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02 December 2019

HARROGATE ROAD, WETHERBY
HYDROLOGICAL REBUTTAL REPORT

FOR
HALLAM LAND MANAGEMENT LIMITED AND STOCKELD PARK

Also at:- Centaur House, Ancells Business Park, Ancells Road, Fleet, Hampshire, GU51 2UJ 01252 360580

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1.0 INTRODUCTION

1.1 Purpose of report

This report has been prepared by me Dr Keith Emmett on behalf of the Appellants (Hallam Land Management Ltd and Stockeld Park) in response to the submitted document Planning Appeal – Proof of Evidence (PoE) by David Howard on behalf of Better Wetherby Appeal Ref: APP/E2734/W/193236153.

I hold a Masters of Engineering Honours Degree in Civil Engineering with a Modern Language (MEng) and a Phd in geotechnical engineering on the topic of Piling in Layered Ground from the University of Sheffield. I have over 5 years' experience working in the civil engineering construction and consulting industry, including time as an industrial research consultant, and over eight years' experience as a hydraulics and water engineering lecturer. I have experience in drainage design, flood risk management, construction planning, groundwater and sediment transportation. My Phd was sponsored by the Environment Agency and English Heritage to create a physical model in order to investigate changes in groundwater flows around piles on brownfield sites that could create preferential flow paths in layered ground. I also investigated the radius of influence of piles on soil movement and its impact on in-situ archaeological artefacts. I also conducted additional research for Stent, Aarsleff and Bullivant, broadening the piling scenarios and soil compositions in the laboratory. During my Phd I won the 36th Cooling Prize for my research on piling in layered ground.

I am a Senior Engineer at Eastwood and Partners (Consulting Engineers) Ltd who specialise in civil and structural engineering with over 47 years' experience of award-winning development projects. Our expertise has been utilised by numerous nationally known clients undertaking work ranging from small to larger schemes in excess of £100 million.

The evidence which I have prepared and provided for this appeal is true and has been prepared and is given in accordance with guidance of my professional institution and I confirm that the opinions expressed are my true and professional opinions.

1.2 Previously submitted documents

Following the submission of a Hydrological Assessment, 40866-003 issued by Eastwood and Partners in May 2018, identifying that the " ….development of the site will have a low impact on the SSSI…" a proof of evidence report was submitted and received on Friday 22 November 2019 alleging that the development will subject the Great Crested Newt (GCN) ponds (referred to hereafter as SAC / SSSI site) to irreparable damage due to drying.

This rebuttal report reviews the existing geotechnical and hydrological conditions in the area surrounding the proposed development and SAC / SSSI sites and assesses the above and below ground catchment characteristics. This report also addresses the points highlighted in the PoE of Mr Howard and provides rebuttal evidence to substantiate that the proposed development by Hallam Land Management Ltd will have a low impact, if any, on the SAC / SSSI ponds next to Kirk Deighton.

1.2 Items raised by the Proof of Evidence Report

Mr Howard's proof of evidence raises the following main claims in seeking to demonstrate the proposed development would have an impact on the SAC / SSSI ponds:

i. The geological dip directs groundwater flows from the proposed development towards the SAC / SSSI. This groundwater recharges the ponds under existing and current circumstances.

ii. The Bellway works have altered the drainage pattern in the area.

iii. The Appellant's hydrological report does not formally identify the site as a SAC.

iv. The soil and geology on the SAC / SSSI site mean that they require constant recharge.

v. The mudstone will not impede northward flows and lies on Limestone with faults that will allow water to flow past the mudstone and towards the SAC / SSSI.

vi. The low effectiveness of the impermeable nature of the soil preventing water reaching the Limestone and flowing towards the SAC / SSSI.

vii. The mudstone does not impede the northwards ground water flows towards the SAC / SSSI but allows an increased water flow to the pond.

2.0 GEOLOGY AND GEOTECHNICAL LANDSCAPE

2.1 Site locations and ground conditions

The proposed development site is located on land at the western edge of Wetherby and centred on National Grid Reference SE 391 491. It is bounded by a disused railway route (Harland Way) now a cycle track to the north, Harrogate Road to the south, a residential development under construction to the east and arable land to the west. The SAC / SSSI is located south west of Kirk Deighton next to National Grid Reference SE 398 502 (Appendix 1).

2.2 Superficial soil composition

The site investigation report (Appendix 2) prepared for the Appellant by Lithos 2638/2 identifies two areas (Area 1 and Area 2) of specific superficial deposits within the boundary of the proposed development. Ground conditions typically comprise residual soils to an average depth of 1.3m over Cadeby Formation (Limestone) bedrock. Cohesive (low permeability) residual soils are present to depths of between 0.4m and 2.6m.

Area 1: Encompasses the majority of the site. Superficial deposits are comprised of residual soils (granular and cohesive). The 0.3m topsoil is comprised of sandy CLAY which overlies between 0.4 and 2.6m CLAY across the area with the average depth 0.7m.

Area 2: Located in the north eastern corner of the site comprises 0.3m sandy clay topsoil overlying a Clay stratum ranging from 0.3 to 3.6m deep

Intrusive ground investigations were conducted in 36 trial pits with soakaway testing in 10 of those (Appendix 2). No significant inflows of groundwater were encountered during the investigation, and the stability of excavations was generally good.

2.3 Geological composition

The proposed development site lies over Lower Magnesium Limestone (LML) bedrock with a south easterly plunge (dip direction) as identified in Geological Map, Sheet 70 (Appendix 3). A fault is indicated north of Harland Way with a downthrow on the north side of the fault. The fault does not alter the plunge of the bedrock. The north western area of the SAC / SSSI is located on Middle Permian Marl (MPM) with the main body of the SAC / SSSI on Upper Magnesium Limestone (UML) (Appendix 3). Superficial deposits of Boulder Clay are shown to exist in the centre line of the SAC / SSSI directed in a north west to south easterly alignment.

2.4 Local topography and surface water runoff

The proposed development site falls in a north easterly direction at a steady rate of 1 in 20. Land contours north of Harland Way quickly transition to an easterly direction towards west Wetherby before reaching a localised valley contoured at 35m AOD running parallel to west Wetherby before joining the valley which passes through the SAC / SSSI, between Kirk Deighton and Wetherby, heading south east into Wetherby. A ridge at approximately 45m AOD is located south west of the SAC / SSSI site as identified in Appendix 4. Land contours consequently fall north west and south east of this watershed feature.

The surface water runoff and catchment plan in Appendix 4 highlights the surface water runoff routes which flow perpendicular to the land contours. It can be seen that the indicative SAC/SSSI catchment provided in the original hydrological report is representative of the overland flow paths (represented by blue arrows) that provide surface water recharge to the ponds and Great Crested Newt (GCN) habitat. Surface water runoff from the proposed development can be seen to contribute to a different catchment (represented by red arrows) flowing south of the SAC / SSSI and joining natural flow routes into west Wetherby.

Surface water runoff from the proposed development can therefore be seen not to contribute to the surface catchment of the SAC / SSSI. It is also of note that while there will be a degree of infiltration within the soil, the clay content will promote surface runoff, particularly when saturated during times of more persistent rainfall, which is directed by the natural landscape away from the SAC / SSSI.

2.5 Groundwater flows

The geological map shows the underlying bedrock on the proposed development site to be LML. The plunge of the bedrock is directed in a south easterly direction. Any infiltration on the proposed development site into the LML bedrock is therefore directed towards the River Wharfe as was identified in the original hydrological assessment (Appendix 3).

In the event that surface water originating from the proposed development infiltrates into the bedrock in the area between the proposed development and SAC / SSSI, groundwater flows will also follow the south easterly plunge away from the SAC / SSSI.

3.0 POINT REBUTTAL

3.1 Raised issues

Mr Howard's proof of evidence report and adjoining appendices are addressed by me below. Whilst I respond to the main substantive issues raised within the proof, where I do not respond this should not be considered as an acceptance of the residual points made by Mr Howard.

3.2 Rebuttal – Mr Howard's Main PoE Report

Items 1.0 – Introduction no response required.

Item 2.1 - Ground assessment – no response required.

Item 2.2 – The Geological maps show the plunge (dip direction) of the underlying Limestone bedrock to be in a south easterly direction. The East - West fault line shows a downthrow indicating the dropping of the bedrock north of the fault. The fault does not alter the direction of the dip, therefore groundwater flow remains in a south easterly direction towards the Wetherby and the River Wharfe (Appendix 3).

Figure 1: Should read "Flood Risk from Surface Water". The map does not represent standard drainage but worse case scenarios resulting from saturated soil, thus indicating surface runoff collection points.

Item 2.3 – The images provided are during different years and compare the landscapes during different seasons.

- October 2019 photographs are taken after a recent harvest. The soil would still be under a certain degree of moisture deficit due to the recently harvested crop water demand. December/January 2015-16 photographs are taken in winter when the soil is most likely to become saturated in uncultivated and furrowed fields.

Notwithstanding the ambient soil conditions, it is important to assess meteorological events leading up to each image.

- November and December 2015 rainfall was above average around Wetherby: 175-200% and >200% monthly average respectively, 60mm rainfall (stated in Mr Howard's PoW report) in three days is therefore representative of this (Appendix 5).
- September and October 2019 rainfall was above average around Wetherby: 175-200% and >200% monthly average respectively, 29mm rainfall (stated in Mr Howard's PoE report) in three days is therefore representative of this (Appendix 5).

Whilst the preceding rainfall was above the monthly average prior to the images being taken, the gross impact on rainfall in summer/autumn is notably lower than during the autumn/winter period, as defined by 29mm over three days in comparison to 60mm over three days respectively. Comparing these images is therefore not a viable exercise.

Item 3.1 – The statement is a personal opinion, no evidence provided.

Item 3.2 – The site of the proposed development does not form part of the SAC / SSSI catchment either for groundwater or surface water flows. The comment is a based on personal opinion.

Item 3.3 – See point 2.2. The argument is incorrect as the geological maps show the plunge to be south easterly.

