	11

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

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

Hand shear vane testing

- 13.3.7 Hand shear vane testing was undertaken within trial pits in-situ to around 1.2m depth (wherever clays were present and could be practicably and safely tested) and from larger blocks of excavated clay below that depth.
- 13.3.8 The cohesive glacial deposits in the main site area exhibited shear strengths in the order of 70kPa to 130kPa, which is indicative of firm and stiff consistency; this is consistent with the engineers' field soil descriptions.
- 13.3.9 A single vane test undertaken in TP12 in the 'extra' parcel of land to the north-east close to the surface water stream yielded a result of 38kPa at 2.0mbgl. The clay material tested was a lens of soft clay 'sandwiched' between layers of granular deposits; as such the result is not representative of clays in the wider site area. Moreover, no development is proposed in this area.

14 GEOTECHNICAL ISSUES

14.1 Conceptual site model

- 14.1.1 The site is underlain by topsoil across its entire area, with underlying strata predominantly comprising medium dense granular glacial deposits and locally, cohesive glacial deposits (firm and stiff clays) in the western edge and south-eastern corner. Shallow groundwater is present at around 2.0mbgl across much of the site, within the granular glacial materials.
- 14.1.2 Solid strata of Oaks Rock (fine grained sandstone and siltstone strata) is present at around 2mbgl in the east of the site.

14.2 Foundation recommendations

General

- 14.2.1 The site is to be developed for low rise residential housing with associated adoptable highways, gardens and POS. A sketch layout has been prepared by Barratt, a copy of which is shown as Drawing 2366/2 in Appendix B.
- 14.2.2 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.
- 14.2.3 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, Barratt should consider implications for the foundation recommendations outlined below.
- 14.2.4 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.
- 14.2.5 Sub-surface concrete in contact with the made and natural ground should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.
- 14.2.6 Foundation solutions for two or three storey residential properties constructed on this site are discussed below.

Strip/trench fill footings

- 14.2.7 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses constructed at the site. This solution is viable across the entire site wherever firm or stiff clay or competent rock is the founding material.
- 14.2.8 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.
- 14.2.9 If required, over deepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.
- 14.2.10 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).
- 14.2.11 In addition to the above, Barratt should review proposed plot designs and layouts, since deeper excavations for trench fill are likely to be unstable where the centre-lines of parallel trenches are closer than about 2m (assuming 600mm widths). Barratt should supervise their groundworker to ensure footings are excavated in a controlled and safe manner.
- 14.2.12 Barratt or their groundworker should seek further advice from Lithos if unexpected ground conditions are encountered in foundation or sewer excavations, including any conflict between soft ground associated with a backfilled trial pit excavation and the line of a proposed footing.

Granular soils (sand & gravel)

- 14.2.13 The calculations below are based on quantitative data (SPT results) obtained by REC during their ground investigation; along with soil descriptions from the trial pits excavated by Lithos.
- 14.2.14 A safe bearing capacity of around 150kPa (120kPa at 0.45m) can be assumed if the following are true:
- A maximum foundation line load of 90kN/m run
 - A foundation length of 8m
 - A foundation breadth of 0.6m
 - A foundation thickness of 225mm
 - A foundation depth of 0.6m
 - An angle of shearing resistance of $\phi=31^\circ$ for the granular deposits
- 14.2.15 Assuming the foundation geometry detailed above, settlements in the order of less than 25mm would be anticipated. This is considered likely to be acceptable. However, further advice should be sought from the Structural Engineer responsible for foundation design.
- 14.2.16 In accordance with NHBC Standards, a minimum founding depth of 450mm is required in the granular soil (due to potential frost susceptibility). 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).

- 14.2.17 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.
- 14.2.18 It should be noted that founding at shallow depth (450mm), whilst desirable from an excavation stability viewpoint, may not provide sufficient bearing capacity due to the lesser depth of (resisting) overburden. Consequently, a minimum founding depth of 600mm is recommended.
- 14.2.19 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).
- 14.2.20 Where plots are underlain by granular soil and within the influence of existing trees, footings can be cast in the granular soil at a "standard" depth of 600mm, provided that all the following conditions are satisfied:
- consistent ground across the plot
 - the depth of granular soil is greater than $\frac{3}{4}$ of the depth which would be computed if founding in shrinkable clay
 - the thickness of granular soil beneath the footing is equal to or greater than the foundation width (i.e. usually >600mm)
- 14.2.21 Good control\supervision of groundworks will be essential because there is a significant risk that over-excavation into granular soils (especially below the water table at around 2.0m) will result in unstable trenches and collapse which may render the ground unsuitable and necessitate a piled solution.

Clay/cohesive soils

- 14.2.22 A safe bearing capacity of around 180kPa can be assumed if the following are true
- A maximum foundation line load of 90kN/m run
 - A foundation length of 8m
 - A foundation breadth of 0.6m
 - A foundation thickness of 225mm
 - A foundation depth of 0.9m depth
 - An undrained shear strength of 70kPa for the firm clay (typical minimum recorded on site)
- 14.2.23 Assuming the foundation geometry detailed above, settlements in the order of less than 25mm would be anticipated. This is considered likely to be acceptable, although further advice should be sought from the Structural Engineer responsible for foundation design.
- 14.2.24 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 clay / cohesive soils on the site where strip footings are proposed.
- 14.2.25 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.
- 14.2.26 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. No layout has been provided to date but it is likely that some plots may be affected by trees, most notably those around the site boundaries in the south and east.

14.2.27 Softer clay, with a lower safe bearing capacity was encountered at founding depth in TP12 in the parcel of land to the north-east of the main site. This area is shown in Drawing 2236/6. However, Lithos understands that the land in the vicinity of TP12 is not to be used for the construction of houses and as such the soft strata as reported require no consideration in the context of foundation design and allowable bearing capacity.

Bedrock

14.2.28 The Oak Rock (sandstone and siltstone) bedrock is generally considered to have a safe bearing capacity of at least 250kPa and minimal settlements would be anticipated. Whilst unlikely to be encountered in the majority of foundation excavations, bedrock may be the founding strata for plots in areas of significant tree influence.

14.2.29 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 over-deepening of foundations.

Summary of foundation recommendations

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

Plot nos	Foundation solution(s)	Remarks (influencing factors)
1 to 5 96 to 98 142 to 151	Over-deepened strips / trench fill at $\geq 1.0\text{m}$	Areas where medium dense gravels are present but overlain by a thin layer of unsuitable founding material
6 to 14 25 to 26 29 to 34 41 to 56 73 to 74 80 to 91 93 to 95 99 to 112 115 to 120 122 to 125 152 to 153	Strip footings at $\geq 0.6\text{m}$	Medium dense glacial sand and gravels
15 22 to 24 35 to 40 57 to 72 75 to 76 79 91 to 92 126 to 141 154	Strip footings at $\geq 0.9\text{m}$	Firm and stiff glacial clay deposits
77 78 92 113 to 114 121 to 130	Over-deepened strips at 0.9 to 2.0m	These plots lie in areas which may be affected by the influence of existing trees and as such, over-deepening may be necessary
16, 17, 18, 19, 20, 21, 27, 28	No access, outside the site area but strip footings in clay at c.1m could be tentatively assumed.	

14.2.31 The preliminary foundation zones are shown in Drawing 2366/8 in Appendix B.

- 14.2.32 Lithos could prepare a detailed Foundation Schedule if provided with: a proposed layout plan, an External Works Drawing (with proposed FFLs & infrastructure details); a topographic survey and a tree survey.
- 14.2.33 The foundation solutions outlined above 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.

14.3 Floor slabs

- 14.3.1 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). Floor slabs should not be cast in-situ where made ground is either greater than 600mm or found to be shrinkable.
- 14.3.2 It is estimated that the thickness of made ground is likely to exceed 600mm beneath only a very small number (5%) of the plots within the vicinity of TPs 101 and 104 in the area.
- 14.3.3 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.
- 14.3.4 It is considered that, outside the zone of influence of trees, the natural ground is generally suitable for the use of ground bearing floors. However, ground bearing slabs should not be cast on topsoil or made ground. Where plots are elevated for design reasons, the depth of engineered stone below a ground bearing slab should not exceed 600mm, in accordance with NHBC guidance.
- 14.3.5 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.
- 14.3.6 It should be noted that NHBC have suffered a significant number of claims resulting from the use of ground bearing floor slabs. Consequently, if ground bearing slabs are proposed, care should be taken correct and careful construction. For example, if fill to the internal face of the foundation excavation is not properly compacted, subsequent settlement can result in cracking of the slab.

14.4 Designated concrete mixes

- 14.4.1 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	All site soils DS-1 conditions ACEC Class AC-1s
Unreinforced strip/trench fill footings	GEN1
Unreinforced concrete floor slabs	GEN2
In situ reinforced concrete floor slabs	RC28/35

14.5 Excavations

- 14.5.1 Groundwater should be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".
- 14.5.2 Based on the results of the investigation it is considered likely that groundwater inflows will be encountered in excavations of greater than around 1.5m.
- 14.5.3 Excavations to 2m should remain stable in the short term but if left open for any significant period of time may require shoring most notably in granular soils.
- 14.5.4 Where sand is encountered (especially running sand), beware of over-digging and creating a "large hole". It is generally prudent to stop excavation and "probe" to check thickness of sand. If in doubt, please seek advice from Lithos.
- 14.5.5 Bedrock was encountered in several exploratory holes, especially in the west of the site. Based on the exploratory hole logs, excavation greater than 2m is likely to prove difficult across about 30% 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.

14.6 Drainage

- 14.6.1 The site surface is relatively flat and level. Most of the site is underlain by granular soils with a shallow perched water table at around 2.0m depth.
- 14.6.2 CIRIA C697:2007 recommends that 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'.
- 14.6.3 Based on groundwater levels and observations made during the previous ground investigation works (see Section 5), soakaways are unlikely to provide a suitable drainage solution for surface water run-off on-site. Consequently, it may be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.
- 14.6.4 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 the best solution.
- 14.6.5 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.
- 14.6.6 Land drains were encountered within the site investigation trial pits in at least one location. Provision of surface drainage infrastructure will negate the need for field drainage. However, field drainage encountered during construction of the infrastructure works, should, where practicable and where the layout allows, be maintained.

14.6.7 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.

14.7 Highways

14.7.1 This site is greenfield and the routes, formation level and total length, of proposed estate roads are not known.

14.7.2 The natural soils present at shallow depth (anticipated formation) are predominantly granular, with a lesser amount of cohesive materials present. Based on visual inspection of the natural materials and the recorded and 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 deposits will provide a CBR value of at least 3%. This value should be verified prior to or during construction.

14.7.3 Whilst the CBRs estimated above should be achievable, significant deterioration during/after periods of significant rainfall is likely and/or site trafficking. Consequently, it would be prudent to consider flexibility in the groundworks programme to enable highway construction during prolonged dry/warm weather (typically between May and September) when formation will be least vulnerable to deterioration. Alternatively, a minimum 200mm thickness of suitable granular fill (ie a "blanket" of 6F2) could be placed along the line of proposed highways to protect formation during the construction phase.

14.8 External works

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

15 REDEVELOPMENT ISSUES

15.1 General

15.1.1 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.

15.2 Good practice guidance

15.2.1 The construction phase groundworker should follow good environmental practice to minimise the risks of spillage, leakage etc with reference, but not limited, to the following documents:

- CIRIA C502 'Environmental Good Practice on Site'
- EA Pollution Prevention Guidelines:
 - PPG6 - Working at construction and demolition sites
 - PPG2 - Above ground oil storage tank
 - PPG7 – The safe operation of refuelling facilities.
 - PPG21 – Incident Response Planning

15.3 New utilities

- 15.3.1 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.
- 15.3.2 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.
- 15.3.3 Consequently, the use of 'standard' polyethylene water supply pipes should be acceptable, although Barratt should consult Yorkshire Water at the earliest opportunity to confirm this.

15.4 Health & safety issues - construction workers

- 15.4.1 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.
- 15.4.2 Before site operations are started, the necessary COSHH statements and Health & Safety Plan should be drafted in accordance with the CDM regulations.

15.5 Potential development constraints

- 15.5.1 The possible Yorkshire Water soakaway field in the south-east of the site may represent a potential development constraint unless it can be relocated. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required if it remains in-situ.

16 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

16.1 General

- 16.1.1 The site comprises a disused grazing field and paddocks located off Lee Lane, Royston. It is understood that development proposals exist for a number of low rise residential dwellings with gardens, adoptable highways and services.
- 16.1.2 Most of the site is underlain by medium dense Granular Glacial Deposits, mainly gravels, with some areas of Cohesive Glacial Deposits (gravelly clay) in the western edge and south-east corner. Two minor pockets of made ground (reworked natural soil) of around 1m thickness were also present locally on-site.
- 16.1.3 Bedrock comprising Oaks Rock (sandstone and siltstone) was encountered in the west of the site at shallow depth (around 2.0mbgl).

16.2 Hazardous gas

- 16.2.1 There are no known or suspected areas of landfilling within 250m, and the site is not in area considered susceptible to mines gas, nor is it underlain by shallow mineworkings.
- 16.2.2 The Envirocheck report states that less than 1% of properties in the area are above the action level and as such, radon protection measures are not necessary in new dwellings.

16.3 Mining and quarrying

- 16.3.1 The shallowest coal seam is of limited thickness (0.2m) and is likely to be at >20m depth. Whilst the site lies within a Coal Authority Low Risk area, no significant risks have been identified, and an intrusive mining investigation will not be required.
- 16.3.2 No quarries have been identified on, or within the vicinity of, the site.

16.4 Contamination

- 16.4.1 No significant contamination has been encountered. Testing of topsoil suggests it is chemically suitable for re-use.

16.5 Foundations

- 16.5.1 The entire site should be suited to strip / trench fill footings at a minimum of 0.6m depth within the natural Granular Glacial Deposits, increased to 0.9m depth within the Cohesive Glacial Deposits. Depending on finished floor levels and tree influence, some footings may be founded on weathered bedrock in the west of the site.

16.6 Flooding

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

16.7 Drainage

- 16.7.1 Based on visual observations and locally high groundwater levels within the Granular Glacial Deposits, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off at the site where clay materials are present.
- 16.7.2 Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

16.8 Highways

- 16.8.1 Based on visual inspection of the shallow natural materials and published guidance, and testing undertaken by REC, the natural glacial deposits should provide a CBR value of at least 3%. This value should however be verified prior to or during construction.

Appendix A
General Notes

General

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

Geology, mining & quarrying

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

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

Landfills

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

Radon

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

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

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

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

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

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

Hydrogeology

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

- groundwater quality
- recorded pollution incidents
- licensed groundwater abstractions

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

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

The maps display the following aquifer designations:

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

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

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

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

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

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

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

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

Hydrology

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

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

Generic notes – geoenvironmental Investigations

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

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

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

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

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

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

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

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

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

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

COMAH & explosive sites

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

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

Preliminary conceptual ground model

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

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

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

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 stones¹ – 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.

Generic notes – geoenvironmental investigations

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:

$$I'p = Ip * (\% < 425\mu\text{m} / 100)$$

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 SO₄ 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).

Generic notes – geoenvironmental investigations

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.

Generic notes – geoenvironmental investigations

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)	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.

Generic notes – geoenvironmental investigations

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

Generic notes – geoenvironmental investigations

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

Generic notes – geoenvironmental investigations

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	1,000 [^]
Aromatic 7-8	GRO	15	16	21	
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

$$HI = \sum_{F_i=1}^{39} HQ F_i = \frac{\text{Measured concentration } F_i \text{ (mg kg}^{-1}\text{)}}{SGV F_i \text{ (mg kg}^{-1}\text{)}}$$

where: HI = Hazard Index
 HQ = Hazard Quotient
 F_i = Fraction
 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 ICRC 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.

Generic notes – geoenvironmental investigations

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.