Item 3.4 – The text refers to the hypothetical circumstance that, should ground water from the proposed development be directed northward the south easterly dip orientation will promote water contouring the Mudstone outcrop to the east and then flow north easterly

towards. Open water refers to the cumulative water ponding on the glaciofluvial terrace deposits south west of Kirk Deighton.

Item 3.5 – The surface water flood map illustrates temporary ponding features once the soil is fully saturated. To impose a hydraulic gradient at this location as a standard occurrence is incorrect.

Item 3.6 – Geological maps indicate the north west end of the SAC / SSSI to be located on Mudstone and the remaining areas on Limestone. The ponds form in localised depressions in the ground following the low points in the area, hence the flood map similarity. Surface water will flow perpendicular to the contours until in a valley where it will flow parallel to equal gradient contours. Groundwater will predominantly follow the dip of the bedrock unless they encounter random fissures. Therefore, the geological catchment for the SAC / SSSI is north west of Kirk Deighton whilst the surface water runoff catchment of the SAC / SSSI is west of Kirk Deighton (Appendix 4).

Item 3.7 – The plunge will promote groundwater flows towards Wetherby and the River Wharfe.

Item 3.8 – Language use issue only:

- Clay is impermeable. While granular content will increase the permeability of the soil, the PoE is ignoring the topographical map where surface water flows are directed away from the SAC / SSSI as indicated in Appendix 4.
- The PoE assumes a bedrock plunge towards the SAC / SSSI which is incorrect as shown on the geological maps (Appendix 3).

3.2 Rebuttal – PoE Appendices

A1.2 – Surface water is shown to flow uphill from the pond north east of the “Field A” (Appendix 6). This is incorrect and would also imply groundwater emergence through the valley. Strategic Flood Risk Assessment maps show there to be <25% risk of groundwater emergence on the site. Furthermore, the PoE states that there are no such features in Item 3.6.

A2.1 - Spring 2017 and 2018 have been drier than average (70-90%) while summer was wetter (130-150%) during those two years the net values of rainfall were:

Spring: 100 - 200mm (drier than normal)

Summer: 100 – 300mm (wetter)

The percentage of rainfall deficit has a higher impact on a usually wetter season resulting in a drier net impact for the combined seasonal events (Appendix 5).

A2.2: The last two years have resulted in predominantly average to below average rainfall.

	2017	2018
Spring	70 - 90%	130 – 150%
Summer	130 – 150%	50 – 70%
Autumn	90 – 100%	90 – 100%
Winter	50 – 70%	70 – 90%

Seasonal rainfall anomaly in 2017 and 2018 taken from Met Office UK actual and anomaly maps

Season	Year	Average seasonal rainfall
Spring	2016	100 – 300mm
	2017	100 – 200mm
	2018	200 – 300mm
Summer	2016	100 - 200mm
	2017	200 – 300mm
	2018	<100mm

Spring and Summer actual seasonal rainfall from 2016 to 2018 taken from Met Office UK actual and anomaly maps

The drier meteorological events have coincided with the works from Bellway, particularly the droughts of 2018.

A2.3 – The “High Risk” water flood map shows the SAC / SSSI as an accumulated water “pond” due to it residing in a depression feature and therefore will feature as a more permanent body of water in the landscape

A2.4 – The resultant surface ponding is a consequence of higher than average rainfall in November/December 2015, i.e. 60mm in three days falling on non-cultivated, ploughed and saturated ground.

A2.5 – Although rainfall maps show above average summer precipitation, the net increase is less than in winter. 200 – 300mm rainfall in summer was preceded by a below average spring. Therefore, the saturation of the soil was not optimal due to the crop water demand being higher in summer. The argument ignores the cumulative effect of preceding meteorological events and land use. Hay bales indicate a recent dry period allowing for crop harvest and collection of straw. Images do not represent a valid comparative argument.

A2.6 – As above. Dry spring, preceding drier years, See rebuttal A2.2.

A2.7 – Drier years.

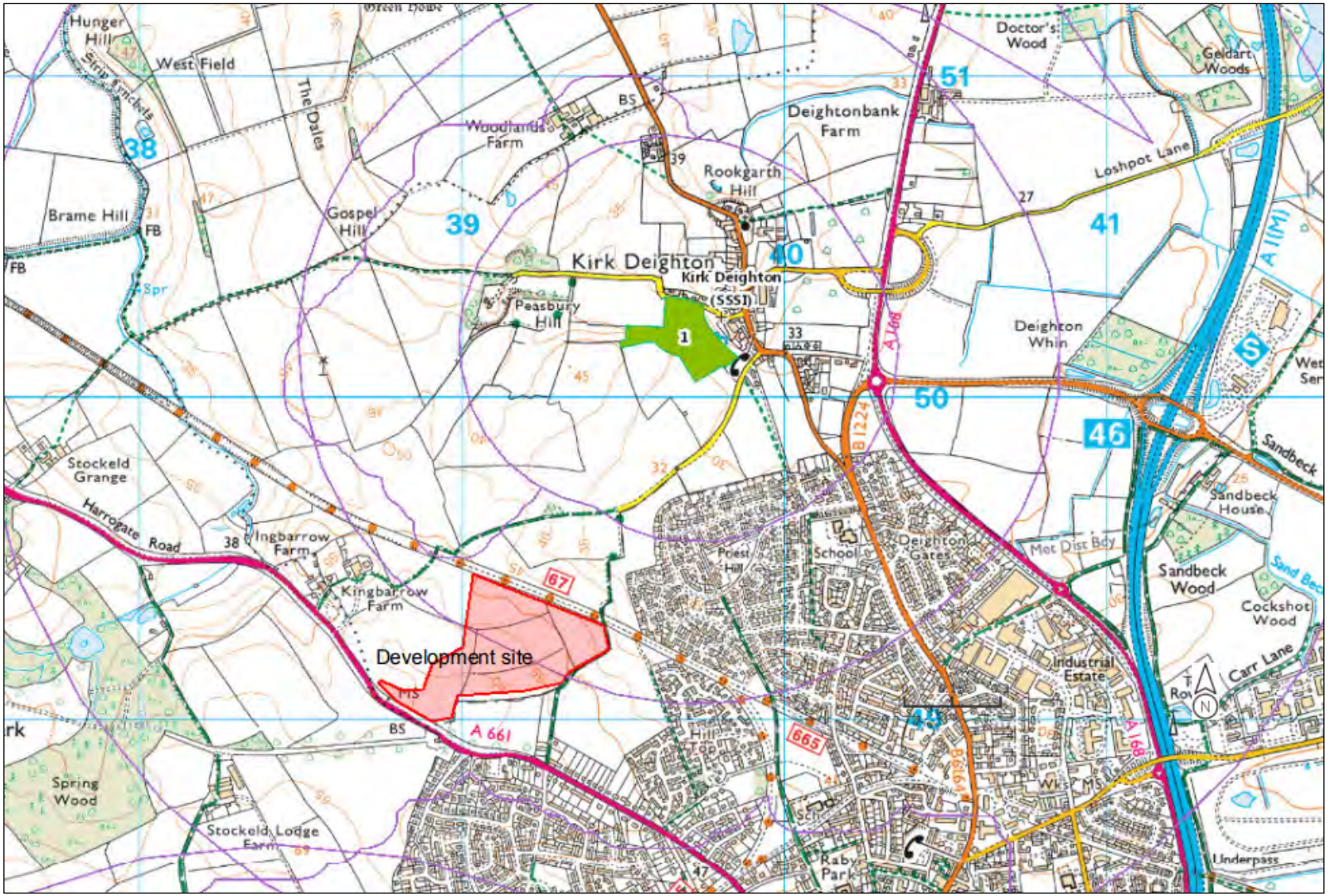
A2.8 – Different geology and catchment characteristics result in an unrepresentative comparison.

Having reviewed the original hydrological report and above facts, there is a very low likelihood, if at all, of water originating from this current greenfield site reaching the SAC / SSSI. Therefore, the effect of the proposed development on the surface and groundwater flows is also considered sufficiently insignificant (de minimis) to have a hydrological impact on the SAC / SSSI.