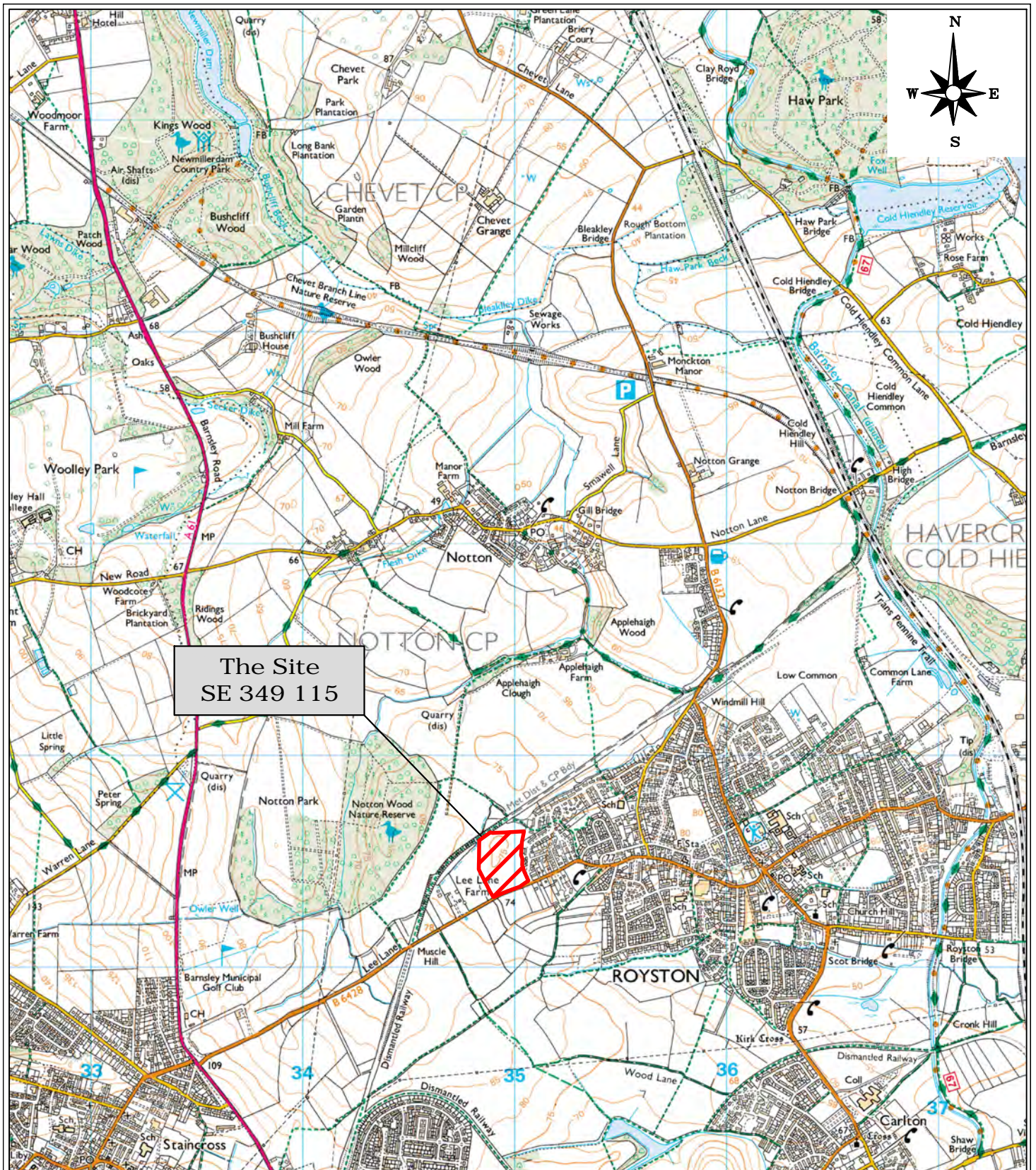
However, Lithos consider the concept of a single garden as an averaging area to be inappropriate with respect to brownfield redevelopment, which is regulated by the planning regime. In this context, contamination across the entire site needs to be characterised by reference to the Conceptual Site Model. 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.

Appendix B
Drawings



Reproduced from OS Explorer map 1:25,000 scale by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office. Crown copyright. All rights reserved. Licence number 100049696.



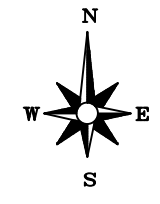
info@lithos.co.uk
www.lithos.co.uk
Tel 01937 545330

CLIENT
BARRATT HOMES

JOB TITLE
**LEE LANE,
ROYSTON**

DRAWING TITLE
**SITE LOCATION
PLAN**

DRAWN	MC	DATE	19 08 16
CHECKED	MJT	DATE	19 08 16
STATUS	FOR COMMENT <input type="checkbox"/>	DRAFT	<input type="checkbox"/>
	FOR APPROVAL <input type="checkbox"/>	FINAL	<input checked="" type="checkbox"/>
SCALE	1:25,000	SHEET	A4
		DRAWING NO.	2366/1
		REVISION	



NOTES

— APPROXIMATE SITE BOUNDARY

REPRODUCED FROM :
 'LEE LANE, ROYSTON: SKETCH LAYOUT
 (Drawing No. KSL-01 dated November 2015)

REV.	DESCRIPTION	DATE

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

CLIENT

BARRATT HOMES

JOB TITLE

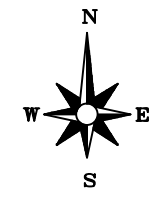
LEE LANE,
 ROYSTON

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	IMC	DATE	19 08 16	STATUS	FOR COMMENT <input type="checkbox"/>
CHECKED	MJT	DATE	19 08 16	FOR APPROVAL	<input type="checkbox"/>
				DRAFT	<input type="checkbox"/>
				FINAL	<input checked="" type="checkbox"/>

SCALE	1:2000	SHEET	A3	DRAWING NO.	2366/2	REVISION	
-------	--------	-------	----	-------------	--------	----------	--



NOTES

- APPROXIMATE SITE BOUNDARY
- GRASS & OVERGROWN AREAS
- THIRD PARTY LAND
- TREES
- TARMAC HIGHWAY

REV.	DESCRIPTION	DATE



info@lithos.co.uk
www.lithos.co.uk

Tel 01937 545330

CLIENT

BARRATT HOMES

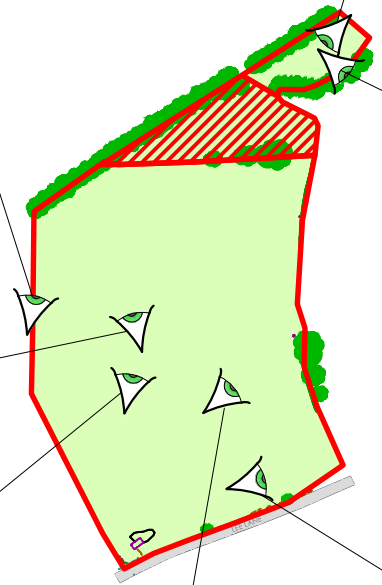
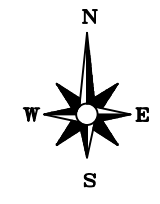
JOB TITLE

LEE LANE,
ROYSTON

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS	
MC	19 07 16	FOR COMMENT	<input type="checkbox"/>
CHECKED	DATE	FOR APPROVAL	<input type="checkbox"/>
MJT	19 07 16	DRAFT	<input type="checkbox"/>
		FINAL	<input checked="" type="checkbox"/>
SCALE	SHEET	DRAWING NO.	REVISION
1:2000	A3	2366/3	



NOTES

- APPROXIMATE SITE BOUNDARY
- LOCATION & ORIENTATION OF PHOTOGRAPH
- GRASS AND PADDOCKS
- TREES AND SHRUBS
- TARMACADAM ROAD

REV.	DESCRIPTION	DATE

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

BARRATT HOMES

LEE LANE,
ROYSTON

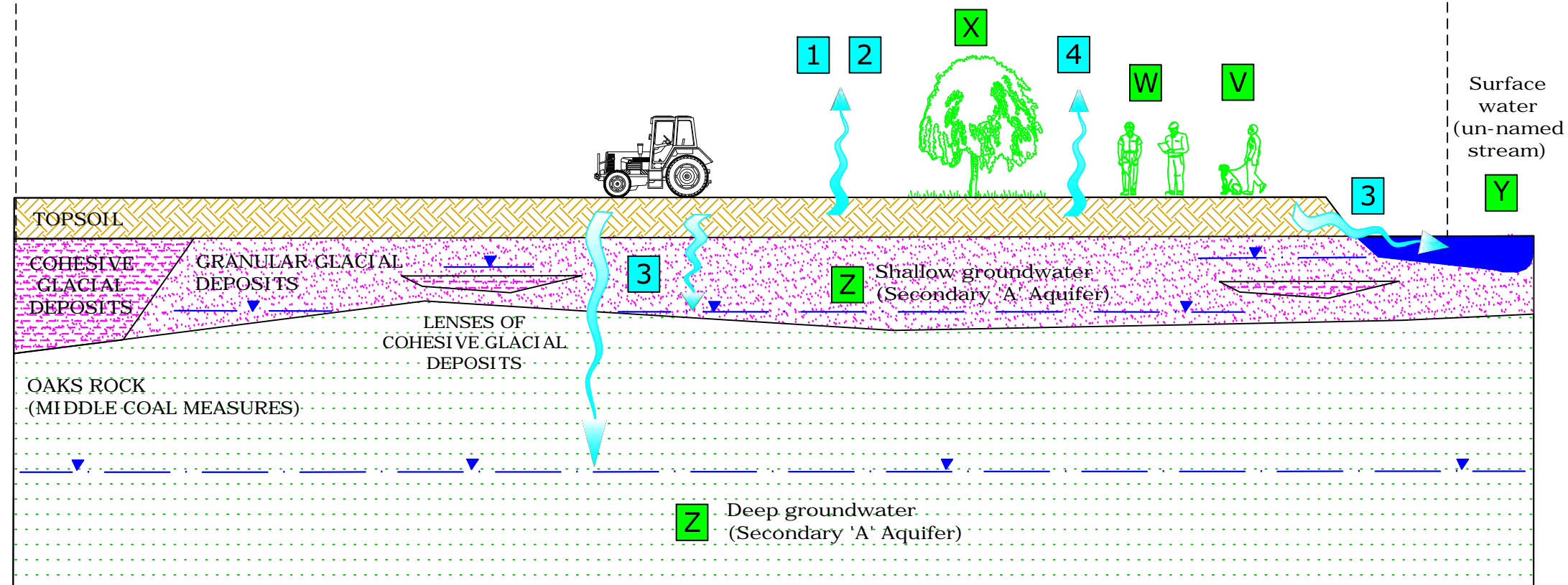
SITE PHOTOGRAPHS

DRAWN	DATE	STATUS	
MC	19 08 16	FOR COMMENT	<input type="checkbox"/>
CHECKED	DATE	FOR APPROVAL	<input type="checkbox"/>
MJT	19 08 16	DRAFT	<input type="checkbox"/>
		FINAL	<input checked="" type="checkbox"/>

SCALE	SHEET	DRAWING NO.	REVISION
NOT TO SCALE	A3	2366/4	

SITE BOUNDARY

SITE BOUNDARY



SOURCES	
A	AGRICULTURAL ACTIVITIES

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION\INHALATION
3	LEACHING OF CONTAMINANTS
4	UPTAKE BY PLANTS

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

NOTES

REV.	DESCRIPTION	DATE

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

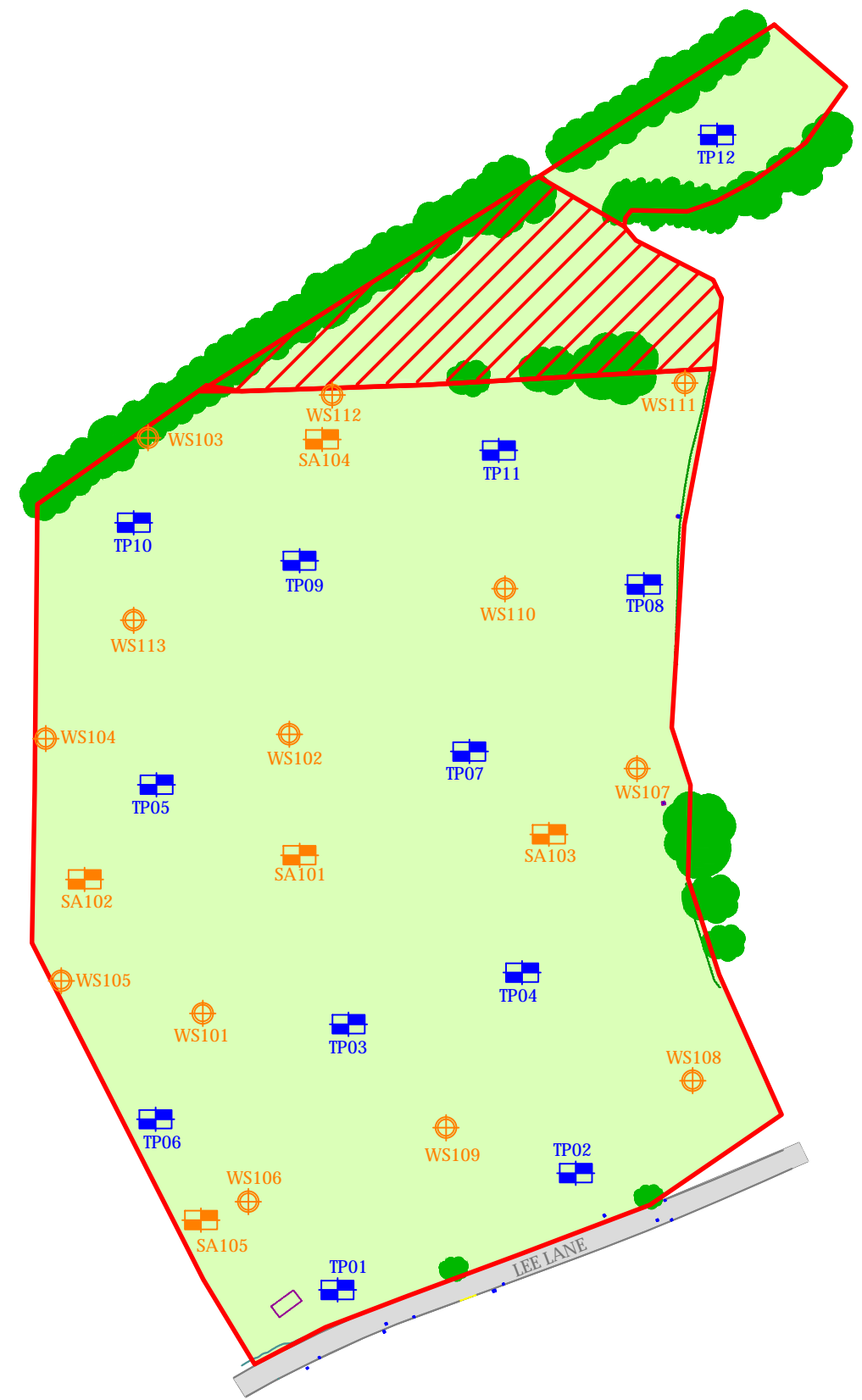
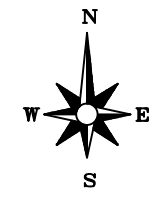
BARRATT HOMES

**LEE LANE,
ROYSTON**

**PRELIMINARY CONCEPTUAL
SITE MODEL**

DRAWN	DATE	STATUS
MC	19 08 16	FOR COMMENT <input type="checkbox"/>
MJT	19 08 16	FOR APPROVAL <input type="checkbox"/>
		DRAFT <input type="checkbox"/>
		FINAL <input checked="" type="checkbox"/>

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2366/5	



NOTES

- APPROXIMATE SITE BOUNDARY
- GRASS & OVERGROWN AREAS
- NO ACCESS (THIRD PARTY LAND)

LITHOS INVESTIGATION 2016

- TRIAL PIT LOCATION (TP01 to TP12)

RESOURCE & ENVIRONMENTAL CONSULTANTS LTD INVESTIGATION 2014

- HAND DUG SOAKAWAY PIT (SA101 to SA105)
- ⊕ WINDOW SAMPLE (WS101 to WS113)