Dr Keith Emmett

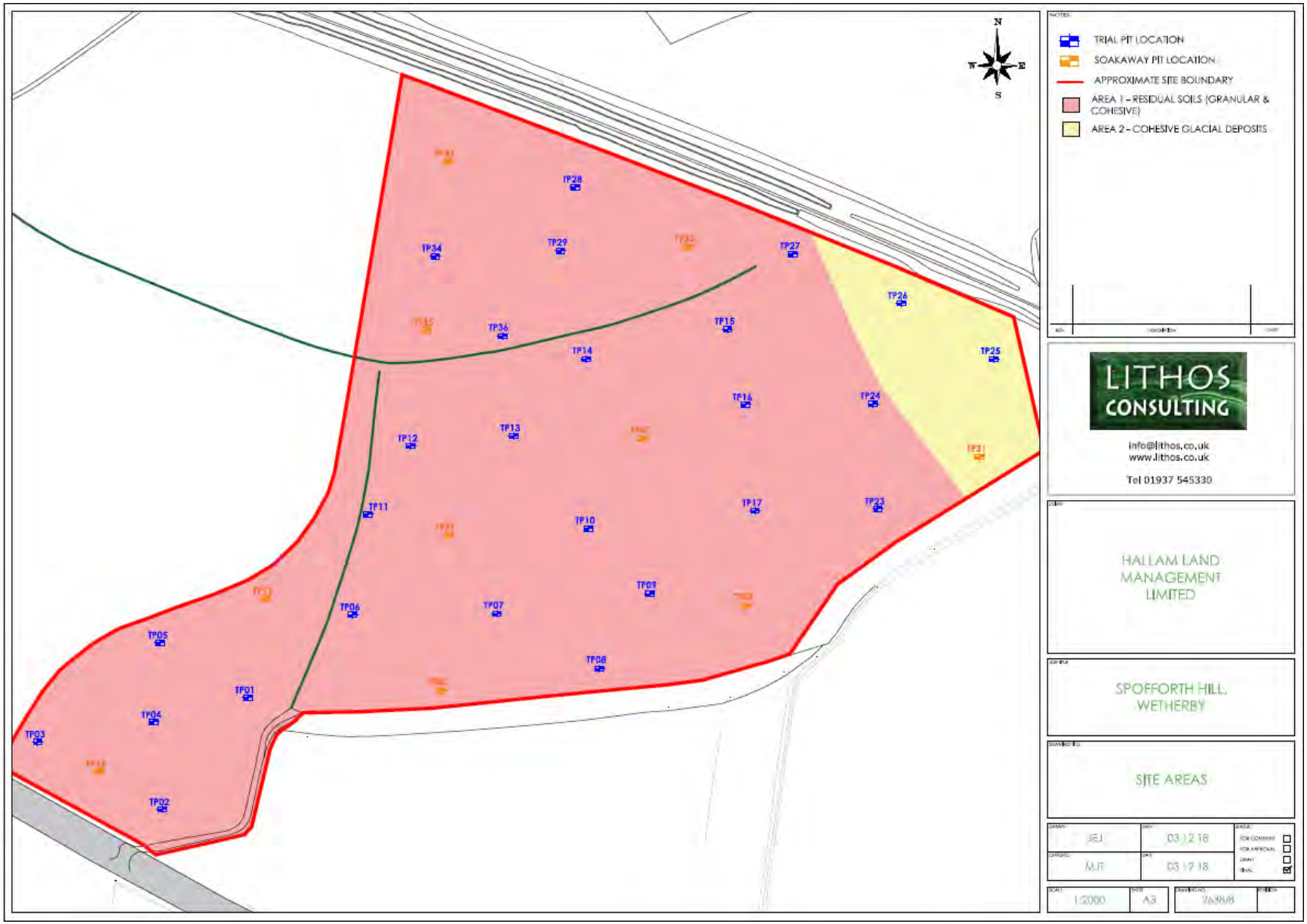
APPENDICES

APPENDIX 1



Extract OS plan showing location of SSSI relative to developemnt site

APPENDIX 2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TP36
TRIAL PIT LOCATION
SOAKAWAY PIT LOCATION
APPROXIMATE SITE BOUNDARY
AREA 1 – RESIDUAL SOILS (GRANULAR & COHESIVE)
AREA 2 – COHESIVE GLACIAL DEPOSITS
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SPOFFORTH HILL, WETHERBY
SITE AREAS
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LITHOS

Geoenvironmental Appraisal

Land at Spofforth Hill, Wetherby

For Hallam Land Management & Stockeld Park

Report no: 2638/2

Date: December 2018

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

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	2638	Site area/ha	12.8
Client:	Hallam Land Management & Stockeld Park	NGR:	SE 392 491
Site:	Spofforth Hill, Wetherby	Nearest postcode:	LS22 6SF

The site is located off Harrogate Road (A661), approximately 1.5km north-west of Wetherby town centre, and currently comprises a single parcel of cropped agricultural land split into 3 fields by mature hedgerows.

Lithos were commissioned by Hallam & Stockeld to provide a geoenvironmental appraisal of the site, where development with housing is being considered. Lithos' investigation included a review of site's history and environmental setting, and a ground investigation comprising 36 trial pits with soakaway testing in 10 trial pits.

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

Issue	Remarks
Made ground	None encountered.
Natural ground	Ground conditions typically comprise residual soils to an average depth of 1.3m over Cadeby Formation (limestone) bedrock. Locally, Cohesive Residual soils are present to depths of between 0.4m and 2.6m. Cohesive Glacial Deposits (stiff gravelly clay) are present to depths of up to >3.6m in the north-east.
Contamination	No significant contamination has been encountered. Topsoil typically 300mm thick is present across the site, testing suggests this material is chemically suitable for re-use.
Mining & quarrying	This site is located beyond the Coal Authority's defined coalfields. There are no known quarries on, or within 50m of the site.
Hazardous gas	The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level. 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. As such, no special precautions against hazardous gas are required.
Preparatory works	General site clearance, topsoil strip and stockpile.
Foundations	Traditional strip/trench-fill foundations are considered the most suitable solution for all proposed plots at the site. Minimum founding depths within the Granular Residual Soils (majority of the site) will be 0.6m, increased to 0.9m where clays are encountered. Where founding within clay, influence of any nearby trees will also need accounting for.
Groundwater & excavations	Groundwater was not encountered within any of the exploratory holes during the investigation. Stability of excavations was generally good, however overbreak and in some cases subsequent spalling occurred due to the coarse nature of the granular deposits and weathered bedrock.
Flooding & drainage	The EA indicate that the site is not located within an indicative floodplain. Based on in-situ testing, soakaways constructed in natural granular soils or weathered bedrock might provide a suitable drainage solution for surface water run-off at this site, but further testing to 'zone' the site is recommended once development proposals are further progressed.
Highways	Based on visual inspection of the shallow natural materials and published guidance, the shallow granular and cohesive soils should provide a CBR values of at least 5% and 3% respectively. These values should be verified prior to or during construction.

CONTENTS

APPENDICES

Appendix A - General notes

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

Appendix B - Drawings

Drawing	Revision	Title
2638/1	-	Site location plan
2638/3	-	Site features
2638/4	-	Site photographs
2638/5	-	Preliminary conceptual site model
2638/6	-	Exploratory hole locations
2638/7	-	Revised conceptual site model
2638/8	-	Site areas

Appendix C - Commission

Appendix D - Historical OS plans

Appendix E - Search responses

From	Date	Content
Landmark	26th January 2018	Environmental search data
BGS	6th February 2017	BGS Ground Stability Report

Appendix F - Exploratory records

Appendix F	TP01 to TP36

Appendix G - Chemical test results

Appendix H - Geotechnical test results

Appendix I – Soakaway test results

FOREWORD (geoenvironmental appraisal report)

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

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

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

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
SPOFFORTH HILL, WETHERBY

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Hallam Land Management & Stockeld Park to carry out a geoenvironmental appraisal of land at Spofforth Hill, Wetherby.

1.1.2 Lithos have previously issued a Preliminary Investigation Report (Ref 2638/1a, dated February 2017). The information contained in Report 2638/1 has been incorporated within this Report, which now supersedes Report 2638/1.

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

- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- An intrusive ground investigation comprising 36 trial pits with soakaway testing in 10 of those
- 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

1.1.4 Primary aims of this investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable Hallam & Stockeld 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 traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. No site layout has been provided at this stage.

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
- Soakaways

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

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 2638/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	1.5 km northwest of Wetherby town centre
NGR	SE 392 491
Approximate area	12.8 ha (32 acres)
Known services	Overhead electric

2.2 Site features

February 2018

2.2.1 Lithos completed a walkover survey of the site on 3rd February 2018.

2.2.2 The site can be accessed off Harrogate Road (the A661) in the southwest and comprises part of two fields separated by a hedgerow, with mature and semi-mature trees located along the eastern, southern and western boundaries. A single mature tree is also located in the centre north. There is no physical demarcation of the northern boundary to either field.

2.2.3 In the far southwest is a grass verge adjacent to Harrogate Road, separated from the gently undulating western field (Field A) by a hedgerow. At the time of the walkover this field was in crop. A timber fence marks the south eastern boundary.

2.2.4 The larger, eastern field (Field B) slopes gently down to the northeast becoming steeper in the east. At the time of the walkover this field had been harvested with hay bales across the entire area. A public footpath runs northwest-southeast adjacent to the north eastern boundary.

2.2.5 An overhead electric cable runs north-south adjacent to the hedgerow separating the two fields.

2.2.6 The far east of the site was noted to be slightly boggy at the time of the walkover.

2.2.7 Existing salient features, at the time of the walkover are presented on Drawing 2638/3 in Appendix B to this report and summarised in the table below.

Feature	Field A	Field B
Current access	Off Harrogate Road	
Topography	Gently undulating	Slopes gently down towards the northeast, steeper in the east
Nature of boundaries	North – no physical boundary East – hedgerow and timber fence South – timber fence West – Harrogate Road	North – no physical boundary and mature trees East – sparse hedgerow South – semi mature trees West – hedgerow
Surrounding land uses	North – open fields and public footpath East & south – building site (Bellway Homes), with housing beyond West – Harrogate Road, with open fields beyond	

November 2018

2.2.8 During the fieldwork between 14th November and 16th November 2018 Field A was noted to contain a low level broad leaf crop, whilst Field B consisted of a recently harvested potato crop.

2.2.9 No further significant changes to the original site description were noted during the fieldwork.

2.2.10 A selection of site photographs is included on Drawing 2638/4.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1850 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
1850	Open fields	Open fields in all directions with outskirts of Wetherby approximately 1.2km southeast York and North Midland Railway adjacent to north eastern boundary Unnamed road adjacent to south western boundary Limestone quarry 200m south and 270m northwest and north
1893	No significant change	Railway renamed N.E.R Church Fenton & Harrogate Quarries to northwest and south renamed Old Quarry
1895		Limestone quarry 270m north no longer shown
1909		Slight expansion of industrial area surrounding Wetherby
1952		Expansion of residential area around Wetherby to within 250m to the south of site Windpump shown at Old Quarry 200m south
1963		Road adjacent to south western boundary labelled Harrogate Road Old Quarry 200m replaced by buildings
1973		Leconfield Court (open land) shown in place of buildings that replaced quarry to the south
1974		Railway line adjacent to northwest boundary shown to be dismantled
1987		Massive expansion of residential area around Wetherby to within 120m east and south Old Quarry 270m northwest replaced by Spoil Tip
1990		Spoil tip 270m northwest no longer shown
1999		Dismantled railway adjacent to northwest boundary relabelled Harland Way (cycle track)

3.1.2 Based on observations made of the area, the former limestone quarry 200m south is not believed to have been backfilled.

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 BGS are presented in Appendix D. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 70) 1:10,000 BGS map (Sheet SE 34 NE) BGS Memoir/Technical Report	Drift – None recorded. Solid – Cadeby Formation (Dolostone). Shallowest coal seam – Top Haigh Moor Coal at least 50m depth below surface. Strata Dip – gentle to southeast. Faults – northwest-southeast orientated fault down-throwing to the northeast located approximately 250m north.
Mining	Coal Authority	This site is located beyond the Coal Authority's defined coalfields.
Quarrying	Historical OS plans	Limestone quarry shown 200m south on 1850 OS plan. Renamed to Old Quarry from 1893 to 1952.
Landfills	Envirocheck Report	No known landfills within 250m.
Radon	Public Health England	The site lies in an area where between 1% and 3% of homes are estimated to be above the action level.
Hydrogeology	Environment Agency	Source Protection Zone? No. Aquifer Principal (Solid). Groundwater abstractions? Nearest recorded abstraction 242m south operated by Northern Landscapes Limited domestic and agricultural use (license revoked). BGS logs suggest groundwater rest level of approx. 20mbgl Soil leaching potential - Intermediate. Pollution incidents? None recorded.
Hydrology	Environment Agency Envirocheck Report	Nearest watercourse(s) – Stockeld Beck approximately 700m northwest flowing north. Water quality – Site located within Crimple beck from Park beck to River Nidd and Nidd from Crimple Beck to River Ouse catchments. Currently rated as ecologically poor and chemically good (Crimple Beck) and ecologically moderate and chemically moderate (River Nidd) Pollution incidents? Nearest recorded incident 860m west with unknown pollutant entering unnamed freshwater stream/river classified as Category 3 - minor incident. Abstractions? None recorded within 1km. Discharge consents? Nearest consent 688m west discharging trade effluent to Stockeld Beck.
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, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency).

4.2 Ground Stability

4.2.1 Given that the site is underlain by limestone bedrock, it was considered prudent to obtain a natural ground stability report from the BGS in order to check whether or not bedrock is considered prone to dissolution resulting in underground cavities that could lead to surface collapses and hollows.

4.2.2 The BGS report (copy included in Appendix E) suggests that there are no known issues relating to soluble rocks and dissolution. Whilst risks associated with limestone dissolution cannot be entirely discounted, they appear to be very low.

4.2.3 The report does indicate that the site lies within an area where there is a 'Level C' risk relating to the 'Shrink-Swell' of cohesive soils. It is understood that this relates to Glacial Clays indicated to the north east of the development area. Geological maps suggest the drift does not extend to the subject site, however this would need to be demonstrated via an intrusive investigation. The shrinkability of cohesive soils encountered is discussed further in Sections 12.2 and 13.4 where the results of shrinkability testing (Plasticity Indices) has been considered.

5 GROUND INVESTIGATION DESIGN

5.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	Not anticipated
Natural soils	Topsoil over residual soils (weathered bedrock)
Bedrock	Limestone (Cadeby Formation) at shallow depth
Groundwater	Likely to be at depths greater than 20m in limestone bedrock

5.1.2 Lithos have undertaken an intrusive investigation of land within the close vicinity; typical ground conditions encountered were:

- Topsoil (c. 300mm thick).
- Glacial Till (stiff/very stiff gravelly clay) encountered in the far north, to depths in excess of 3m.
- Weathered bedrock (limestone) was identified beyond the areas of Glacial Till from depths of 0.3m to 1.5m, recovered as gravel/cobbles. In about half of the trial pits, bedrock was encountered directly beneath the Topsoil.
- Weathered Marl recovered as a stiff red-brown clay was encountered beneath limestone in one pit in the far west.

5.1.3 Ground conditions on this site are expected to be similar.

5.1.4 No significant inflows of groundwater were encountered during the investigation, and the stability of excavations was generally good.

5.1.5 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. topsoil	1. background inorganics and possible presence in sludges from land spreading
Potential off-site contamination sources	None	
Potential geotechnical hazards	1. shallow bedrock	1. breaking out for deeper excavations
Other potential constraints	1. overhead utilities	1. electric cable crossing north-south

5.2 Preliminary conceptual site model

5.2.1 A preliminary conceptual site model, presented as Drawing 2638/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 5.1 inclusive of this report.

5.2.2 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.

5.2.3 Potential pollutants associated with farming activity might include the following:

Agricultural activity	Potential contaminant
Soil conditioners	Metals, sulphates, PAH
Field sports	Lead shot

5.2.4 Whilst it is likely that pesticides have been applied during arable use of the land, these are not likely to include the persistent organochloride pesticides such as Dieldrin, Aldrin, DDT etc. Pesticides routinely used on arable crops the UK (Phenoxy Acetic acid herbicide or PAAH) rapidly degrade in soils or leach via rainwater infiltration to groundwater. It is highly unlikely these would be detected by soil sampling and therefore these have not been included within the proposed sampling suite.

5.3 Ground investigation design & strategy

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

Exploratory holes	Purpose
TPs 01 to 36	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of shallow soils, including any made ground • Suitability of the ground for founding structures and highways
Within 10 TPs	To determine whether soakaways could be utilised for storm water drainage

5.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site. A nominal 50m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

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

6 FIELDWORK

6.1 Scope of works

6.1.1 Fieldwork was supervised by Lithos between the 14th to 16th November and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 01 to 36	1.0m to 3.6m	Vane tests where possible within cohesive deposits
Soakaway tests	Within TPs 18 to 22, 30 to 33 & 35	1.5m to 3.0m	

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

6.1.3 Exploratory hole logs are presented in Appendix F to this Report. These logs include details of the:

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

6.1.4 Exploratory hole locations are shown on Drawing 2638/6 presented in Appendix B.

7 GROUND CONDITIONS

7.1 General

7.1.1 A complete record of strata encountered beneath the proposed development site is given on the trial pit logs, presented in Appendix F.

7.1.2 The site can be divided into areas based on ground conditions. These areas are shown on Drawing 2638/8 and are summarised below:

Site area	General location	Area (m^2)
1	Underlain by residual soils and limestone bedrock	118,000
2	Underlain by glacial till, typically with residual soils below	10,000

7.1.3 Typical ground conditions encountered at the site are described below in 7.2 (natural ground), with a summary provided in the table on pages 9 & 10.

7.2 Natural ground

7.2.1 Natural ground was encountered in the majority of the exploratory holes, and typically comprised the following ground types:

- Area 1
  - Topsoil: sandy clay with occasional rootlets to (average 0.3m thick) from ground level.
  - Cohesive Residual Soil: encountered in the majority of trial pits between 0.3m depth and 2.6m depth (average depth to base of 0.7m), comprising firm to stiff reddish brown gravelly slightly sandy CLAY, gravel is of limestone.
  - Granular Residual Soil: encountered in all exploratory holes except TPs 25 & 31 between 0.3m and >2.7m depth (average depth to base of 1.3m), comprising yellowish brown sandy slightly clayey angular fine to coarse GRAVEL with low cobble content.
  - Cadeby Formation Bedrock (limestone): encountered in all TPs except 25, 31 & 33 from between 0.5m and 2.5m depth (average depth to bedrock of 1.3m), comprising weak becoming medium strong yellowish brown thinly laminated LIMESTONE. Recovered as sandy clayey gravel and cobbles
- Area 2
  - Topsoil: sandy clay with occasional rootlets to (average 0.3m thick) from ground level.
  - Cohesive Glacial Deposits: encountered in TPs 25, 26 & 31 in the far north-east only; between 0.3m depth and >3.6m, comprising stiff reddish brown and grey gravelly CLAY with gravels of limestone, mudstone and sandstone.

7.3 Obstructions

7.3.1 It is apparent from review of the trial pit logs that competent bedrock is present across the majority of the site from at average depth of 1.3m, any deep excavations for drainage and/or trenches will require significant breaking out.

7.4 Visual & olfactory evidence of organic contamination

7.4.1 No visual or olfactory evidence of organic contamination was encountered during the investigation.

7.5 Groundwater

7.5.1 Groundwater was not encountered within any of the exploratory holes during the investigation.

7.6 Stability

7.6.1 Stability of excavations was generally good, however overbreak and in some cases subsequent spalling occurred due to the coarse nature of the granular deposits and weathered bedrock.

7.7 Revised conceptual ground model (ground conditions)

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

- The strength, nature and depth of underlying natural strata

7.7.2 The revised Conceptual Site Model is presented in Appendix B, as Drawing 2638/7.

Summary of Ground Conditions

Hole	Final depth (m)	Depth to Base of (m)				Depth to Cadeby Formation Bedrock – limestone (m)	Remarks
		Topsoil	Cohesive Glacial Deposits	Cohesive Residual Soil	Granular Residual Soil		
TP01	2.1	0.3	-	-	1.6	1.6	-
TP02	1.8	0.4	-	0.6	1.5	1.5	-
TP03	2.0	0.4	-	0.6	1.4	1.4	-
TP04	2.2	0.4	-	-	1.5	1.5	-
TP05	1.6	0.3	-	-	1.0	1.0	-
TP06	1.8	0.3	-	0.6	1.4	1.4	-
TP07	1.6	0.4	-	-	1.0	1.0	Slight overbreak due to boulders from 0.5m.
TP08	1.7	0.4	-	0.7	1.1	1.1	-
TP09	2.4	0.3	-	-	1.7	1.7	Spalling of trial pit walls from 0.5 to 1.1m.
TP10	1.4	0.3	-	0.7	1.0	1.0	Slight spalling of trial pit walls from 0.3m to 0.8m.
TP11	1.9	0.3	-	0.5	1.1	1.1	-
TP12	1.5	0.3	-	-	1.0	1.0	-
TP13	2.1	0.3	-	-	1.3	1.3	Slight overbreak due to cobbles and boulders from 0.8m.
TP14	2.5	0.3	-	-	1.4	1.4	Slight overbreak due to cobbles from 1.3m.
TP15	2.5	0.3	-	-	1.3	1.3	Slight overbreak due to cobbles from 1.1m.
TP16	1.7	0.3	-	-	1.4	1.4	Slight overbreak due to cobbles from 0.5m.
TP17	1.9	0.3	-	0.5	0.9	0.9	Slight overbreak due to cobbles from 0.7m.
TP18	1.5	0.3	-	0.5	0.8	0.8	Slight overbreak due to cobbles from 0.8m to 1.5m.
TP19	1.9	0.3	-	0.4	1.4	1.4	Slight overbreak due to cobbles from 1.1m.
TP20	1.6	0.3	-	0.4	0.8	0.8	-
TP21	1.8	0.3	-	-	0.9	0.9	Slight overbreak due to cobbles from 0.4m.
TP22	2.2	0.3	-	-	0.9	0.9	Slight overbreak due to cobbles from 0.3m.
TP23	1.6	0.3	-	0.5	0.8	0.8	Slight overbreak due to cobbles from 0.5m.
TP24	1.0	0.3	-	0.4	0.5	0.5	Slight overbreak due to cobbles from 0.4m.
TP25	3.6	0.3	>3.6	-	-	-	-
TP26	2.9	0.3	1.6	-	2.0	2.0	-