REV.	DESCRIPTION	DATE



info@lithos.co.uk
www.lithos.co.uk

Tel 01937 545330

CLIENT

BARRATT HOMES

JOB TITLE

LEE LANE,
ROYSTON

DRAWING TITLE

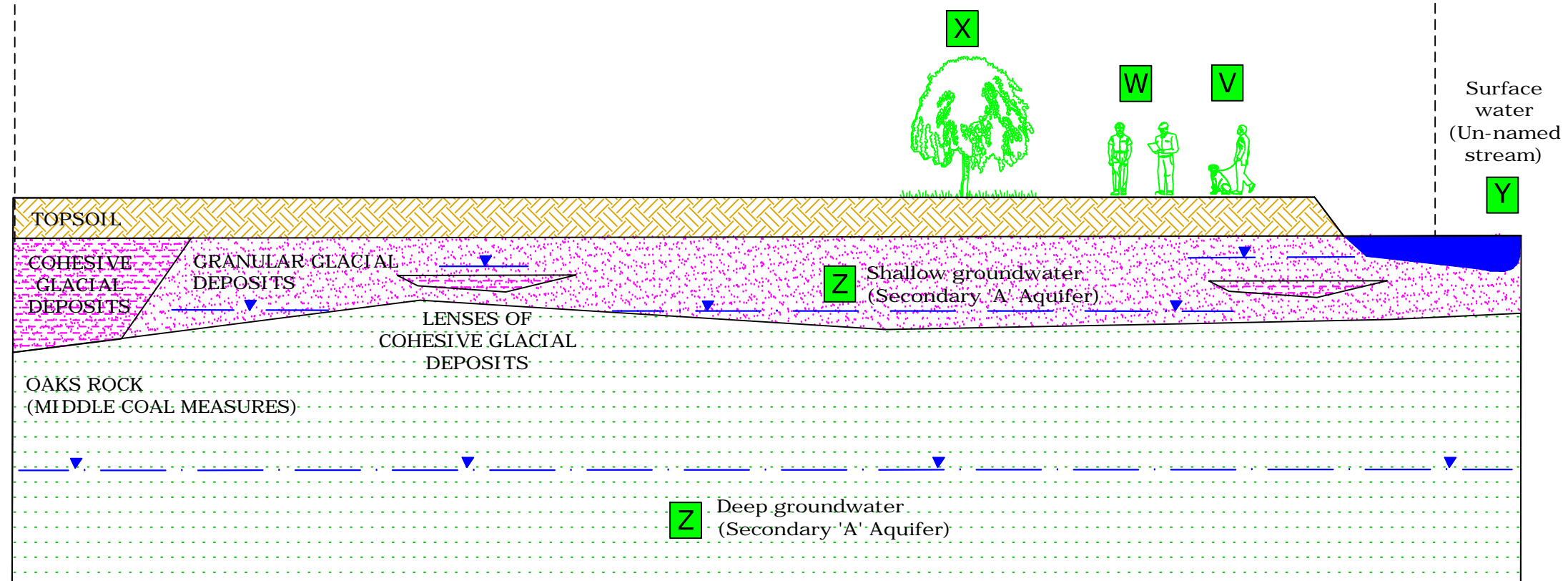
EXPLORATORY HOLE
LOCATIONS

DRAWN	DATE	STATUS	
MC	29 07 16	FOR COMMENT	<input type="checkbox"/>
CHECKED	DATE	FOR APPROVAL	<input type="checkbox"/>
MJT	29 07 16	DRAFT	<input type="checkbox"/>
		FINAL	<input checked="" type="checkbox"/>

SCALE	SHEET	DRAWING NO.	REVISION
1:2000	A3	2366/6	

SITE BOUNDARY

SITE BOUNDARY



SOURCES

PATHWAYS

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

NOTES		
REV.	DESCRIPTION	DATE



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

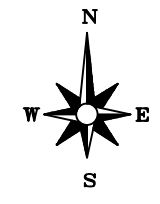
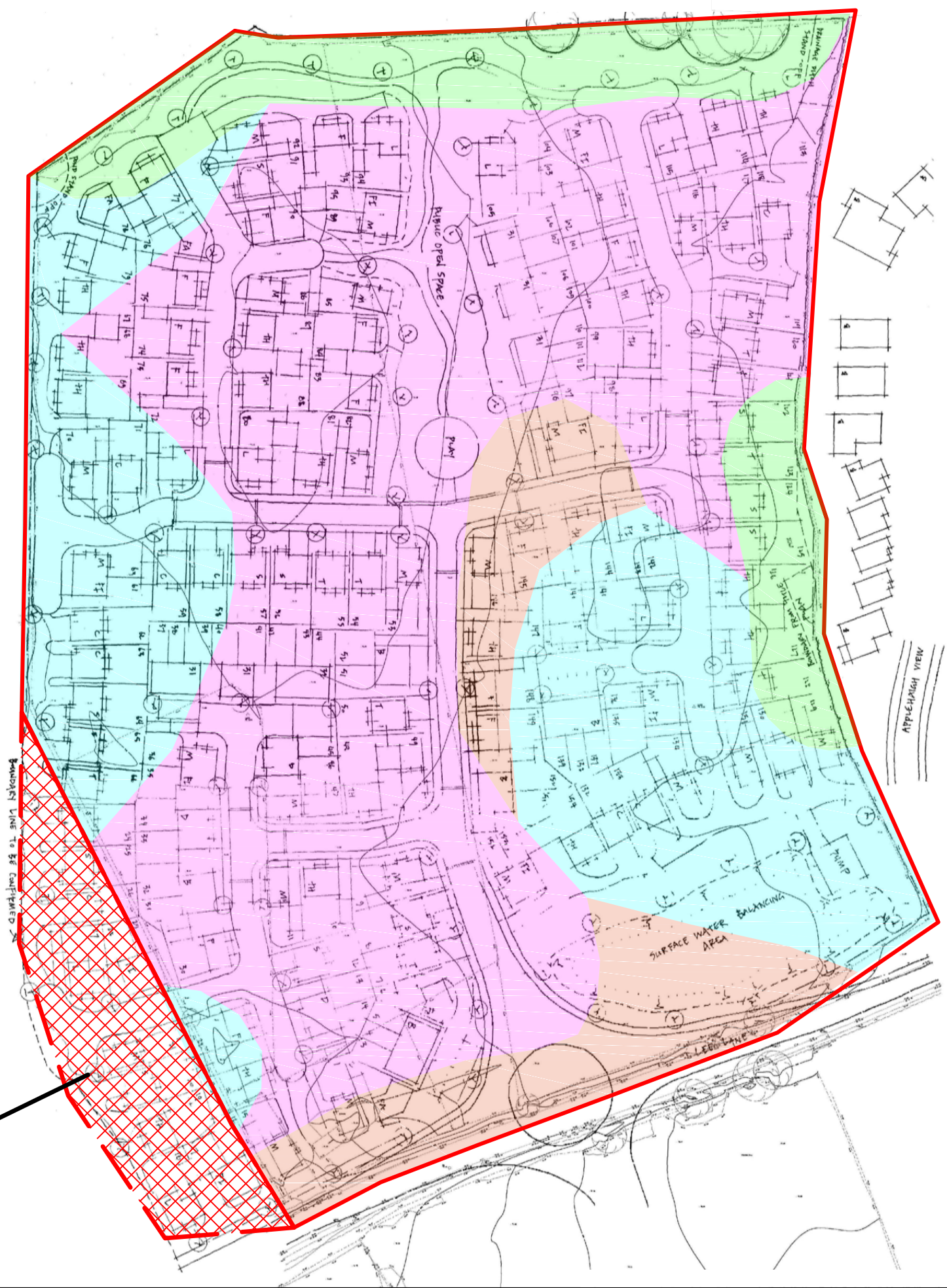
BARRATT HOMES

LEE LANE,
ROYSTON

REVISED CONCEPTUAL
SITE MODEL

DRAWN	DATE	STATUS
MC	19 08 16	FOR COMMENT <input type="checkbox"/>
CHECKED	DATE	FOR APPROVAL
MJT	19 08 16	DRAFT <input type="checkbox"/>
		FINAL <input checked="" type="checkbox"/>

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2366/7	



- NOTES
- 5DDFLA 5H9H96CIB85FM
 - █ Gfjd Zcjb[gUha bja ia \$"-a 'b[fubi 'Ufg:]g
 - █ Gfjd Zcjb[gUha bja ia \$"-a 'b'WUM
 - █ Cj YfXYdYbYX gfd cfHYbW Z' b[fubi 'Ufg:]g
 - █ Cj YfXYdYbYX gfd Zcjb[gXi Y'ic HY'Y bZi YbW'fk jh'b &sa czfYYE

F91'	8'927 F.DHC B	851P
------	---------------	------



jbZc4 'jh'cg"Vé"i _
 k k k "'jh'cg"Vé"i _
 HY"\$%- '+) () ' ' \$

65FF5H<CA 9G

@9' @B9z
 FC MGC B

B8 7 5HJ 9: C I B85HC B
 HMD9G'5B8 '89DH<G

5fYU 'ZU' gVYmc bX
 gWc dY' cZ[fci bX
 'bj Yg[Uhc b!
 h'bhUj Y'm
 Ugg a YX' ic VY
 g jh'X' ic gfd
 Zcjb[g
 Utr %\$a V['

BFSK B	851P	86HG
A 7	& '\$- %*	.CF 7CAA 98H <input type="checkbox"/>
A >H	& '\$- %*	.CF 5DDFCJ 5@ <input type="checkbox"/>
		BFS: H <input type="checkbox"/>
		.B5@ <input checked="" type="checkbox"/>
G7 51P	G-99H	BFSK B: BC'
BHG	5'	& '* * #,
		F'9J GCB

Appendix C
Commission

002/2366/REG

11th January 2016

Ms D Matkowska
Barratt Homes & David Wilson Homes Yorkshire West
Vico Court
Ring Road
Lower Wortley
Leeds
LS12 6AN



Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330
www.lithos.co.uk

Dear Daria

Lee Lane, Royston

Further to your recent invitation, please find attached our proposal for undertaking a supplementary site investigation on the above land. We understand that your proposed development will include traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; a sketch layout showing 154 plots has been provided.

Review of the drawing the REC Report supplied suggests the site:

- Comprises several parcels of pasture land (total area c. 6.7 hectares) located immediately north of Lee Lane at the western fringe of Royston village. Access is via Lee Lane to the south of the site
- Has been agricultural land with little or no development recorded.
- Is not located within 250m of a known landfill site.
- Is not within a groundwater source protection zone.
- Is located within a Coal Mining Development Low Risk Area (within the defined coalfield, but no known defined risks have been recorded by the Coal Authority; there may still be unrecorded issues).
- Is underlain by stiff Glacial Till in the west (with sandstone bedrock at relatively shallow depth), and medium dense Glaciofluvial sands and gravel in the east. Clays are of low and medium shrinkability. Made Ground was not encountered.
- Groundwater typically lies at around 2.0m.
- Testing of 6 samples of topsoil (and 4 of natural soil !) yielding no contaminant concentrations of concern.

The REC Report provides useful data, but is based only on an earlier (RSK) Desk Study and 16 window sample boreholes, advanced using a mini percussion drilling rig. To provide a 50m grid on a site of this size about 30 exploratory holes (in total) should be advanced. Furthermore significant sub-areas in the north and west were "inaccessible due to third party constraints". REC also undertook soakaway testing in 5 hand-dug pits – only about 0.6m and therefore of very limited use.

The REC Executive summary incorrectly suggests no radon measures are required; in fact basic measures will be necessary. REC suggest an allowable bearing capacity of between 75kN/m²; this would necessitate widened footings or even rafts for typical (2-storey house) line loads. However, this bearing capacity is considered conservative.

This proposal assumes that you are happy to 'rely' on existing data, and therefore we only supplement it; for example we are proposing a further 14 or so trial pits, bringing the total number of exploratory holes to 30.



Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, CLR11 etc). Our proposed Report may not fully compliant with Eurocode 7 (EC7) and will not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. The proposed ground appraisal is intended to assist others as they prepare the design of the proposed works. Our proposal allows for the following works:

Desk study: We will complete a more detailed review of the REC report, and obtain 'new' environmental search data.

Fieldwork: We have allowed for a day's trial pitting (about 14 trial pits), with all trial pits to be supervised and logged by an experienced geoenvironmental engineer.

Based on ground conditions reported by REC (including a relatively shallow water table) soakaways are considered unlikely to provide a satisfactory solution for surface water drainage, although they would remove any ambiguity with respect to Yorkshire Water queries. Consequently, no allowance has been made for soakaway testing at this stage.

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.

If the pitting encounters significant thicknesses of made ground or very soft/loose deposits (neither considered likely), 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.

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.

Soils testing: This will comprise routine geotechnical soils analysis, including 9 moisture content & Atterberg limits, and 9 pH & water soluble sulphate.

The site is understood to be essentially Greenfield, and therefore testing of potentially contaminated samples should only be required if made ground is encountered in the exploratory holes. However, we have allowed for analysis of topsoil (6 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH; 2 samples will also be analysed for pesticides.

Within in our proposal we have allowed for the screening (ID) of 6 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 3 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 3 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion.

A copy of the final report will be issued to the relevant regulatory authorities on receipt of written instruction from yourselves.

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 our invoice for this project with the final 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 a working day 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: BDW Yorkshire West and Lithos have an agreed Appointment document, and this work will be undertaken in accordance with that.


It is hoped the above is sufficient for your present needs. However, should you require any further information, please contact the undersigned.

Yours sincerely



Mark Perrin
Director

**for and on behalf of
LITHOS CONSULTING LIMITED**

BDW TRADING LIMITED Region – Barratt & David Wilson Homes Yorkshire West ("the Client")	TO: Lithos Consulting Ltd ("the Consultant")						
This Project Order is issued pursuant to the Agreement dated 17/06/2015 (SHE03)							
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: Carry out additional site investigation at Lee Lane Royston and additional land at Parkhead Close in line with quotation number 002/2366/REG and Matt Thompson's email to Daria Matkowska on 19.07.2016.							
Project No: Royston/DM/1 Project Start Date: 20.07.2016 Project Finish Date:							
Site: Lee Lane, Royston, Barnsley							
Works: As detailed in quote number 002/2366/REG							
Client Contact: Daria Matkowska daria.matkowska@barrthomes.co.uk 0113 307 6889							
Scope of Services: The Services of Lithos Consulting Ltd Consultant as attached to this Project Order as Schedule 1 subject to the following amendments if any:							
Fee: the sum of £ (exclusive of VAT) payable [monthly] [in stages] as follows:							
<table border="1"> <thead> <tr> <th data-bbox="193 1254 603 1290">Month/Work Stage *</th> <th data-bbox="603 1254 1018 1290">% / Amount of fee due</th> <th data-bbox="1018 1254 1433 1290">Cumulative Fee</th> </tr> </thead> <tbody> <tr> <td data-bbox="193 1290 603 1364">On completion as per BDW payment terms</td> <td data-bbox="603 1290 1018 1364">.....</td> <td data-bbox="1018 1290 1433 1364">.....</td> </tr> </tbody> </table>	Month/Work Stage *	% / Amount of fee due	Cumulative Fee	On completion as per BDW payment terms	
Month/Work Stage *	% / Amount of fee due	Cumulative Fee					
On completion as per BDW payment terms					
Expenses to be paid in addition to the Fee:							
Special Conditions (if any)							
Signed for and on behalf of BDW Trading Limited Daria Matkowska  Dated ...20.07.2015.....	Signed for and on behalf of [insert Consultant name] Dated						