Hole	Final depth (m)	Depth to Base of (m)				Depth to Cadeby Formation Bedrock – limestone (m)	Remarks
		Topsoil	Cohesive Glacial Deposits	Cohesive Residual Soil	Granular Residual Soil		
TP27	2.3	0.3	-	1.3	1.9	1.9	-
TP28	2.3	0.3	-	-	1.2	1.2	Slight overbreak due to cobbles from 0.6m.
TP29	2.7	0.3	-	2.6	2.1	2.1	-
TP30	1.6	0.4	-	0.5	1.0	1.0	Slight overbreak due to cobbles from 0.5m.
TP31	3.0	0.3	>3.0	-	-	-	-
TP32	2.3	0.3	-	0.5	1.5	1.5	-
TP33	2.7	0.4	-	0.9	>2.7	-	-
TP34	2.7	0.3	-	0.4	2.5	2.5	-
TP35	2.2	0.4	-	-	1.4	1.4	-
TP36	2.1	0.3	-	-	0.6	0.6	Slight overbreak due to cobbles from 0.5m.

8 SOAKAWAY TEST RESULTS

8.1 UK Guidance

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

8.1.2 CIRIA C753:2015[1] recommends that soakaways should not be constructed 'in ground where the water table reaches a level within 1m below the base of the soakaway at any time of the year'.

8.1.3 BRE Digest 365 "Soakaway Design" advises that each soakaway pit should be filled and allowed to drain three times to near empty on the same or consecutive days.

8.2 Field tests

8.2.1 A total of 18 soakaway tests were carried out in general accordance with BRE Digest 365[2] "Soakaway Design". The locations of the soakaways are shown on Drawing 2638/6 presented in Appendix B to this report.

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

8.2.3 Where the water level did not fall to 25% effective depth within 2 hours, the test was not considered suitable for calculation of an infiltration rate; this was the case for unsuccessful tests in TPs 21, 31, 32 & 35.

8.2.4 Where the water level did not quite reach the 25% effective depth, the data has been extrapolated in order to derive a representative infiltration rate; this was the case for the test in TP20.

8.2.5 Where possible and if drainage rates allowed more than one cycle of filling/draining was undertaken within each soakaway pit.

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

Soakaway	Test Number	Stratum	Infiltration rate (m/s)	Remarks
TP18	1	0.6m to 0.8m Granular Residual Soil 0.8m to 1.5m Cadeby Formation	$5.00x10^{-4}$	-
	2		$5.84x10^{-4}$	
	3		$4.51x10^{-4}$	
TP19	1	1.0m to 1.4m Granular Residual Soil 1.4m to 1.9m Cadeby Formation	$2.35x10^{-5}$	-
	2		$2.61x10^{-5}$	
TP20	1	1.0m to 1.6m Cadeby Formation	$6.98x10^{-6}$	Data extrapolated to calculate infiltration rate
TP21	1	1.0m to 1.8m Cadeby Formation	N/A	Test didn't reach 25% effective depth
TP22	1	1.5m to 2.2m Cadeby Formation	$3.3x10^{-4}$	-
	2		$2.44x10^{-4}$	
	3		$2.28x10^{-4}$	

[1] CIRIA C753. The SUDS Manual (2015).
[2] BRE Digest 365. Soakaway Design (1991).

Soakaway	Test Number	Stratum	Infiltration rate (m/s)	Remarks
TP30	1	0.7m to 1.0m Granular Residual Soil 1.0m to 1.6m Cadeby Formation	$1.07x10^{-4}$	-
	2		$8.71x10^{-5}$	
	3		$6.78x10^{-5}$	
TP31	1	2.0m to 3.0m Cohesive Glacial Deposits	N/A	Test didn't reach 75% effective depth
TP32	1	1.4m to 1.5m Granular Residual Soil 1.5m to 2.3m Cadeby Formation	N/A	Test didn't reach 25% effective depth
TP33	1	1.4m to 2.7m Granular Residual Soil	$2.43x10^{-5}$	-
	2		N/A	Test didn't reach 25% effective depth
TP35	1	1.5m to 2.2m Cadeby Formation	N/A	Test didn't reach 25% effective depth

8.3 Discussion & conclusions

8.3.1 Drainage Engineers could use the infiltration rates reported above to determine the feasibility of soakaways as a solution for the discharge of surface water run-off. However, regard must be made to seasonal groundwater levels; UK guidance indicates that the seasonally high groundwater table must be at least 1m below the base the soakaway.

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

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

8.3.4 Soakaways placed in the cohesive soils (predominantly in the north-east) will not work.

8.3.5 The soakaway results are mixed consequently, soakaways might provide a suitable drainage solution for the discharge of surface water run-off at the site; however there maybe a need for 'zoning' in terms of soakaway feasibility. Further testing could be undertaken in order to 'target' proposed soakaway locations.

8.3.6 Drainage solutions are discussed further in Section 13.8.

8.3.7 If the developer pursues soakaways as a drainage solution following any additional testing, consideration should be given to the installation of groundwater wells to depths of around 6m in 6 boreholes, and subsequent groundwater level monitoring over about 12 months. Given depth to bedrock, these boreholes will need to be advanced by rotary probing.

9 CONTAMINATION (ANALYSIS)

9.1 General

9.1.1 The site's former/current usage is considered unlikely to have given rise to any significant ground contamination. Furthermore, no 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 5.2.

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

9.2 Testing scheduled

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

Type of sample	No. of samples	Determinands
Topsoil	9	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Speciated Polycyclic Aromatic Hydrocarbons (PAH)
	6	Clay/sand/silt content and visible contaminants, sharps (glass etc) to check compliance with BS3882

9.3 Soil contamination results

9.3.1 The soil contamination test results are summarised in the table on page 14.

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

Summary of degree of soils contamination (topsoil)

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.												
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Zn $	PAH		Asbestos I.D.
														B(a)P ∞	Naphthalene	
				37	5	26	3000	200	200	169	127	350	200	5	8	
TP01	0.10	Topsoil	8.3	12	0.8	0.3	18	18	28	0.1	20	< 0.2	50	< 0.1	< 0.1	N.D.
TP03	0.10	Topsoil	8.2	11	1.0	0.3	18	18	32	0.1	20	< 0.2	58	< 0.1	< 0.1	N.D.
TP09	0.10	Topsoil	8.0	9.8	0.6	0.3	17	13	24	< 0.1	19	< 0.2	45	< 0.1	< 0.1	N.D.
TP12	0.10	Topsoil	8.1	11	0.9	0.3	16	12	26	< 0.1	17	< 0.2	42	< 0.1	< 0.1	N.D.
TP14	0.10	Topsoil	8.0	11	0.9	0.3	18	16	33	< 0.1	21	< 0.2	46	< 0.1	< 0.1	N.D.
TP25	0.10	Topsoil	8.0	9.1	0.7	0.3	21	16	24	< 0.1	27	0.2	50	< 0.1	< 0.1	N.D.
TP27	0.10	Topsoil	7.9	8.3	0.9	0.3	15	14	20	< 0.1	16	0.2	44	< 0.1	< 0.1	N.D.
TP29	0.10	Topsoil	8.1	10	0.7	0.3	17	14	22	0.1	20	< 0.2	51	< 0.1	< 0.1	N.D.
TP34	0.10	Topsoil	8.0	11	0.8	0.3	15	12	22	0.1	17	< 0.2	47	< 0.1	< 0.1	N.D.

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

Source of Guidance Trigger Level	
With the exception of those annotated with one of the symbols below (∞, $, ~), all Soil Screening Values in brackets above have been derived using CLEA v1.06. Values assume contaminants located in a sandy loam, with 6% soil organic matter (SOM).	
∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE\Defra)
$	Ministry of Agriculture, Fisheries & Food. Code of Practice for Agricultural Practice for the Protection of Soil. 1998
~	Engineering judgement (Lithos). Boron is a phytotoxic, although most phytotoxic compounds can pose a risk to human health if sufficient concentrations are present. However, plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.
N.D.	Not detected, applicable to asbestos I.D. screen only

Inorganic determinands

9.3.3 Of the 9 samples of topsoil analysed for inorganic parameters, all can be classified as uncontaminated.

9.3.4 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

9.3.5 No asbestos fibres were identified in any of the 9 samples screened.

Organic determinands

9.3.6 This site is essentially greenfield and therefore for organic compounds, 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).

9.3.7 Lithos have used the CLEA model to derive risk-based screening values for hydrocarbons, in accordance with the methodology detailed by the TPHCWG, and reviewed by a UK workshop of experts with respect to UK adoption of the method.

9.3.8 However, 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 comparison of soil results with lower screening values may be required.

9.3.9 In order to check the validity of Lithos' Tier 1 Soil Screening Values, the average TOC for each common fill type (beyond any areas of obvious hydrocarbon impact) have been determined.

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Topsoil	1.6%	Yes, but no significant organic contamination was recorded in this soil type. All determinands below limit of detection.

Polycyclic Aromatic Hydrocarbons (PAH)

9.3.10 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.

9.3.11 The analytical data for this site has been compared against Tier 1 screening values for the most problematic (16 USEPA) PAHs. All concentrations are below Tier 1 screening values, therefore whilst a range of PAHs may be present, these are not considered to pose a risk to health.

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

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

9.4 Topsoil

9.4.1 Topsoil), typically 300mm thick is present across most of the site. Testing suggests this material is chemically suitable for re-use.

9.4.2 The clay/sand/silt content and visible contaminants, sharps (glass etc) of 6 topsoil samples has been determined to check compliance with BS3882[3] requirements. BS3882 considers visual contaminants to comprise 'undesirable potentially injurious foreign object(s) visible to the naked eye'.

9.4.3 It should be noted that this is a reduced suite of analysis, and no N-P-K etc. testing has been undertaken.

9.4.4 The results are summarised below:

Parameter	BS3882 Specification	TP03, 0.2m	TP09, 0.2m	TP12, 0.2m	TP23, 0.1m	TP26, 0.1m	TP33, 0.1m
Clay content	5 to 35%	19	21	19	19	21	18
Silt content	0 to 65%	31	26	18	29	27	31
Sand content	0 to 90%	50	53	63	52	52	52
Visible contaminants	< 0.5%	ND					

Notes
Values in bold type fail the required specification for multipurpose topsoil
ND – none detected

9.4.5 The above results suggest that the topsoil at this site complies to the standards set out in BS3882. In terms of textural classification, the majority of topsoil falls into the 'sandy clay loam' class, with one result TP33, 0.1m falling into the 'sandy loam' class.

9.4.6 The results indicate that the topsoil complies with the requirements for multipurpose topsoil, in terms of textural classification and visible contaminants, however no N-P-K testing has been undertaken to date.

10 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

10.1 Revised conceptual ground model (contamination)

10.1.1 No plausible contaminant linkages have been identified.

10.2 Waste classification

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

10.2.2 As there is no WRAP protocol for soils, the characterisation, sampling and classification of soils arising from brownfield sites has been incorporated within the Environment Agency's Technical Guidance WM3[4]. Classification of soils as inert, non-hazardous or hazardous in accordance with WM3 is quite a complex process. However, all soil arisings generated by excavations at this site are likely to be classified inert.

10.2.3 Off-site disposal to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[5] 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.

[3] *BS3882:2015. Specification for topsoil. Published by BSI Standards Limited.*
[4] Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015
[5] The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

11 HAZARDOUS GAS

11.1 Methane & carbon dioxide

11.1.1 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 (e.g. 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

11.1.2 A former quarry is shown on historical OS plans around 200m south of the site, however inspection of the suggests it has not been backfilled, and therefore is not considered a significant source of hazardous gas.

11.2 Radon

11.2.1 Requirements with respect radon measures are set out in Building Regulations Approved Document C. Probability bandings (based on the proportion of properties in a given area that exceed the Action Level; currently 200 $Bq.m^{-3}$) are used to determine whether a property requires no, basic or full measures.

11.2.2 At present Approved Document C advocates basic measures for the probability banding 3% to 10% (full measures if >10%). However, Public Health England would like to see all new build include basic measures.

11.2.3 The Public Health England UK radon map and the Landmark report indicate that the site is in an area where between 1% and 3% of homes are estimated to be above the action level.

11.2.4 Consequently, basic radon protection measures are not required. However, in light of Public Health England advice, the developer might consider providing all new dwellings with basic radon protection measures.

12 GEOTECHNICAL TESTING

12.1 General

12.1.1 A total of 12 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

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

12.2 Atterberg limits

12.2.1 The plasticity indices of 12 samples of cohesive soil have been determined; results are summarised below.

Soil type	No. samples tested	Moisture content range (average)	Range of Plasticity Indices* (average)	Shrinkability
Cohesive Glacial Deposits	5	13 to 19 (16)	14 to 25 (20)	Medium
Cohesive Residual Soils	7	14 to 24 (19)	16 to 36 (25)	Medium

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

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

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

12.3 Soluble sulphate and pH

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

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

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

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Cadeby Formation	8	8.7	<10
Cohesive Residual Soil	2	8.2	98
Cohesive Glacial Deposits	4	8.2	12
Granular Residual Soil	8	8.7	<10

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

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

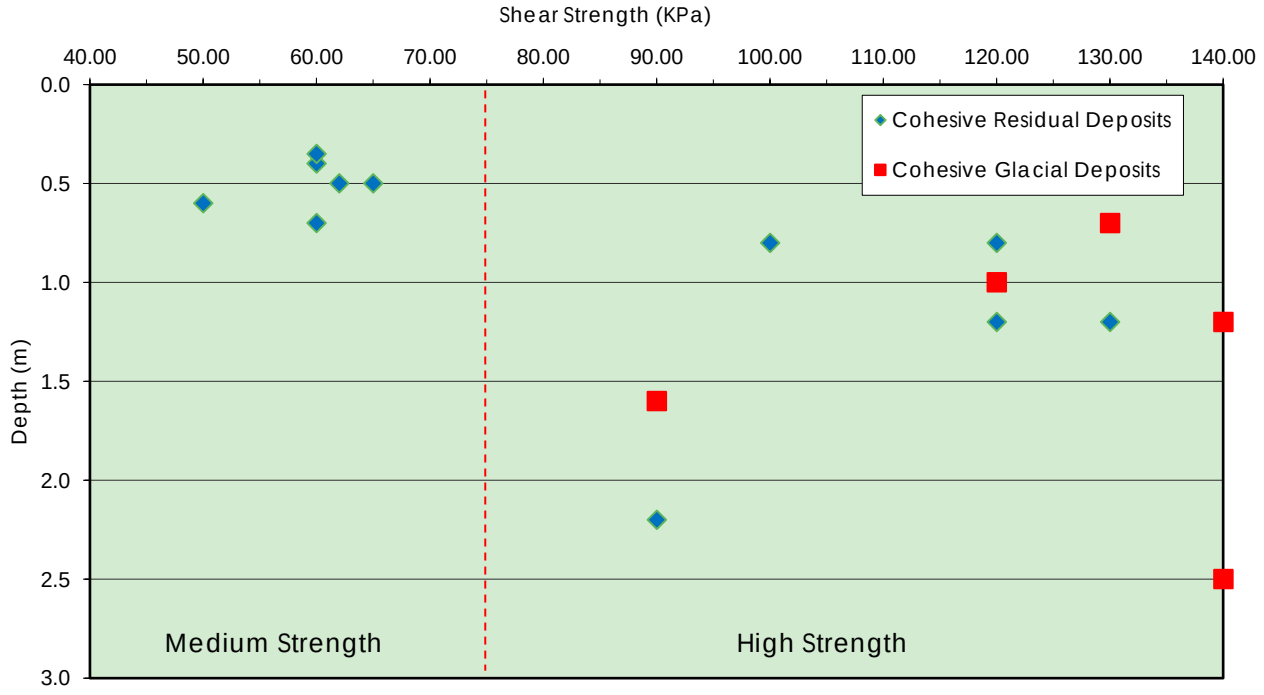
12.4 Undrained shear strength testing

Hand shear vane testing

12.4.1 Hand shear vane testing was undertaken within trial pits in-situ to around 1.3m depth and from larger blocks of excavated clay below that depth.

12.4.2 The results are summarised within the plot below and illustrate a linear increase in undrained shear strength (Su) with depth within the cohesive deposits. Below approximately 0.5m depth Su is typically greater than 60kPa (medium strength); all Cohesive Glacial Deposits are considered to be of high strength.

12.4.3 The plot below provides a summary of undrained shear strengths.



13 GEOTECHNICAL ISSUES

13.1 Conceptual site model

13.1.1 Ground conditions typically comprise topsoil over residual soils (predominantly granular) to around 1.3m over limestone bedrock. Deeper Cohesive Residual soils and Cohesive Glacial deposits are present in the far north & north-east.

13.1.2 The revised Conceptual Site Model is reproduced as Drawing 2638/7 in Appendix B to this report.

13.2 Mining & quarrying

13.2.1 This site is located beyond the Coal Authority's defined coalfields.

13.2.2 This site is underlain by Cadeby Formation (limestone) bedrock and the shallowest coal seam lies at least 50m below the surface.

13.2.3 There are no known quarries on, or within 50m of the site.

13.3 Site regrade and/or ground improvement

13.3.1 Some of the site is sloping and consequently there may be a requirement for some localised regarding in order to create suitable development platforms. Topographical survey data (levels) have not been made available, but slopes appear to be at gradients of less than around 1 in 12. If any significantly steeper gradients are present, some revision to the advice given below may be required.

13.3.2 Any digital terrain modelling undertaken or commissioned by Hallam should consider implications for the foundation recommendations outlined below.

13.3.3 Natural ground underlying this site is often clayey, therefore consideration should be given to the implication of undertaking earthworks in poor/wet weather when the ground surface is likely to become difficult to cross with heavy machinery.

13.3.4 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 10.2 should apply.

13.4 Foundation recommendations

General

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

13.4.2 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 the developer should consider implications for the foundation recommendations outlined below.

13.4.3 Sub-surface concrete in contact with natural ground should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.

13.4.4 The foundation solution options for two or three storey residential properties constructed on this site and are discussed below.

Strip/trench fill footings

13.4.5 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for the majority of two or three storey houses constructed at the site. Footings will be founded in firm to stiff cohesive deposits, granular deposits or competent rock.

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

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

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

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

13.4.10 The developer 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)

13.4.11 The granular soils are assumed to have a relative density of at least medium dense (in accordance with BS5930:2015).

13.4.12 A safe bearing capacity of at least 150kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true:

- A foundation length of 10m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.6m
- An angle of shearing resistance of ϕ=32° for the granular deposits

13.4.13 Assuming the foundation geometry detailed above, settlements 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.

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

13.4.15 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).

Cohesive soils (clays)

13.4.16 Clay classification tests suggest that natural cohesive soils at the site should be regarded as being of medium shrinkability. A minimum founding depth of 0.9m is therefore recommended for all soils on the site where strip footings are proposed, predominantly within Area 2, but locally within Area 1.

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

13.4.18 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 70% of the Area 2 may be affected by trees.