Appendix D
Historical OS Plans



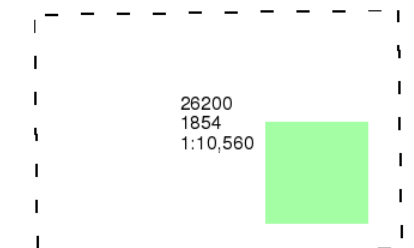
Yorkshire

Published 1854

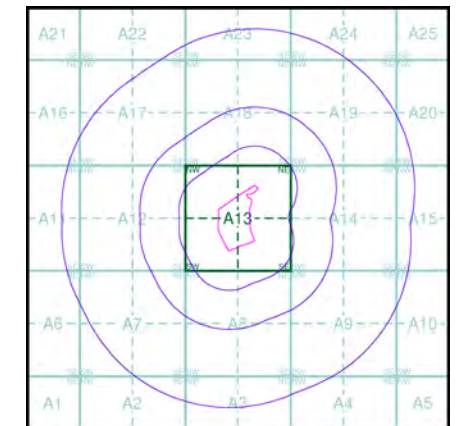
Source map scale - 1:10,560

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



Order Details

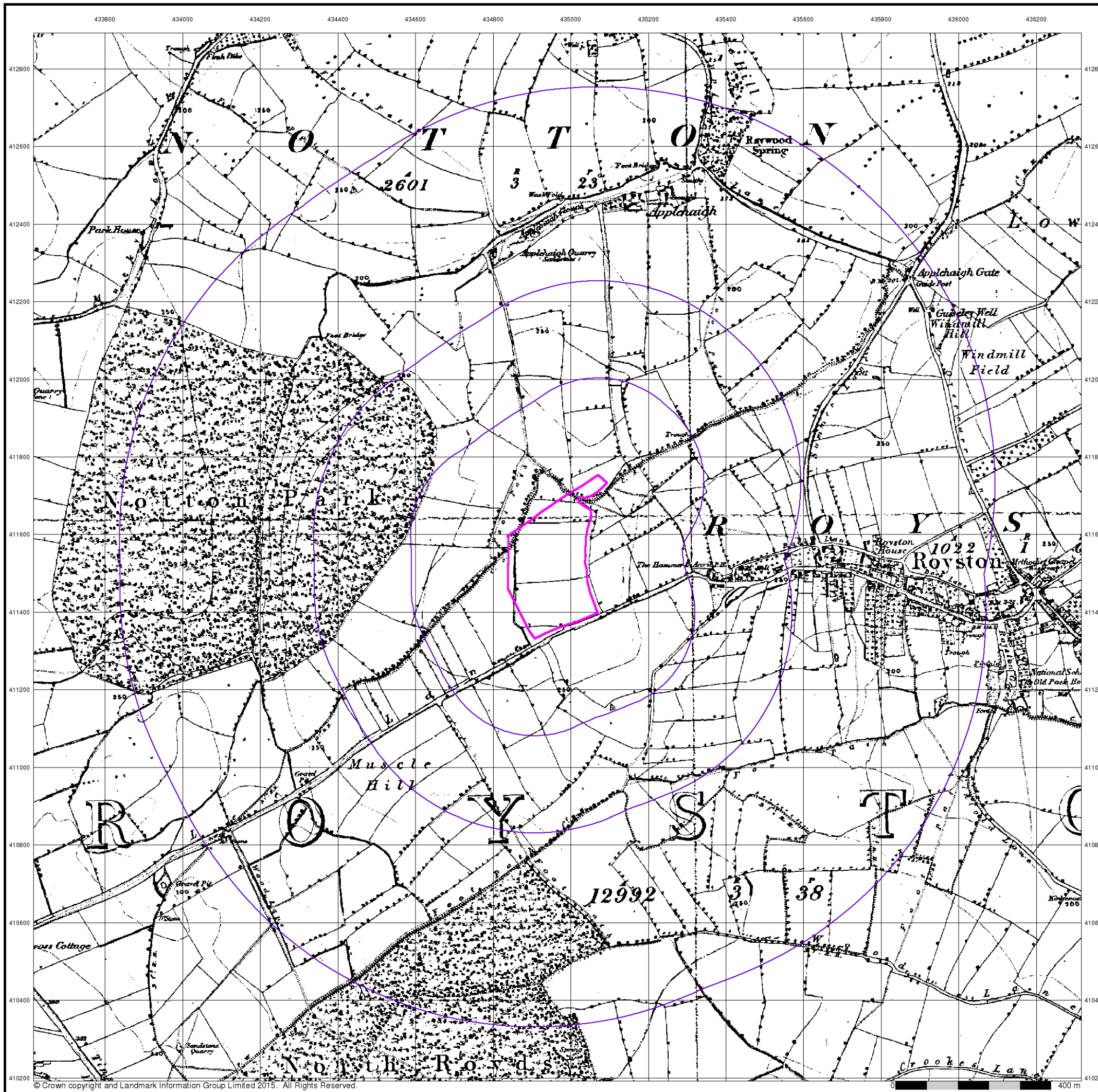
Order Number: 93473836_1_1
Customer Ref: 2366
National Grid Reference: 434980, 411540
Slice: A
Site Area (Ha): 6.26
Search Buffer (m): 1000

Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER



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





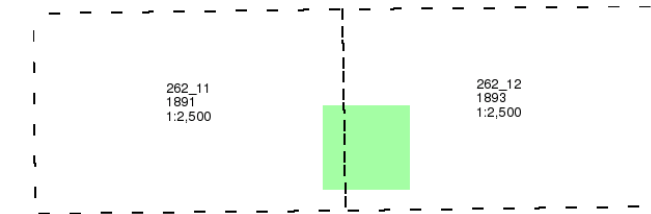
Yorkshire

Published 1891 - 1893

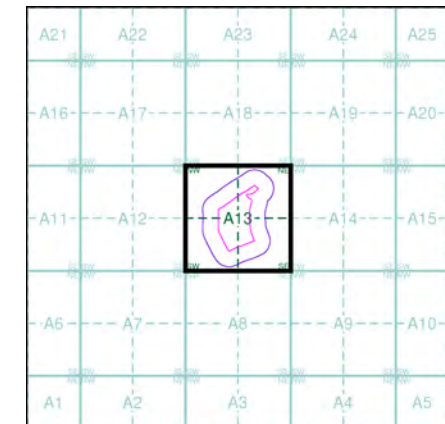
Source map scale - 1:2,500

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

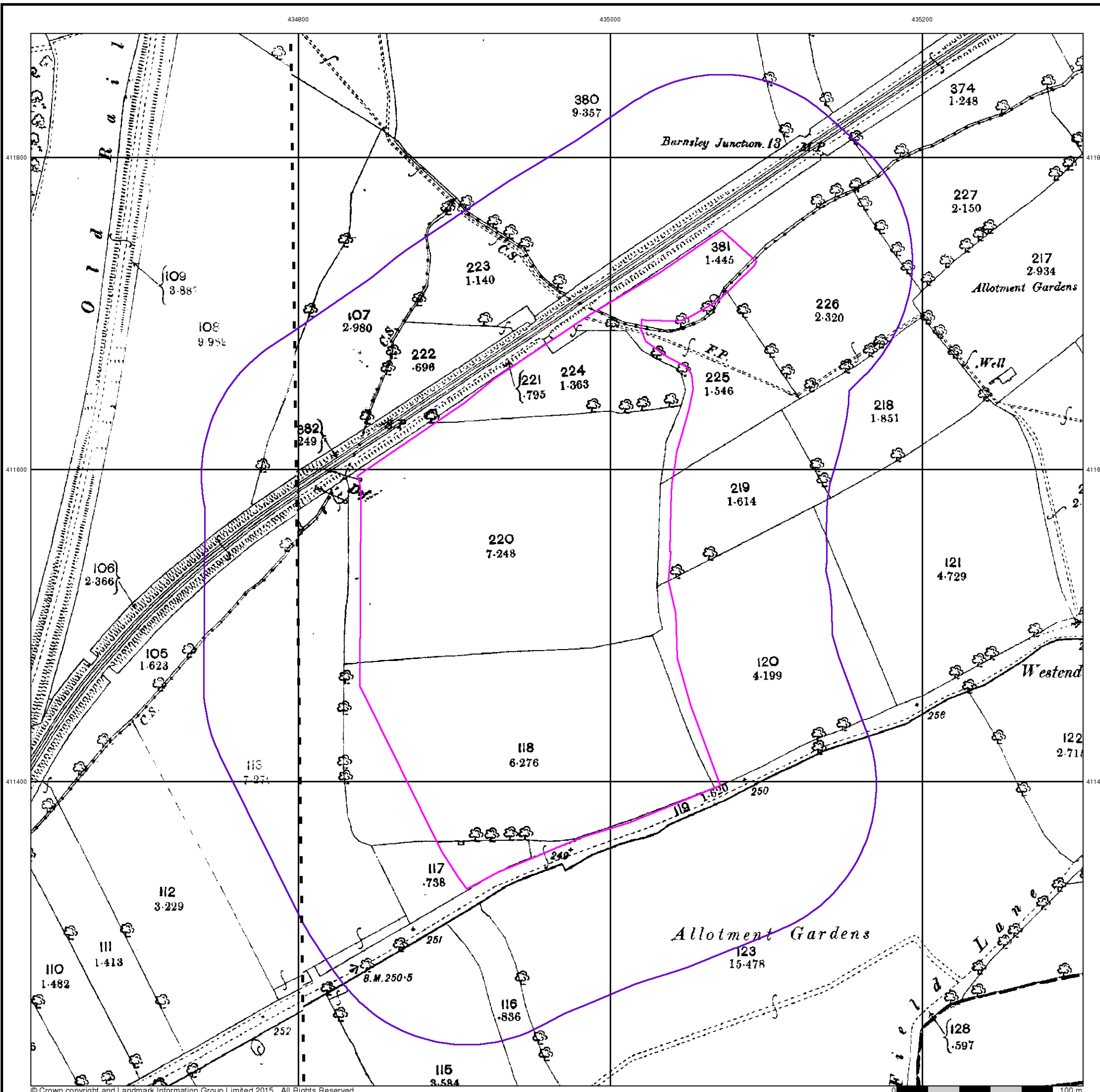
Order Number: 93473836_1_1
Customer Ref: 2366
National Grid Reference: 434980, 411540
Slice: A
Site Area (Ha): 6.26
Search Buffer (m): 100

Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER



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





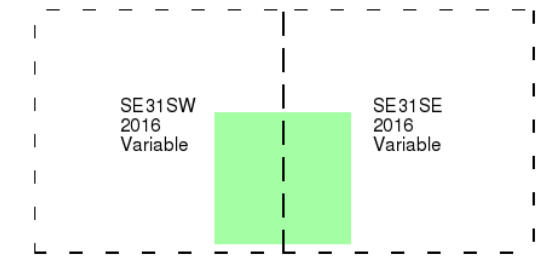
VectorMap Local

Published 2016

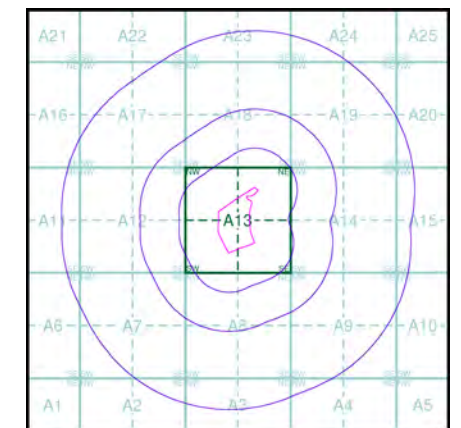
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities), 1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

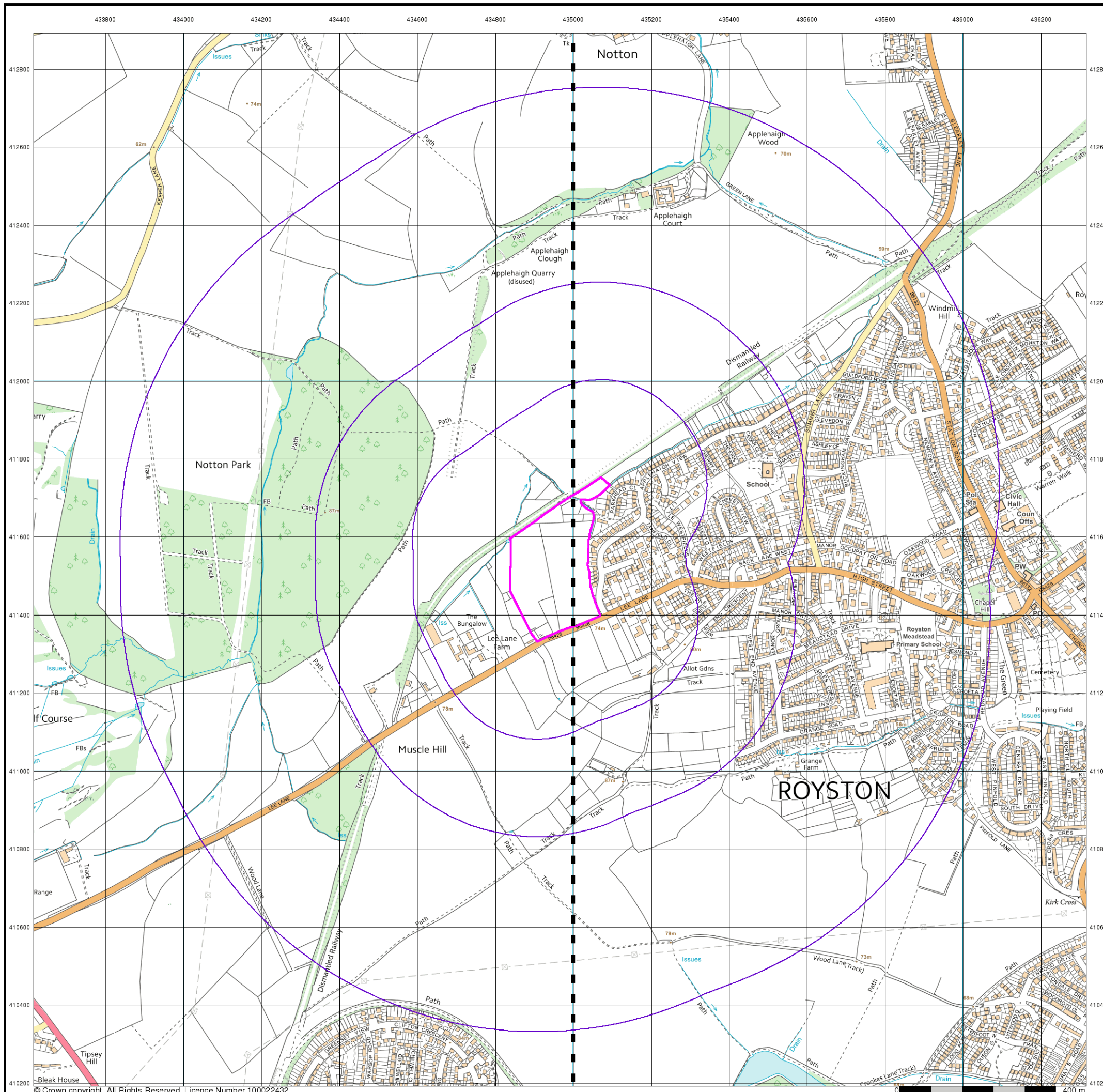
Order Number: 93473836_1_1
Customer Ref: 2366
National Grid Reference: 434980, 411540
Slice: A
Site Area (Ha): 6.26
Search Buffer (m): 1000

Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER



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



Appendix E

Search Responses & other Correspondence



Envirocheck[®] Report:

Datasheet

Order Details:

Order Number:

93473836_1_1

Customer Reference:

2366

National Grid Reference:

434980, 411540

Slice:

A

Site Area (Ha):

6.26

Search Buffer (m):

1000

Site Details:

Lee Lane
Royston
BARNSELY
South Yorkshire
S71 4ER

Client Details:

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

Report Section	Page Number
Summary	-
Agency & Hydrological	1
Waste	7
Hazardous Substances	-
Geological	8
Industrial Land Use	14
Sensitive Land Use	17
Data Currency	18
Data Suppliers	23
Useful Contacts	24

Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination. For this reason, Landmark's Site Sensitivity maps and Datasheet(s) place great emphasis on statutory data provided by the Environment Agency/Natural Resources Wales and the Scottish Environment Protection Agency; it also incorporates data from Natural England (and the Scottish and Welsh equivalents) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the Landmark database to a distance defined by the client from a site boundary provided by the client.

In the attached datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers.

Copyright Notice

© Landmark Information Group Limited 2016. The Copyright on the information and data and its format as contained in this Envirocheck® Report ("Report") is the property of Landmark Information Group Limited ("Landmark") and several other Data Providers, including (but not limited to) Ordnance Survey, British Geological Survey, the Environment Agency/Natural Resources Wales and Natural England, and must not be reproduced in whole or in part by photocopying or any other method. The Report is supplied under Landmark's Terms and Conditions accepted by the Customer.

A copy of Landmark's Terms and Conditions can be found with the Index Map for this report. Additional copies of the Report may be obtained from Landmark, subject to Landmark's charges in force from time to time. The Copyright, design rights and any other intellectual rights shall remain the exclusive property of Landmark and /or other Data providers, whose Copyright material has been included in this Report.

Natural England Copyright Notice

Site of Special Scientific Interest, National Nature Reserve, Ramsar, Special Protection Area, Special Conservation Area, Marine Nature Reserve data (derived from Ordnance Survey 1:10000 raster) is provided by, and used with the permission of, Natural England who retain the copyright and Intellectual Property Rights for the data.

Ove Arup Copyright Notice

The Data provided in this report was obtained on Licence from Ove Arup & Partners Limited (for further information, contact mining.review@arup.com). No reproduction or further use of such Data is to be made without the prior written consent of Ove Arup & Partners Limited. The information and data supplied in the product are derived from publicly available records and other third party sources and neither Ove Arup & Partners nor Landmark warrant the accuracy or completeness of such information or data.

Peter Brett Associates Copyright Notice

The cavity data presented has been extracted from the PBA enhanced version of the original DEFRA national cavity databases. PBA/DEFRA retain the copyright & intellectual property rights in the data. Whilst all reasonable efforts are made to check that the information contained in the cavity databases is accurate we do not warrant that the data is complete or error free. The information is based upon our own researches and those collated from a number of external sources and is continually being augmented and updated by PBA. In no event shall PBA/DEFRA or Landmark be liable for any loss or damage including, without limitation, indirect or consequential loss or damage arising from the use of this data.

Radon Potential dataset Copyright Notice

Information supplied from a joint dataset compiled by The British Geological Survey and Public Health England.

Report Version v50.0

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

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 Landfill Coverage	pg 7	1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 7				2
Potentially Infilled Land (Water)	pg 7			1	
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					

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Geological					
BGS 1:625,000 Solid Geology	pg 8	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 8	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 11				3
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
Brine Compensation Area			n/a	n/a	n/a
Coal Mining Affected Areas	pg 11	Yes	n/a	n/a	n/a
Mining Instability	pg 11	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain	pg 11	Yes	Yes	n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 11	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 12		Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 12	Yes		n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 12	Yes		n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 12	Yes		n/a	n/a
Radon Potential - Radon Affected Areas			n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 14		8		8
Fuel Station Entries					
Points of Interest - Commercial Services	pg 15		3		2
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 15				4
Points of Interest - Public Infrastructure	pg 16				3
Points of Interest - Recreational and Environmental	pg 16		2	1	
Gas Pipelines					
Underground Electrical Cables					

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland	pg 17			2	
Areas of Adopted Green Belt	pg 17	1	1		
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves	pg 17			1	
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 17	1	1		
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					



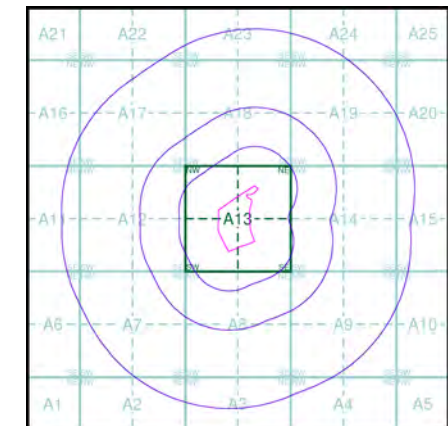
General

- Specified Site
- Specified Buffer(s)
- 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



Order Details

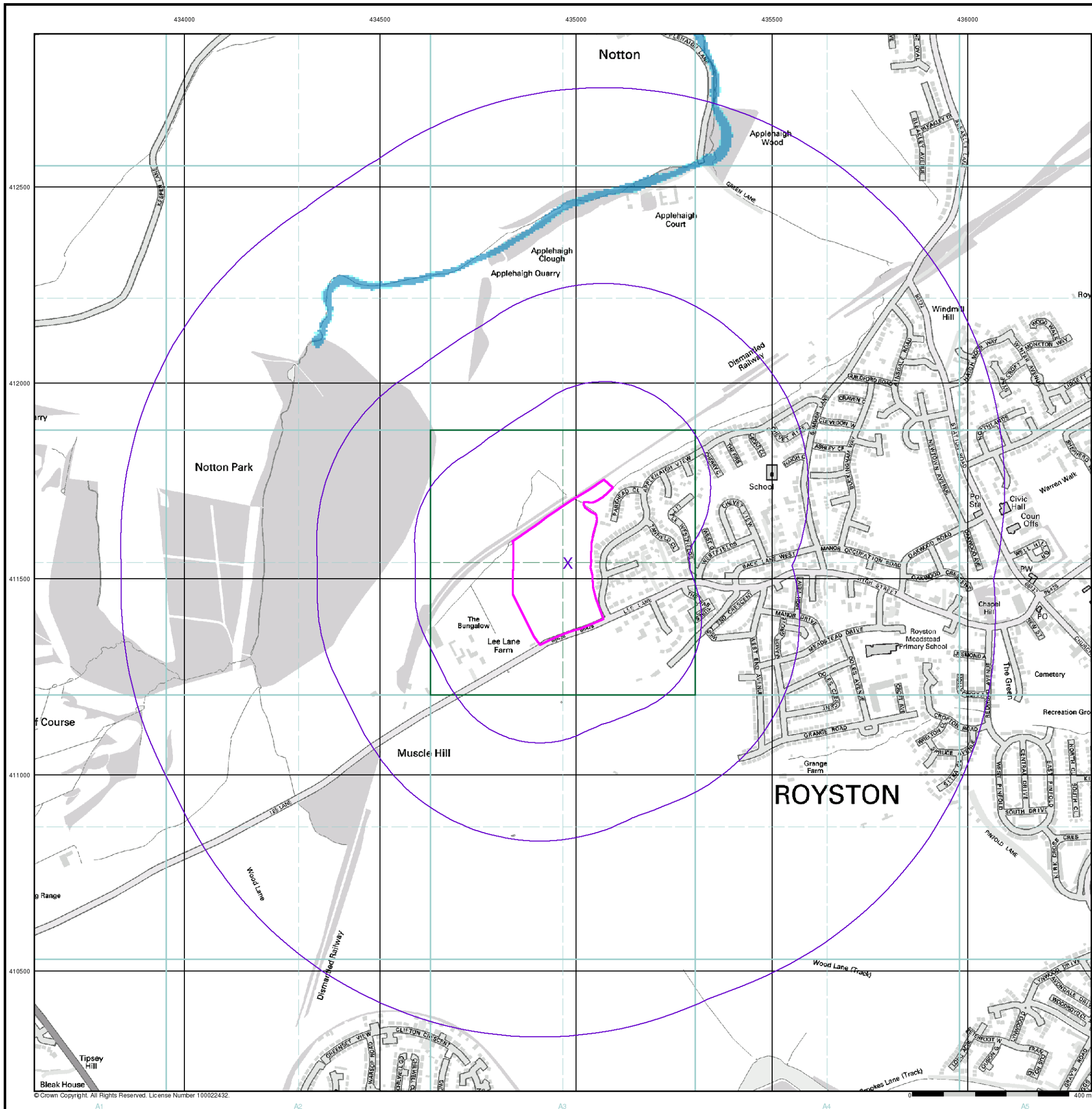
Order Number: 93473836_1_1
 Customer Ref: 2366
 National Grid Reference: 434980, 411540
 Slice: A
 Site Area (Ha): 6.26
 Search Buffer (m): 1000

Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER



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



© Crown Copyright. All Rights Reserved. License Number 100022432.



General

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

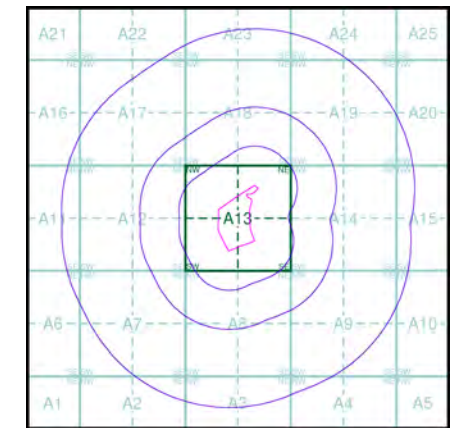
Detailed River Network Data

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

Contours (height in metres)

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

EANRW Detailed River Network Map - Slice A



Order Details

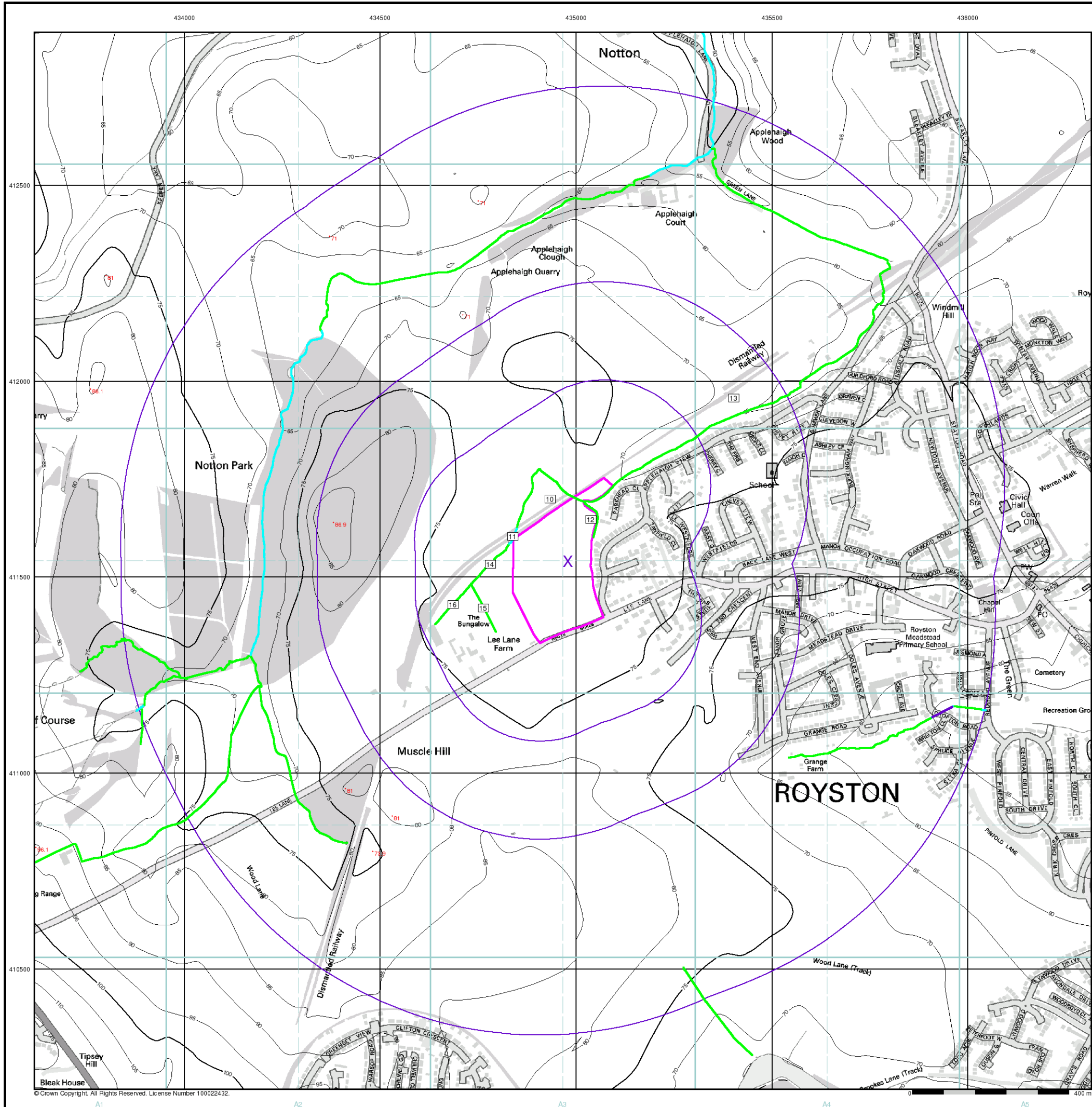
Order Number: 93473836_1_1
 Customer Ref: 2366
 National Grid Reference: 434980, 411540
 Slice: A
 Site Area (Ha): 6.26
 Search Buffer (m): 1000

Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER

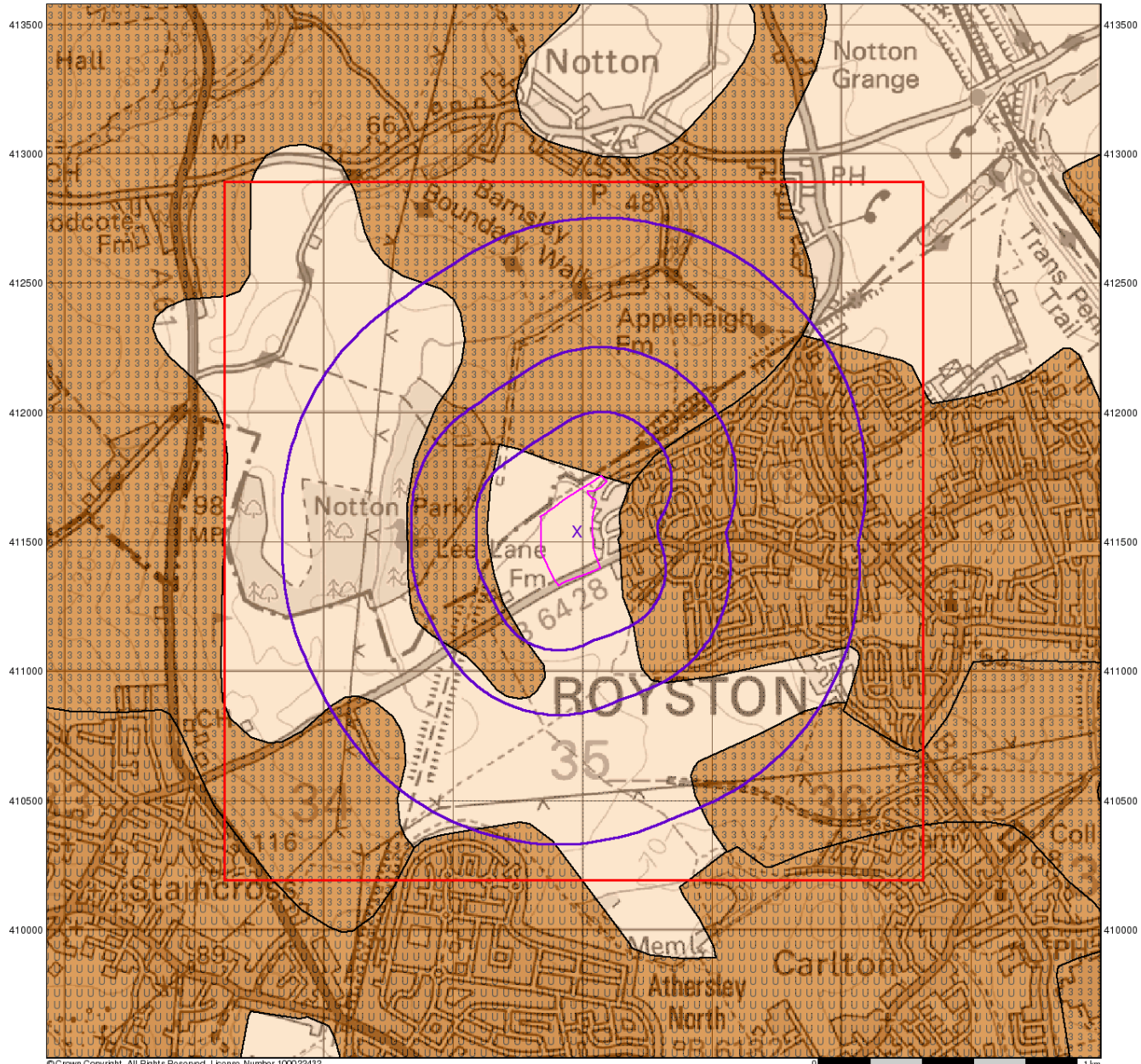


Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk



© Crown Copyright. All Rights Reserved. License Number 100022432.

433000 433500 434000 434500 435000 435500 436000 436500 437000



© Crown Copyright. All Rights Reserved. License Number 100022432.