13.4.19 The current layout suggests some plots will be built on ground from which hedgerows will be removed. Whilst the hedgerows at the site are relatively low (<2.5m height) and appear to have been maintained at that height by trimming, it is often difficult to definitively prove that they have not desiccated soils to significant depth. In theory, if mature Hawthorn is removed from within the footprint of a plot, founding depth (in low shrinkability clay) would be around 2.5m. However, this comment is only likely to apply for plots within the central north of site.

13.4.20 Trench fill foundations should be designed in accordance with NHBC Standards, Chapter 4.2. Heave precautions (a suitable approved compressible void former) should be used on the internal face of all external walls where the foundation is within the zone of influence of trees and greater than 1.5m deep.

13.4.21 Any trench fill foundation deeper than 2.5m will need to be designed by a Chartered Engineer, whose status is accepted by NHBC (NHBC Standards, Technical Requirement R5); however, it is likely that the presence of bedrock will result in few foundations being deeper than 1.5m, with the exception of the far north-east.

13.4.22 A safe bearing capacity of around 150kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true

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

13.4.23 Assuming the foundation geometry detailed above, settlements 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.

13.4.24 Further investigation should be commissioned if any apartment blocks with higher line loads (say >120kN/m run) are proposed within Area 2. Such investigation would include cable percussion boreholes and geotechnical analysis (triaxial and oedometer testing) of recovered, undisturbed samples.

Cadeby Formation Bedrock

13.4.25 The Cadeby Formation (limestone) bedrock is generally considered to have a safe bearing capacity of at least 300kPa and minimal settlements would be anticipated.

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

Summary of foundation recommendations

13.4.27 In summary, the following foundation solutions are likely to be most appropriate (subject to developer preferences regarding site preparatory works, final levels & costs associated w0ith each foundation option).

Area 1

13.4.28 The majority of foundation excavations within Area 1 will encounter competent Granular Residual Soils at the recommended minimum founding depth of 0.6m. However, locally deeper clays are present (to between 0.7m and 1.3m). Where this is the case, foundations should extend to the minimum founding depth in clay (i.e. 0.9m or deeper if there is any tree influence) or until Granular Residual Soils is encountered, whichever is the shallower.

Area 2

13.4.29 All foundation excavations within Area 2 are likely to encounter high strength, medium shrinkability clays and therefore a minimum foundation depth of 0.9m is recommended. Foundations within Area 2 will also need to account for tree influence in accordance with NHBC Chapter 4.2.

13.4.30 A summary of the above recommendations is given in the table below:

Plot nos	Foundation solution(s)	Remarks (influencing factors)
Area 1	Strips at a minimum depth of 0.6m	Granular soils at founding depth
Area 2	Strips at a minimum depth of 0.9m, overdeepened where necessary due to tree influence	Medium shrinkability clays at founding depths

13.4.31 A ground conditions plan is presented as Drawing 2638/8 in Appendix B.

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

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

13.5 Floor slabs

13.5.1 Where foundations are within the influence of existing or proposed trees, NHBC require a suspended floor slab, with sub-floor void. The floor slab is most commonly a precast block and beam construction, but alternatively could comprise a suspended timber floor, or a slab cast on a suitable compressible void former. Ground-bearing and cast in-situ suspended slabs (other than those cast on a void former) are not acceptable where foundations are within the influence of trees.

13.5.2 In accordance with NHBC Standards Chapter 4.2, a minimum void height of 250mm should be adopted for a precast block and beam (or suspended timber) floor; this includes a 150mm ventilation allowance. If a suspended, cast in-situ slab (on a void former) is proposed, a minimum clear void height of 100mm should be adopted; of course, the actual thickness of the void former will be significantly greater.

13.5.3 Beyond the influence of existing or proposed trees, it is considered that the natural ground is generally suitable for the use of ground bearing floors; this is the case for the majority of Area 1. 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.

13.5.4 The natural ground beneath this site includes cohesive soils and is therefore subject to seasonal variation in moisture content. If ground slabs were constructed on desiccated soil, heave of the slab would occur on re-hydration of the ground. If any significantly desiccated soil is present, a suspended floor slab, with sub-floor void will be required.

13.5.5 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 to ensure 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.

13.6 Designated concrete mixes

13.6.1 Designated mixes are considered in BRE Special Digest SD1 and BS 8500 -1:2015+A1:2016. However, in addition to soil chemistry (sulphate class), there are a number of other considerations relating to structural design that need to be taken into account when determining an appropriate concrete mix.

13.6.2 Consequently, the developer should seek advice from their appointed Structural Engineer.

13.7 Excavations

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

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

13.7.3 Excavations should remain stable in the short term.

13.7.4 Overbreak of excavations typically occurred when excavating through coarse granular deposits and bedrock.

13.7.5 Bedrock was encountered in all exploratory holes except TPs 25, 31 & 33. Based on the exploratory hole logs, excavation greater than 1.5m is likely to prove difficult across about 90% of the site. It would therefore be prudent to allow for excavation of hard rock in any deep excavations such as those that may be required for drainage etc.

13.8 Drainage

13.8.1 In-situ testing suggests that adoption of discrete soakaways may be possible, subject to further testing and 'zoning' of the site.

13.8.2 However, CIRIA C753:2015 states that: "*A minimum distance of 1m between the base of the infiltration system and the maximum likely groundwater level should always be adopted. This is to minimise the risk of groundwater rising into the infiltration component and reducing the available storage volume, to protect the functionality of the infiltration process by ensuring a sufficient depth of unsaturated material and to protect the groundwater from any contamination in the run-off*".

13.8.3 Therefore, if the developer pursues soakaways as a drainage solution, consideration should be given to the installation of groundwater wells to depths of around 6m in 6 boreholes, and subsequent groundwater level monitoring over about 12 months.

13.8.4 As an alternative to soakaways, ground within Area 1 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 an alternative solution.

13.8.5 Alternative SUDS options (see CIRIA C753:2015 for further details) include:

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

13.8.6 Yorkshire Water have published a guide[6] for developers and designers outlining their design requirements for surface water attenuation assets.

13.8.7 With respect to detention basins, which should normally be dry, water table levels should be taken from borehole monitoring wells over 4 consecutive seasons, for at least 3 points in the basin area. Ground conditions must be suitable to allow free drainage from the detention basin all year round by having regard to groundwater levels, and impermeable liners are not to be used.

13.8.8 The guide also discusses required access to flow control chambers, large diameter (i.e. >900mm) surface water storage pipes, and surface water storage tanks.

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

13.9 Highways

13.9.1 The natural soils present at shallow depth (anticipated formation) are predominantly granular. Based on visual inspection of the natural materials, published tables[7] indicate that the Granular Residual deposits would be expected to provide a CBR value of at least 5%, whilst the Cohesive Residual & Cohesive Glacial soils should yield a CBR value of at least 3%. These values should be verified prior to or during construction.

13.9.2 Whilst the CBRs estimated above should be achievable, significant deterioration during/after periods of significant rainfall and/or site trafficking is likely. 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 (i.e. a "blanket" of 6F2) could be placed along the line of proposed highways to protect formation during the construction phase.

13.10 External works

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

[6] *Design Requirements for Surface Water Attenuation Assets, February 2017.*

[7] *Interim Advice Note 73/06 Revision 1 (2009), Chapter 5. Characterisation of Materials Design Guidance for Road Pavement Foundations - Draft HD25*

14 REDEVELOPMENT ISSUES

14.1 General

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

14.1.2 Even after an appropriate preliminary investigation and ground investigation, with exploratory holes on a closely spaced grid (say trial pits at 30m centres), a geoenvironmental appraisal is typically based on inspection of the ground underlying less than 0.5% of the total site area (and much less at depths in excess of about 3.5m). Consequently, there is always a possibility that unanticipated ground conditions will be encountered during the site preparatory works.

14.1.3 If unanticipated ground is encountered during the site preparatory works, the Contractor should immediately seek further advice from the Engineer.

14.2 Control of excavation arisings

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

14.2.2 Further characterisation of stockpiled materials is likely to be required if off-site disposal is proposed. See also comments in Section 10.2.

14.3 Good practice guidance

14.3.1 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[8]:
  - PPG6 - Working at construction and demolition sites
  - PPG2 - Above ground oil storage tank
  - PPG7 – The safe operation of refuelling facilities.
  - PPG21 – Incident Response Planning

[8] *Whilst this has formally been withdrawn it can still be accessed via the EA archives and provides useful information on managing risks.*

14.4 New utilities

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

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

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

14.5 Health & safety issues - construction workers

14.5.1 Access into excavations etc. must be controlled and undertaken in accordance with the CDM Regulations 2015, most notably Regulation 22, to mitigate risk of collapse or asphyxiation.

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

14.6 Potential development constraints

14.6.1 The overhead electric cables present a potential development constraint unless they can be relocated. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required if they remain in-situ.

14.6.2 Shallow bedrock across the site will necessitate significant breaking out for any deep drainage/trenches.

15 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

15.1 General

15.1.1 The site is located off the Harrogate Road (A661) approximately 1.5km north-west of Wetherby town centre and currently comprises a single parcel of cropped agricultural land, split into 3 fields divided by hedgerows. No significant previous development is shown at the site on historical OS plans.

15.1.2 It is understood the proposed development will comprise traditional two and three storey domestic dwellings with associated gardens, adoptable roads and sewers.

15.1.3 Ground conditions typically comprise residual soils to an average depth of 1.3m over Cadeby Formation (limestone) bedrock. Locally, Cohesive Residual soils are present to depths of between 0.4m and 2.6m; Cohesive Glacial Deposits (stiff gravelly clay) is present to depths of up to >3.6m in the north-east.

15.2 Mining

15.2.1 This site is located beyond the Coal Authority's defined coalfields.

15.2.2 There are no known quarries on, or within 50m of the site.

15.3 Hazardous gas

15.3.1 The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level.

15.3.2 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.

15.3.3 As such, no special precautions against hazardous gas are required.

15.4 Contamination

15.4.1 No contamination has been encountered.

15.4.2 Topsoil typically 300mm thick is present across the site, testing suggests this material is chemically suitable for re-use.

15.5 Foundations

15.5.1 Traditional strip/trench-fill foundations are considered the most suitable solution for all proposed plots at the site. Minimum founding depths within the Granular Residual Soils (majority of the site) will be 0.6m, increased to 0.9m where clays are encountered. Where founding within clay, influence of any nearby trees will also need accounting for.