Groundwater Vulnerability

General

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

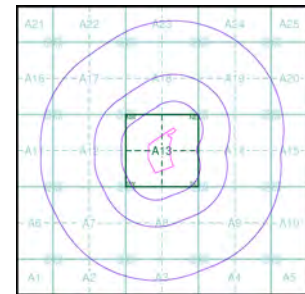
Agency and Hydrological

Geological Classes

- Major Aquifer (Highly Permeable)**
 - High (H) 1, 2, 3, U
 - Intermediate (I) 1, 2
 - Low
- Minor Aquifer (Variably Permeable)**
 - High (H) 1, 2, 3, U
 - Intermediate (I) 1, 2
 - Low
- Non Aquifer (Negligibly Permeable)**
 -
- Water or Sea**
 -
- Drift Deposit**
 -

Soil Classes

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 93473836_1_1
 Customer Ref: 2366
 National Grid Reference: 434980, 411540
 Slice: A
 Site Area (Ha): 6.26
 Search Buffer (m): 1000

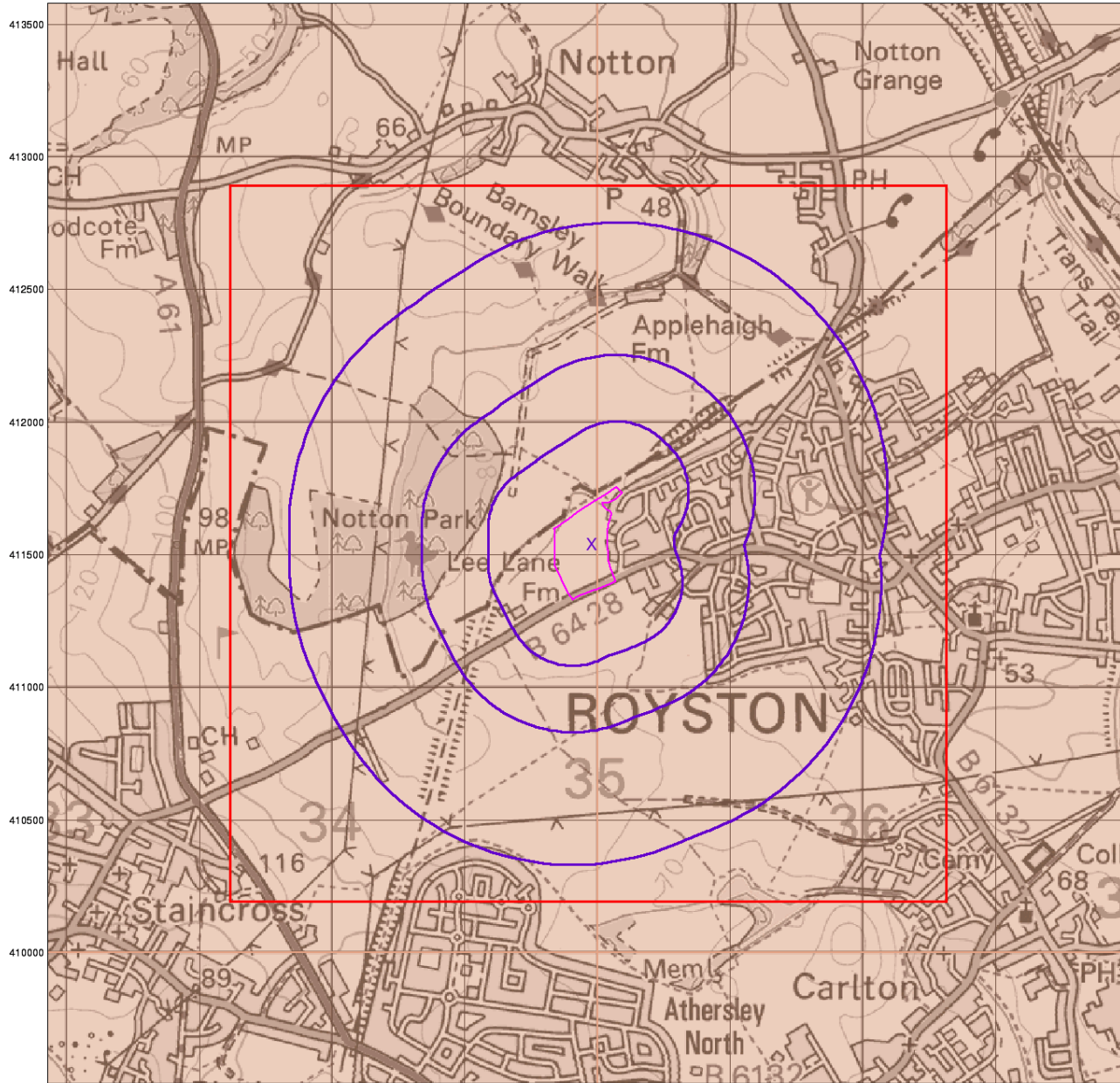
Site Details

Lee Lane, Royston, BARNESLEY, South Yorkshire, S71 4ER



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

433000 433500 434000 434500 435000 435500 436000 436500 437000



© Crown Copyright. All Rights Reserved. License Number 100022432

0 1 km



Bedrock Aquifer Designation

General

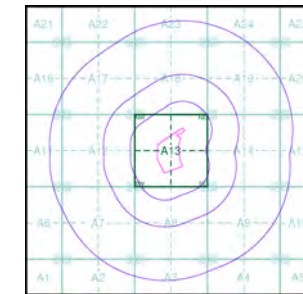
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 93473836_1_1
 Customer Ref: 2366
 National Grid Reference: 434980, 411540
 Slice: A
 Site Area (Ha): 6.26
 Search Buffer (m): 1000

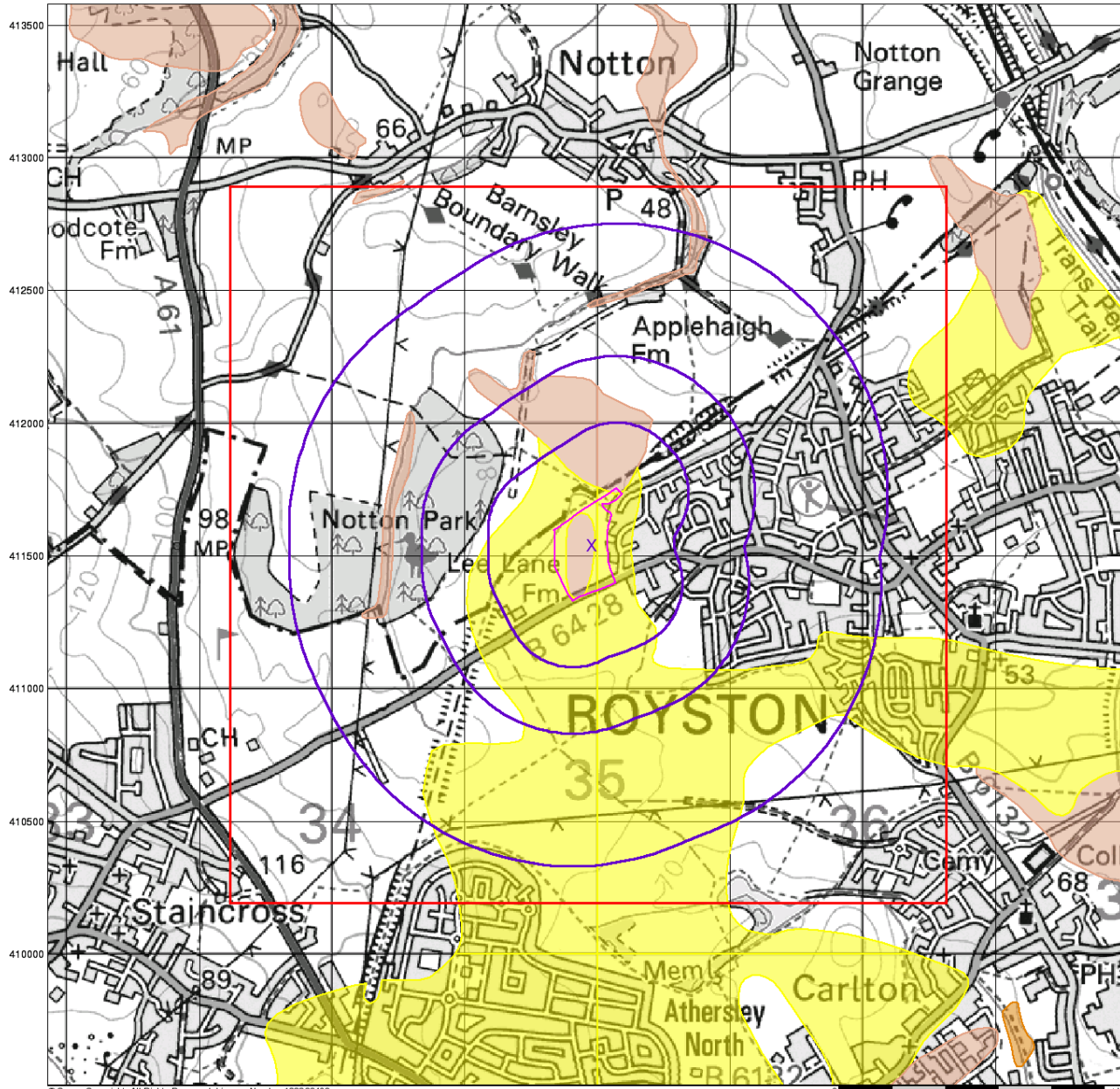
Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER



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

433000 433500 434000 434500 435000 435500 436000 436500 437000



© Crown Copyright. All Rights Reserved. License Number 100022432



Superficial Aquifer Designation

General

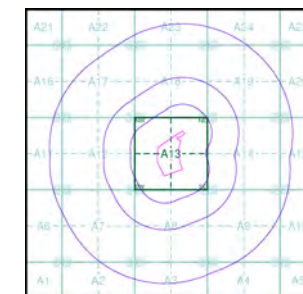
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 93473836_1_1
 Customer Ref: 2366
 National Grid Reference: 434980, 411540
 Slice: A
 Site Area (Ha): 6.26
 Search Buffer (m): 1000

Site Details

Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER

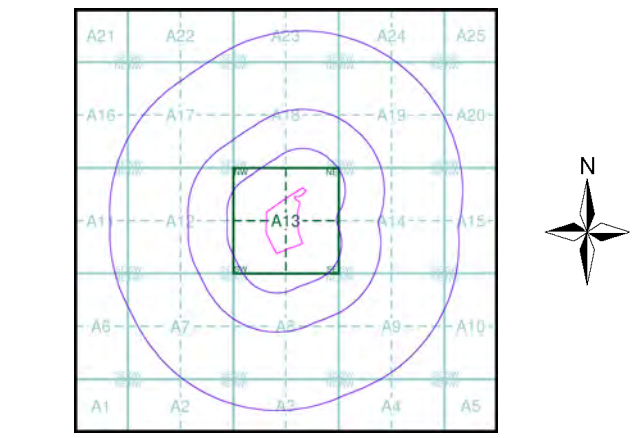


Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk



- 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 and 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
- 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
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - 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
 - NIHS Site
 - Planning Hazardous Substance Consent
 - Planning Hazardous Substance Enforcement
- Geological**
- BGS Recorded Mineral Site

Site Sensitivity Map - Slice A

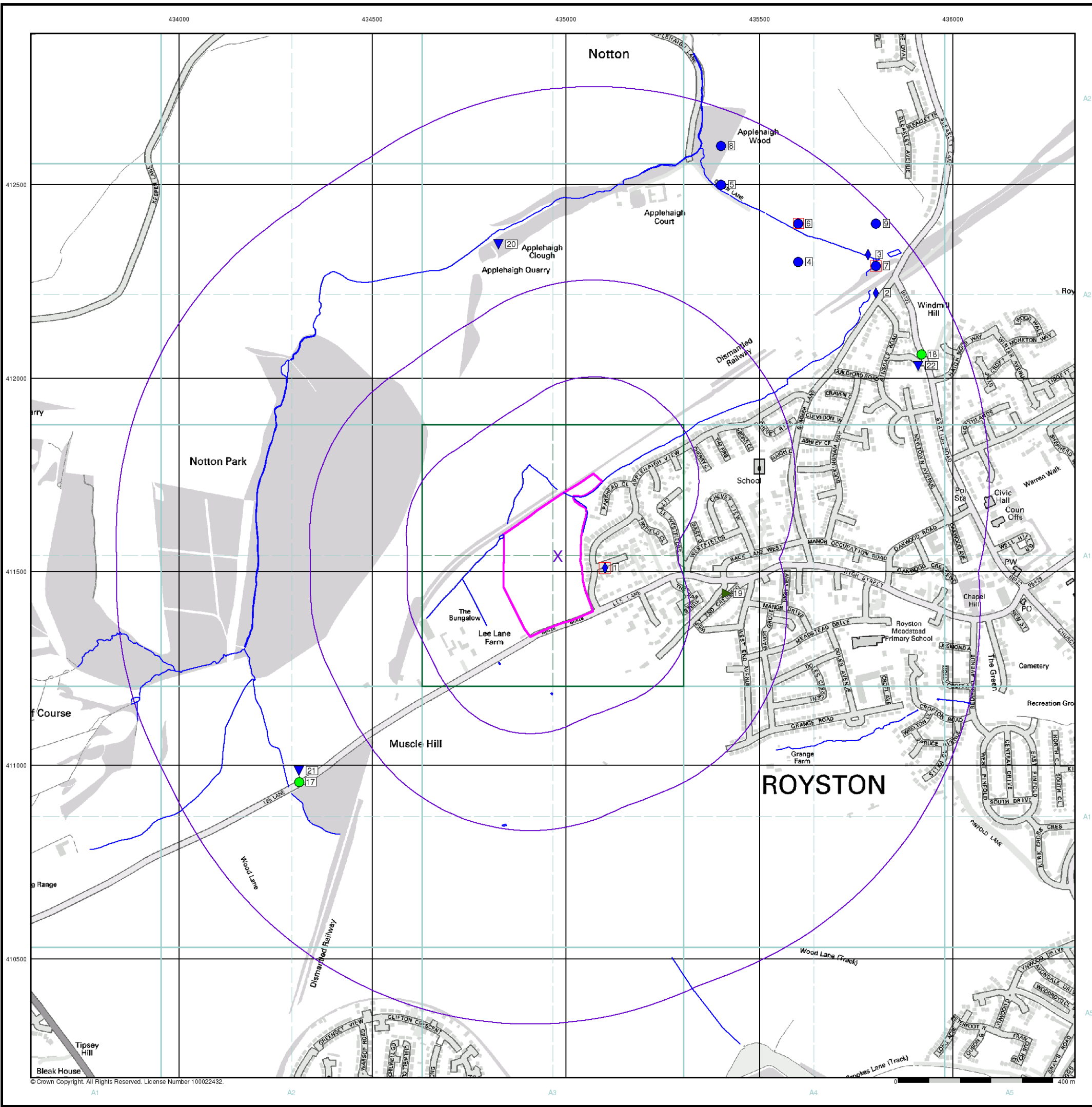


Order Details

Order Number: 93473836_1_1
 Customer Ref: 2366
 National Grid Reference: 434980, 411540
 Slice: A
 Site Area (Ha): 6.26
 Search Buffer (m): 1000

Site Details
 Lee Lane, Royston, BARNSELY, South Yorkshire, S71 4ER

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



© Crown Copyright. All Rights Reserved. License Number 100022432.

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: 0845 762 6848 DX 716176 MANSFIELD 5

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

Our reference: **51000111046003**
Your reference: **39467117**
Date of your enquiry: **06 June 2012**
Date we received your enquiry: **06 June 2012**
Date of issue: **07 June 2012**

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

Non-Residential Coal Authority Mining Report

SITE AT 2 LEE LANE, ROYSTON, BARNSELY, SOUTH 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 10 seams of coal at 180m to 550m depth, and last worked in 1980.

Any ground movement from these coal workings should have stopped by now.

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

There are no known coal mine entries within, or within 20 metres of, the boundary of the property.

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 not 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

The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres, since 31st October 1994.

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

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.

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 1947, 1975, 1977, 1986.

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.

Information from the Cheshire Brine Subsidence Compensation Board

The property lies outside the Cheshire Brine Compensation District.

Additional Remarks

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 2006. The Coal Authority owns the copyright in this report. The information we have used to write this report is protected by our database right. All rights are reserved and unauthorised use is prohibited. If we provide a report for you, this does not mean that copyright and any other rights will pass to you. However, you can use the report for your own purposes.

Location map



Approximate position of property

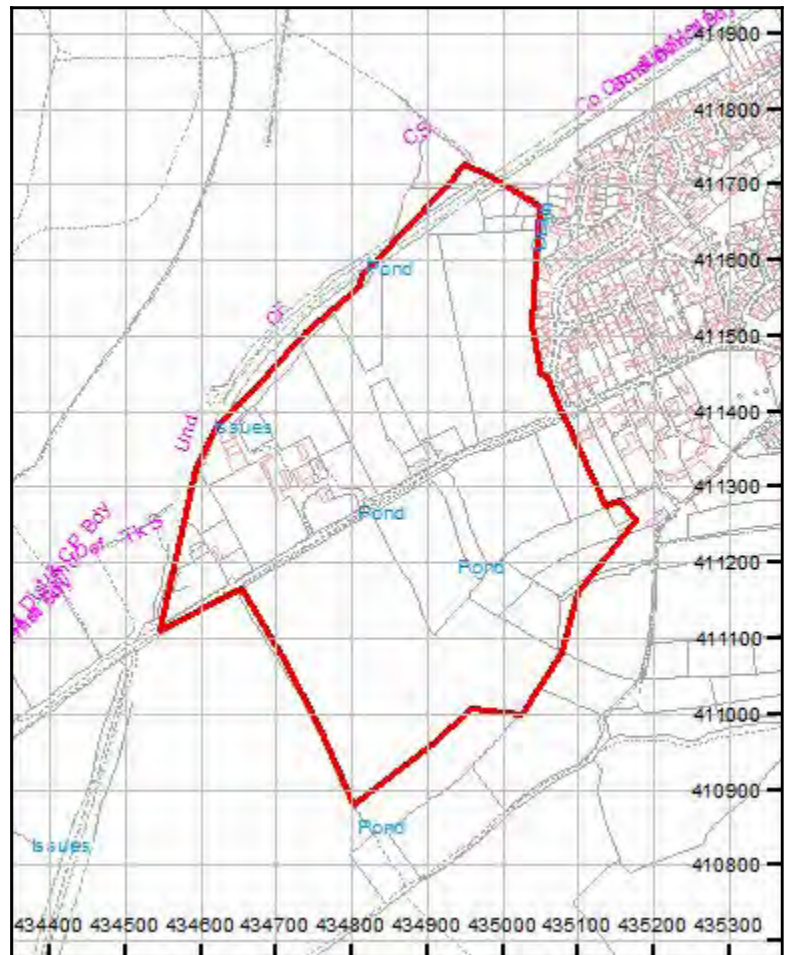


Enquiry boundary

Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2012. All rights reserved. Ordnance Survey Licence number: 100020315

Key

Approximate position of enquiry boundary shown



Appendix F

Trial Pit Logs



Trial Pit Log

Trialpit No

TP01

Sheet 1 of 1

Project Name: Lee Lane

Project No. 2366

Co-ords: 434926.90 - 411348.73
Level:

Date 28/07/2016

Location: Royston

Dimensions (m):

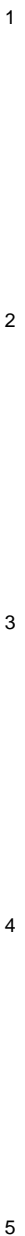
Scale 1:25

Client: Barratt Homes

Depth 2.70

Logged IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.40	0.40		Loose grey-brown organic very sandy clay topsoil. (TOPSOIL)
	0.70	D				0.80	0.80
					Medium dense grey brown slightly sandy gravel. Gravel is angular to sub-rounded fine to medium of various lithologies. (GRANULAR GLACIAL DEPOSITS) <u>Very clayey from 0.8 to 1.2m</u>		
	1.60	B		2.70	2.70		End of pit at 2.70 m



Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered during excavation at 1.8m rising to 1.7m after 5 minutes. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.



Project Name: Lee Lane	Project No. 2366	Co-ords: 435001.32 - 411385.16 Level:	Date 28/07/2016
Location: Royston	Dimensions (m): Depth 2.30		Scale 1:25 Logged IMC
Client: Barratt Homes			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					Soft grey-brown organic very sandy clay topsoil. (COHESIVE MADE GROUND)
				0.50			Soft grey-brown organic very sandy clay topsoil interbedded with orange-brown sand. (COHESIVE MADE GROUND)
	0.80	D		1.10			Stiff pale brown and orange slightly sandy slightly gravelly CLAY. (COHESIVE GLACIAL DEPOSITS)
	1.50	D		1.60			Loose pale brown sandy fine to coarse angular and sub-rounded GRAVEL of various lithologies. (GRANULAR GLACIAL DEPOSITS)
	1.80 1.80	B D		2.30			End of pit at 2.30 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered during excavation at 1.8m rising to 1.7m after 5 minutes. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.





Trial Pit Log

Trialpit No

TP03

Sheet 1 of 1

Project Name: Lee Lane

Project No. 2366

Co-ords: 434930.36 - 411431.65
Level:Date
28/07/2016


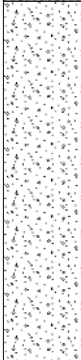
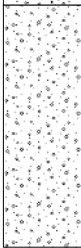
Location: Royston

Dimensions (m):

Scale
1:25

Client: Barratt Homes

Depth
2.30Logged
IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
▼ ▽	0.10	J&T		0.30			Loose brown organic gravelly sand topsoil. (TOPSOIL)
	0.60 0.60	B D					Medium dense orange-brown slightly silty gravelly fine to coarse SAND. (GRANULAR GLACIAL DEPOSITS) <u>Becoming dull brown below 1.0m</u>
	2.00	B		1.50			Brown slightly sandy fine sub-rounded GRAVEL of various lithologies. (GRANULAR GLACIAL DEPOSITS) <u>Damp at 1.5m</u>
				2.30			End of pit at 2.30 m

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 2.0m during excavation, rising to 1.9m after 5 minutes. 3. The sides of the trial pit remained stable during excavation. 4. Backfilled with materials arising upon completion.





Trial Pit Log

Trialpit No

TP04

Sheet 1 of 1

Project Name: Lee Lane

Project No. 2366

Co-ords: 434984.56 - 411447.77
Level:Date
28/07/2016

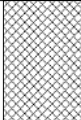
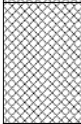
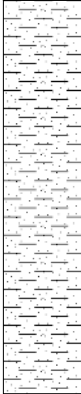
Location: Royston

Dimensions (m):

Scale
1:25

Client: Barratt Homes

Depth
2.10Logged
IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
▼ ▽	0.10	J&T	HVP=80	0.40	2.10		MADE GROUND: Soft grey-brown organic very sandy clay topsoil. (COHESIVE MADE GROUND)
	0.50	J&T					MADE GROUND: Soft grey very sandy gravelly organic CLAY. (COHESIVE MADE GROUND)
	1.20	D				Stiff orange-brown sandy CLAY. (COHESIVE GLACIAL DEPOSITS)	
	2.30	D				End of pit at 2.10 m	

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 2.1m during excavation, rising to 2.0m after 15 minutes. 3. The sides of the trial pit spalled during excavation. 4. Backfilled with materials arising upon completion.





Trial Pit Log

Trialpit No

TP05

Sheet 1 of 1

Project Name: Lee Lane

Project No. 2366

Co-ords: 434870.41 - 411506.40
Level:Date
28/07/2016

Location: Royston

Dimensions (m):

Scale
1:25

Client: Barratt Homes

Depth
2.20Logged
IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.30			Loose brown organic gravelly sand topsoil. (TOPSOIL)
	0.70	D		1.00			Medium dense brown sandy GRAVEL. Gravel is sub-angular to rounded fine to coarse of various lithologies. (GRANULAR GLACIAL DEPOSITS)
	1.40	D		1.30			Firm brown sandy CLAY. (COHESIVE GLACIAL DEPOSITS)
	2.10	D		2.00			Stiff brown sandy CLAY. (COMPLETELY WEATHERED OAKS ROCK)
				2.20			Weak grey fine grained interbedded SILTSTONE & SANDSTONE (recovered as angular fine to coarse tabular gravel). (OAKS ROCK)
							End of pit at 2.20 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.



Trial Pit Log

Project Name: Lee Lane	Project No. 2366	Co-ords: 434870.10 - 411402.00 Level:	Date 28/07/2016
Location: Royston	Dimensions (m): Depth 2.50		Scale 1:25
Client: Barratt Homes			Logged IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.25			Loose brown organic gravelly sand topsoil. (TOPSOIL)
	0.90	B		1.50			Medium dense orange-brown slightly clayey very sandy GRAVEL. Gravel is angular to rounded fine to coarse of various lithologies. (GRANULAR GLACIAL DEPOSITS) <i>Clayey in places below 0.7m</i>
	1.80	D	HVP=130	2.20			Very stiff grey orange-mottled slightly gravelly CLAY. Gravel is angular fine to medium lithorelics of siltstone and sandstone. (WEATHERED OAKS ROCK)
	2.40	D		2.50			Weak grey fine grained SANDSTONE (recovered as angular fine to coarse tabular gravel). (OAKS ROCK)
							End of pit at 2.50 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 spalled slightly due to groundwater during excavation. 4. Backfilled with materials arising upon completion.



Trial Pit Log

Trialpit No

TP07

Sheet 1 of 1

Project Name: Lee Lane	Project No. 2366	Co-ords: 434968.08 - 411516.80 Level:	Date 28/07/2016
------------------------	------------------	--	--------------------

Location: Royston	Dimensions (m): Depth 2.20	Scale 1:25
-------------------	-------------------------------	---------------

Client: Barratt Homes	Logged IMC
-----------------------	------------

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					Soft grey-brown organic very sandy clay topsoil. (TOPSOIL)
	0.60	D		0.40			Stiff dessicated slightly sandy CLAY. (COHESIVE GLACIAL DEPOSITS)
	1.50 1.50	B D		0.80			Brown sandy sub-angular to rounded fine to coarse GRAVEL of various lithologies. (GRANULAR GLACIAL DEPOSITS)
				2.20			End of pit at 2.20 m

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



Project Name: Lee Lane	Project No. 2366	Co-ords: 435022.54 - 411568.89 Level:	Date 28/07/2016
Location: Royston	Dimensions (m): <input type="text"/>		Scale 1:25
Client: Barratt Homes	Depth 2.60		Logged IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
▼	0.10	J&T		0.25			Loose brown organic gravelly sand topsoil. (TOPSOIL)
	0.90	D		1.20			Medium dense orange and grey mottled very clayey medium SAND. (GRANULAR GLACIAL DEPOSITS) <i>Clay field drain broken at 0.3m</i>
	1.50 1.50	B D		2.60			Medium dense grey very sandy fine to coarse sub-angular to rounded GRAVEL. (GRANULAR GLACIAL DEPOSITS) <i>Clay field drain broken at 0.3m</i> <i>Becoming orange brown below 1.6m</i> <i>Becoming grey with clayey pockets below 2.0m</i>
	End of pit at 2.60 m						

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 2.0m during excavation with no rise after 5 minutes. 3. The sides of the trial pit spalled due to groundwater during excavation. 4. Backfilled with materials arising upon completion.






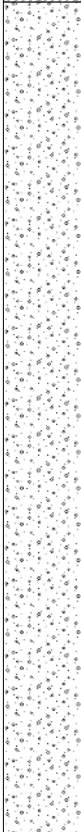
Trial Pit Log

Trialpit No
TP09
Sheet 1 of 1

Project Name: Lee Lane Project No. 2366 Co-ords: 434915.08 - 411576.33 Date 28/07/2016

Location: Royston Dimensions (m): Scale 1:25

Client: Barratt Homes Depth 3.00 Logged IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.25			Loose brown organic gravelly sand topsoil. (TOPSOIL)
							Medium dense slightly silty sandy GRAVEL. Gravel is angular to sub-rounded fine to coarse of various lithologies. (GRANULAR GLACIAL DEPOSITS)
	0.90	D					
	1.50	D					
	1.90	B					
	2.60	D					
				3.00			End of pit at 3.00 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.



Project Name: Lee Lane	Project No. 2366	Co-ords: 434863.29 - 411588.20 Level:	Date 28/07/2016
Location: Royston	Dimensions (m): Depth 2.30		Scale 1:25 Logged IMC
Client: Barratt Homes			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	D	HVP=70	0.30			Loose brown organic gravelly sand topsoil. (TOPSOIL)
							Medium dense grey-brown sandy GRAVEL. Gravel is sub-rounded fine to medium of various lithologies. (GRANULAR GLACIAL DEPOSITS)
	0.80	D		1.00			Firm brown and orange brown grey mottled very sandy CLAY. (GRANULAR GLACIAL DEPOSITS)
	1.50	D		1.30			Stiff brown gravelly clay with siltstone lithorelics. (COMPLETELY WEATHERED OAKS ROCK)
	2.20	D		2.00			Weak interbedded brown SANDSTONE and grey SILTSTONE. (OAKS ROCK)
			2.30			End of pit at 2.30 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.





Trial Pit Log

Trialpit No

TP11

Sheet 1 of 1

Project Name: Lee Lane

Project No. 2366

Co-ords: 434977.26 - 411610.76
Level:Date
28/07/2016


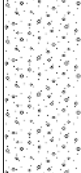
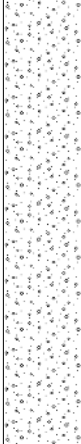
Location: Royston

Dimensions (m):

Scale
1:25

Client: Barratt Homes

Depth
2.50Logged
IMC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
▼	0.10	J&T		0.40			Loose brown organic gravelly sand topsoil. (TOPSOIL)
				1.00			Medium dense brown slightly silty sandy GRAVEL. Gravel is sub-angular to rounded fine to coarse of various lithologies. (GRANULAR GLACIAL DEPOSITS)
	1.60 1.60	B D		2.50			Medium dense grey-brown sandy GRAVEL. Gravel is sub-angular to rounded fine to coarse of various lithologies. (GRANULAR GLACIAL DEPOSITS)
							End of pit at 2.50 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 2.2m during excavation. 3. The sides of the trial pit spalled due to groundwater during excavation. 4. Backfilled with materials arising upon completion.



Project Name: Lee Lane	Project No. 2366	Co-ords: 435045.57 - 411710.01 Level:	Date 28/07/2016
Location: Royston	Dimensions (m): Depth 2.80		Scale 1:25 Logged IMC
Client: Barratt Homes			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	D	HVP=38	0.30			Loose brown organic gravelly sand topsoil. (TOPSOIL)
				0.70			Medium dense orange-brown fine to coarse SAND. (GRANULAR GLACIAL DEPOSITS)
	1.00	D		1.50			Soft damp orange-grey mottled CLAY. (COHESIVE GLACIAL DEPOSITS)
	2.00	D		2.80			Medium dense brown sandy GRAVEL. Gravel is sub-angular to rounded fine to coarse of various lithologies. (GRANULAR GLACIAL DEPOSITS)
							End of pit at 2.80 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 2.5m during excavation. 3. The sides of the trial pit spalled slightly due to groundwater during excavation. 4. Backfilled with materials arising upon completion.

Appendix G
Chemical Test Results



Certificate of Analysis

Certificate Number 16-74725-1

16-Aug-16

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 16-74725-1

Client Reference 2366

Order No PO10686/2366

Contract Title Lee Lane

Description 8 Soil samples.

Date Received 02-Aug-16

Date Started 02-Aug-16

Date Completed 16-Aug-16

Test Procedures Identified by prefix DETSn (details on request).

Notes **This report supersedes 16-74725, extra testing.**

Opinions and interpretations are outside the scope of UKAS accreditation. 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. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis

Soil Samples

Our Ref 16-74725-1
 Client Ref 2366
 Contract Title Lee Lane

Lab No	1032265	1032266	1032267	1032268
Sample ID	TP01	TP02	TP04	TP05
Depth	0.10	0.80	0.50	0.10
Other ID				
Sample Type	SOIL	SOIL	SOIL	SOIL
Sampling Date	28/07/16	28/07/16	28/07/16	28/07/16
Sampling Time	n/s	n/s	n/s	n/s

Test	Method	LOD	Units				
Metals							
Arsenic	DETSC 2301#	0.2	mg/kg	17	16	8.6	15
Boron, Water Soluble	DETSC 2123#	0.2	mg/kg	1.4	1.2	1.1	1
Cadmium	DETSC 2301#	0.1	mg/kg	0.1	0.2	< 0.1	0.2
Chromium	DETSC 2301#	0.15	mg/kg	13	18	14	15
Chromium III	DETSC 2301*	0.15	mg/kg	13	18	14	15
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	24	28	16	21
Lead	DETSC 2301#	0.3	mg/kg	46	50	17	41
Mercury	DETSC 2325#	0.05	mg/kg	0.06	< 0.05	< 0.05	< 0.05
Nickel	DETSC 2301#	1	mg/kg	16	15	16	18
Selenium	DETSC 2301#	0.5	mg/kg	1.3	< 0.5	< 0.5	0.8
Zinc	DETSC 2301#	1	mg/kg	57	70	52	73
Inorganics							
pH	DETSC 2008#			7.9	7.7	8.5	6.7
Total Organic Carbon	DETSC 2002	0.1	%	1.5	1.6	0.5	1.1
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l		22	19	
PAHs							
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.05	0.04	< 0.03	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	0.04	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.08	0.05	0.03	0.03
Pyrene	DETSC 3303#	0.03	mg/kg	0.07	0.04	< 0.03	0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	0.06	< 0.03	< 0.03	< 0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	0.25	0.15	< 0.10	< 0.10

Summary of Chemical Analysis

Soil Samples

Our Ref 16-74725-1
 Client Ref 2366
 Contract Title Lee Lane

Lab No	1032265	1032266	1032267	1032268
Sample ID	TP01	TP02	TP04	TP05
Depth	0.10	0.80	0.50	0.10
Other ID				
Sample Type	SOIL	SOIL	SOIL	SOIL
Sampling Date	28/07/16	28/07/16	28/07/16	28/07/16
Sampling Time	n/s	n/s	n/s	n/s

Test	Method	LOD	Units				
OCPs							
alpha-BHC	DETSC 3441*	0.1	mg/kg				< 0.1
gamma-BHC (Lindane)	DETSC 3441*	0.1	mg/kg				< 0.1
beta-BHC	DETSC 3441*	0.1	mg/kg				< 0.1
delta-BHC	DETSC 3441*	0.1	mg/kg				< 0.1
Heptachlor	DETSC 3441*	0.1	mg/kg				< 0.1
Aldrin	DETSC 3441*	0.1	mg/kg				< 0.1
Heptachlor epoxide	DETSC 3441*	0.1	mg/kg				< 0.1
gamma-Chlordane	DETSC 3441*	0.1	mg/kg				< 0.1
Endosulphan I & Alpha-chlorodane	DETSC 3441*	0.1	mg/kg				< 0.1
4,4-DDE	DETSC 3441*	0.1	mg/kg				< 0.1
Dieldrin	DETSC 3441*	0.1	mg/kg				< 0.1
Endrin	DETSC 3441*	0.1	mg/kg				< 0.1
Endosulphan II & 4,4-DDD	DETSC 3441*	0.1	mg/kg				< 0.1
Endrin aldehyde	DETSC 3441*	0.1	mg/kg				< 0.1
4,4-DDT	DETSC 3441*	0.1	mg/kg				< 0.1
Endosulphan sulphate	DETSC 3441*	0.1	mg/kg				< 0.1
Methoxychlor	DETSC 3441*	0.1	mg/kg				< 0.1
Endrin ketone	DETSC 3441*	0.1	mg/kg				< 0.1
OPPs							
Dichlorvos	DETSC 3443*	0.1	mg/kg				< 0.1
Mevinphos	DETSC 3443*	0.1	mg/kg				< 0.1
Demeton-O	DETSC 3443*	0.1	mg/kg				< 0.1
Ethoprop	DETSC 3443*	0.1	mg/kg				< 0.1
Naled	DETSC 3443*	0.1	mg/kg				< 0.1
Phorate	DETSC 3443*	0.1	mg/kg				< 0.1
Demeton-S	DETSC 3443*	0.1	mg/kg				< 0.1
Diazinon	DETSC 3443*	0.1	mg/kg				< 0.1
Disulfoton	DETSC 3443*	0.1	mg/kg				< 0.1
Methylparathion	DETSC 3443*	0.1	mg/kg				< 0.1
Ronnel	DETSC 3443*	0.1	mg/kg				< 0.1
Fenthion	DETSC 3443*	0.1	mg/kg				< 0.1
Chlopyrifos	DETSC 3443*	0.1	mg/kg				< 0.1
Trichlorinate	DETSC 3443*	0.1	mg/kg				< 0.1
Merphos	DETSC 3443*	0.1	mg/kg				< 0.1
Stirofos	DETSC 3443*	0.1	mg/kg				< 0.1
Tokuthion	DETSC 3443*	0.1	mg/kg				< 0.1
Fensulfothion	DETSC 3443*	0.1	mg/kg				< 0.1
Bolstar	DETSC 3443*	0.1	mg/kg				< 0.1
Azinphos methyl	DETSC 3443*	0.1	mg/kg				< 0.1
Coumaphos	DETSC 3443*	0.1	mg/kg				< 0.1

Summary of Chemical Analysis

Soil Samples

Our Ref 16-74725-1
 Client Ref 2366
 Contract Title Lee Lane

Lab No	1032269	1032270	1032325	1032326
Sample ID	TP11	TP12	TP04	TP10
Depth	0.10	0.10	0.10	0.10
Other ID				
Sample Type	SOIL	SOIL	SOIL	SOIL
Sampling Date	28/07/16	28/07/16	28/07/16	28/07/16
Sampling Time	n/s	n/s	n/s	n/s

Test	Method	LOD	Units				
Metals							
Arsenic	DETSC 2301#	0.2	mg/kg	13	12	15	15
Boron, Water Soluble	DETSC 2123#	0.2	mg/kg	1	1.1	1.2	1
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	0.2	0.2	0.2
Chromium	DETSC 2301#	0.15	mg/kg	17	14	19	17
Chromium III	DETSC 2301*	0.15	mg/kg	19	16	20	16
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	22	19	26	22
Lead	DETSC 2301#	0.3	mg/kg	39	37	40	39
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05	0.06	0.05	< 0.05
Nickel	DETSC 2301#	1	mg/kg	16	15	15	17
Selenium	DETSC 2301#	0.5	mg/kg	0.7	< 0.5	1	< 0.5
Zinc	DETSC 2301#	1	mg/kg	64	66	66	67
Inorganics							
pH	DETSC 2008#			7	6.4	7.4	6.6
Total Organic Carbon	DETSC 2002	0.1	%	1.6	1.8	1.8	1.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l				
PAHs							
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.05	< 0.03	< 0.03	< 0.03
Pyrene	DETSC 3303#	0.03	mg/kg	0.05	< 0.03	< 0.03	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10

Summary of Chemical Analysis

Soil Samples

Our Ref 16-74725-1
 Client Ref 2366
 Contract Title Lee Lane

Lab No	1032269	1032270	1032325	1032326
Sample ID	TP11	TP12	TP04	TP10
Depth	0.10	0.10	0.10	0.10
Other ID				
Sample Type	SOIL	SOIL	SOIL	SOIL
Sampling Date	28/07/16	28/07/16	28/07/16	28/07/16
Sampling Time	n/s	n/s	n/s	n/s

Test	Method	LOD	Units				
OCPs							
alpha-BHC	DETSC 3441*	0.1	mg/kg	< 0.1			
gamma-BHC (Lindane)	DETSC 3441*	0.1	mg/kg	< 0.1			
beta-BHC	DETSC 3441*	0.1	mg/kg	< 0.1			
delta-BHC	DETSC 3441*	0.1	mg/kg	< 0.1			
Heptachlor	DETSC 3441*	0.1	mg/kg	< 0.1			
Aldrin	DETSC 3441*	0.1	mg/kg	< 0.1			
Heptachlor epoxide	DETSC 3441*	0.1	mg/kg	< 0.1			
gamma-Chlordane	DETSC 3441*	0.1	mg/kg	< 0.1			
Endosulphan I & Alpha-chlorodane	DETSC 3441*	0.1	mg/kg	< 0.1			
4,4-DDE	DETSC 3441*	0.1	mg/kg	< 0.1			
Dieldrin	DETSC 3441*	0.1	mg/kg	< 0.1			
Endrin	DETSC 3441*	0.1	mg/kg	< 0.1			
Endosulphan II & 4,4-DDD	DETSC 3441*	0.1	mg/kg	< 0.1			
Endrin aldehyde	DETSC 3441*	0.1	mg/kg	< 0.1			
4,4-DDT	DETSC 3441*	0.1	mg/kg	< 0.1			
Endosulphan sulphate	DETSC 3441*	0.1	mg/kg	< 0.1			
Methoxychlor	DETSC 3441*	0.1	mg/kg	< 0.1			
Endrin ketone	DETSC 3441*	0.1	mg/kg	< 0.1			
OPPs							
Dichlorvos	DETSC 3443*	0.1	mg/kg	< 0.1			
Mevinphos	DETSC 3443*	0.1	mg/kg	< 0.1			
Demeton-O	DETSC 3443*	0.1	mg/kg	< 0.1			
Ethoprop	DETSC 3443*	0.1	mg/kg	< 0.1			
Naled	DETSC 3443*	0.1	mg/kg	< 0.1			
Phorate	DETSC 3443*	0.1	mg/kg	< 0.1			
Demeton-S	DETSC 3443*	0.1	mg/kg	< 0.1			
Diazinon	DETSC 3443*	0.1	mg/kg	< 0.1			
Disulfoton	DETSC 3443*	0.1	mg/kg	< 0.1			
Methylparathion	DETSC 3443*	0.1	mg/kg	< 0.1			
Ronnel	DETSC 3443*	0.1	mg/kg	< 0.1			
Fenthion	DETSC 3443*	0.1	mg/kg	< 0.1			
Chlopyrifos	DETSC 3443*	0.1	mg/kg	< 0.1			
Trichlorinate	DETSC 3443*	0.1	mg/kg	< 0.1			
Merphos	DETSC 3443*	0.1	mg/kg	< 0.1			
Stirofos	DETSC 3443*	0.1	mg/kg	< 0.1			
Tokuthion	DETSC 3443*	0.1	mg/kg	< 0.1			
Fensulfothion	DETSC 3443*	0.1	mg/kg	< 0.1			
Bolstar	DETSC 3443*	0.1	mg/kg	< 0.1			
Azinphos methyl	DETSC 3443*	0.1	mg/kg	< 0.1			
Coumaphos	DETSC 3443*	0.1	mg/kg	< 0.1			

Summary of Asbestos Analysis

Soil Samples

Our Ref 16-74725-1

Client Ref 2366

Contract Title Lee Lane

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1032265	TP01 0.10	SOIL	NAD	none	Michael Kay
1032266	TP02 0.80	SOIL	NAD	none	Michael Kay
1032267	TP04 0.50	SOIL	NAD	none	Michael Kay
1032268	TP05 0.10	SOIL	NAD	none	Michael Kay
1032269	TP11 0.10	SOIL	NAD	none	Michael Kay
1032270	TP12 0.10	SOIL	NAD	none	Michael Kay
1032325	TP04 0.10	SOIL	NAD	none	Michael Kay
1032326	TP10 0.10	SOIL	NAD	none	Michael Kay

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 16-74725-1
Client Ref 2366
Contract Lee Lane

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1032265	TP01 0.10 SOIL	28/07/16	GJ 250ml, PT 1L		
1032266	TP02 0.80 SOIL	28/07/16	GJ 250ml, PT 1L		
1032267	TP04 0.50 SOIL	28/07/16	GJ 250ml, PT 1L		
1032268	TP05 0.10 SOIL	28/07/16	GJ 250ml, PT 1L		
1032269	TP11 0.10 SOIL	28/07/16	GJ 250ml, PT 1L		
1032270	TP12 0.10 SOIL	28/07/16	GJ 250ml, PT 1L		
1032325	TP04 0.10 SOIL	28/07/16	GJ 250ml		
1032326	TP10 0.10 SOIL	28/07/16	GJ 250ml, PT 1L		

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Appendix H
Geotechnical Test Results



LABORATORY REPORT



4043

Contract Number: PSL16/3672

Report Date: 12 August 2016
Client's Reference: 2366
Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Ian Mclain

Contract Title: Lee Lane, Royston
Date Received: 8/8/2016
Date Commenced: 8/8/2016
Date Completed: 12/8/2016

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)

R Berriman
(Quality Manager)

D Lambe
(Senior Technician)

S Royle
(Senior Technician)

L Knight
(Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

Page 1 of



SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % <small>Clause 3.2</small>	Linear Shrinkage % <small>Clause 6.5</small>	Particle Density Mg/m ³ <small>Clause 8.2</small>	Liquid Limit % <small>Clause 4.3/4</small>	Plastic Limit % <small>Clause 5.3</small>	Plasticity Index % <small>Clause 5.4</small>	Passing .425mm %	Remarks
TP01		D	0.70		20			41	20	21	97	Intermediate plasticity CI.
TP02		D	1.50		17			31	16	15	97	Low plasticity CL.
TP04		D	1.20		24			44	21	23	98	Intermediate plasticity CI.
TP12		D	1.00		29			46	22	24	98	Intermediate plasticity CI.
TP03		D	0.60		17							
TP05		D	0.70		22							
TP08		D	0.90		9.9							
TP10		D	0.80		7							
TP08		D	1.80		9					NP		
TP10		D	1.50		16			38	19	19	98	Intermediate plasticity CI.

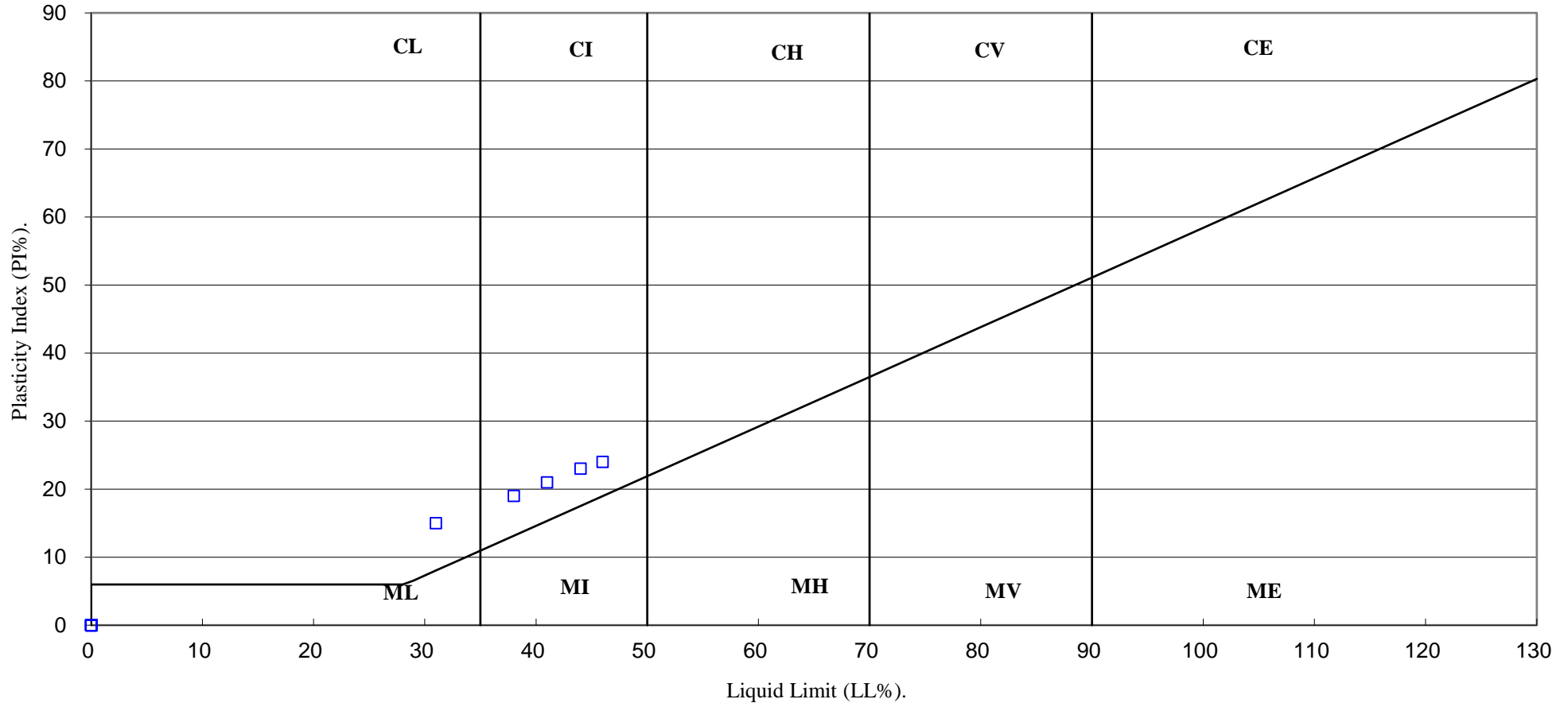
SYMBOLS : NP : Non Plastic

* : Liquid Limit and Plastic Limit Wet Sieved.

		Checked / Approved	<i>Lee</i>	Date	12/08/16	Contract No:	
		Lee Lane, Royston					PSL16/3672
							Client Ref:
							2366

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



PSL
Professional Soils Laboratory

Checked /Approved

[Signature]

Date

12/08/16

Contract No:

PSL16/3672

Lee Lane, Royston

Client Ref:

2366