15.6 Flooding

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

15.7 Drainage

15.7.1 Based on in-situ testing, soakaways constructed in natural granular soils or weathered bedrock might provide a suitable drainage solution for surface water run-off at this site, but further testing to 'zone' the site is recommended once development proposals are further progressed.

15.7.2 If soakaways are pursued as a drainage option, it is recommended that groundwater levels are monitored by installing wells in boreholes across the site to around 6m depth.

15.8 Highways

15.8.1 Based on visual inspection of the shallow natural materials and published guidance, the shallow granular and cohesive soils should provide a CBR values of at least 5% and 3% respectively. These values should 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 by reference to current and historical OS plans.

In July 2011, the Coal Authority (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 High Risk and Low Risk areas. High Risk areas are likely to be affected by a range of legacy issues that pose a risk to surface stability, including: mine entries; shallow coal workings; workable coal seam outcrops; mines gas; and previous surface mining sites. Low Risk areas comprise the remainder of the defined coalfield, and are areas where no known defined risks have been recorded; although there may still be unrecorded issues. Where a site lies within either a High or Low Risk area, a mining report is obtained from the CA.

Landfills

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

Radon

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

In order to assess potential risks associated with radon gas, Lithos refer to BRE Report BR211[1], and the Public Health England website. Advice on the limitation of exposure of the population to radon in buildings was originally published in 1990 by the National Radiological Protection Board (NRPB), which joined the Health Protection Agency (HPA) in 2005; the HPA updated NRPB advice in July 2010[2]. The HPA became part of Public Health England in 2013.

The HPA recommended that the NRPB radon Action Level for homes be retained, and a new Target Level for radon in homes be introduced. The values of the Action Level and Target Level, expressed as the annual average radon concentration in the home, are 200 Bqm^{-3} and 100 Bqm^{-3} respectively. The Target Level was to provide an objective for remedial action in existing homes and preventive action in new homes.

The term 'radon Affected Area' is defined as those parts of the country with >1% of homes estimated to be above the Action Levels. The NRPB first indicated which parts of the country should be regarded as radon Affected Areas in 1990. A more detailed mapping method was developed by the HPA in conjunction with the British Geological Survey in 2007[3]. The level of protection needed is site-specific and can be determined by reference to this mapping on the Public Health England website, which indicates 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. There are 6 'bands': <1%; 1 to 3%; 3 to 5%; 5 to 10%; 10 to 30%; and >30%.

The NRPB advised that action should be taken to reduce radon concentrations in existing homes if the radon concentration exceeded the Action Level of 200 Bqm^{-3} in room air averaged over a year; ten times the average UK domestic radon concentration. NRPB advice informed changes in the requirements for radon protection in new buildings.

- Basic preventive measures are required in new buildings, extensions, conversions and refurbishments if the probability of exceeding the Action Level is >3% in England and Wales, and >1% in Scotland and Northern Ireland.
- Provision for further preventive (Full) measures is required in new buildings if the probability of exceeding the Action Level is >10%.

At present Building Regulations Approved Document C advocates basic measures for the probability banding 3% to 10%, and full measures if >10%. However, Public Health England would like to see all new build include basic measures.

Action and Target Levels should also be applied to non-domestic buildings with public occupancy exceeding 2,000 hours per year and to all schools.

Hydrogeology

Lithos obtain information from the Environment Agency (EA), and Landmark or Groundsure 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 types 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 superficial 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 superficial deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into three 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 - In most cases, this is because the rock type in question has previously been designated as both a minor and non-aquifer in different locations due to the variable characteristics.

[1] BRE Report BR211, 2015: "Radon: guidance on protective measures for new buildings.

[2] Limitation of Human Exposure to Radon, Documents of the Health Protection Agency - Radiation, Chemical and Environmental Hazards, RCE-15. July 2010.

[3] Miles JCH, Appleton JD, Rees DM, Green BMR, Adlam KAM and Myers AH (2007). Indicative Atlas of Radon in England and Wales. Chilton, HPA-RPD-033.

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

The EA maps only display the principal and secondary aquifers as coloured areas. All uncoloured areas on the 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 superficial deposits are present; to do this, it is necessary to consult the published geological survey maps.

For the purposes of the EA's 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 superficial overlies principal bedrock, an overall designation of principal is assumed)

The EA have also designated groundwater 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 Landmark or Groundsure with respect to:

- Surface water quality
- Recorded pollution incidents
- Licensed abstractions (groundwater & surface waters)
- Licensed discharge consents
- Site susceptibility to flooding

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 6 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 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 (Flood Zone 3) 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 (Flood Zone 2) 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. Where there is no blue shading (Flood Zone 1), there is less than a 0.1% (1 in 1000) chance of flooding occurring each year.

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, 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 who can advise on appropriate mitigating measures; i.e. raising slab levels, provision of storage etc. 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, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and any new development in Flood Zones 2 and 3.

COMAH & explosive sites

Lithos obtain information from Landmark or Groundsure with respect to Control of Major Accident Hazards (COMAH) or explosive sites within 1km of the proposed development site. Lithos' 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 site 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 receptors.

Potential pollutant linkages are shown on a preliminary conceptual site model (pCSM). A CSM is essentially a cross-section through a site that reflects both the surface topography and underlying geology, and shows surface features of interest. The most significant sources of contamination are then superimposed onto this cross-section together with potential receptors (human health & controlled waters), and plausible pathways between the two. In addition to environmental issues, the CSM should also highlight geotechnical issues.

A pCSM is prepared after consideration of all available "desk study" data, and before design of the ground investigation. Data reviewed should include historical plans (with superimposition on a current-day plan), previous SI reports, geological maps etc. The pCSM, in conjunction with knowledge of site constraints (buildings, services, slopes etc) is used to design the ground investigation.

The revised CSM takes account of data obtained during the ground investigation, including the distribution of made ground, the nature and distribution of contamination etc.

02 - Ground investigation fieldwork
Generic notes – geoenvironmental investigations

General

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

- BS5930:2015 "Code of practice for site investigation"
- Eurocode 7: BS EN 1997-1:2004. Geotechnical design - Part 1: General rules
- Eurocode 7: BS EN 1997-2:2007. Geotechnical design - Part 2: Ground investigation and testing
- BS10175:2013 "Code of practice for the identification of potentially contaminated sites"
- "Technical Aspects of Site Investigation" – EA R&D Technical Report P5-065/TR (2000)
- "Development of appropriate soil sampling strategies for land contamination" – EA R&D Technical Report P5-066/TR (2001)
- 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 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: 2015 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 (dynamic sampling). 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 tri-cone rock roller or polycrystalline diamond compact (PDC) 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

Relative densities of granular materials given on the trial pit 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 (hand vane readings) reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

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

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

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

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

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

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

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.

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 4ºC, until delivery to the selected laboratory.

Anticipated testing	Container(s)
Asbestos identification	500ml plastic tub
pH & metals, and non-volatile organics	500ml glass jar
Speciated TPH	500ml & 50ml glass jars
VOCs (incl. naphthalene and \or GRO)	50ml glass jar

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 a Lithos investigation are described (logged) in general accordance with BS 5930:2015. 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 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

Where soft, cohesive soils are encountered, one-dimensional consolidation tests are scheduled in order to assess settlement characteristics, and unconsolidated undrained triaxial compression tests to assess shear strength.

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

- Grading
- Compaction tests
- Particle density

Test results are presented as received in an Appendix to the Geoenvironmental Report.

Atterberg limits & moisture content

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

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

I'p = Ip * (%< 425µm/100)

i.e. 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 adopts a conservative approach and recommends 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 (DS class) and
- The aggressive chemical environment for concrete (ACEC class)

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

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

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

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

Oedometer (Consolidation) tests

Oedometer tests measure a soil's consolidation properties, and are performed by applying different loads to a soil sample and measuring the deformation response. Typically the sample is subject to 5 incremental pressures (4 loading & 1 unloading), and the convention is for each subsequent pressure to be double the previous pressure. BS1377 suggests the initial pressure should be:

a) For stiff soils the effective overburden pressure*
b) For firm soils "somewhat less" than the effective overburden pressure
c) For soft soils "appreciably less" than the effective overburden pressure, usually 25 kPa or less
d) For very soft soils very low, typically 5 kPa or 10 kPa

* Effective overburden pressure (kNm^{-2}) = depth (m) x soil bulk unit weight (kNm^{-3})

Results from these tests are used to predict how a soil in the field will deform in response to a change in effective stress.

Triaxial tests

This test measures the mechanical properties of a soil by placing the sample between two parallel platens which apply stress in one (usually vertical) direction, with fluid used to apply a confining pressure in the perpendicular directions. During the test, the surrounding fluid is pressurized, and then stress on the platens is increased until the material in the cylinder fails.

From triaxial test data, it is possible to extract fundamental material parameters, including its angle of shearing resistance, apparent cohesion, and dilatancy angle. These parameters are then used in computer models to predict how the material will behave in a larger-scale engineering application.

Quick (single stage, Unconsolidated, Undrained tests) are most appropriate for foundation design. This is because load is applied relatively quickly, and shear strength of the clay will be lowest initially; after the applied load causes some consolidation of the ground (after drainage results in dissipation of short-term excess pore water pressure), the in-situ clays will become progressively stronger and hence the factor of safety will increase. Confining pressure is specified as equivalent to overburden pressure (kNm^{-2}).

Foundations on granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Unconsolidated Undrained triaxial tests are most appropriate for assessment of the stability of fill slopes on clays. Similar to foundations, the application of load gradually increases the strength of the clays and hence the critical case is the short term undrained condition.

Consolidated Undrained (or sometimes Consolidated Drained) triaxial tests are most appropriate for assessment of the stability of cut slopes in clays. This is because unloading of the ground leads to short term reduction in pore pressures that approximately balance the unloading, hence the soil strength is largely unchanged. Over time the reduced pore pressures suck water in, which leads in to the progressive increase in pore pressure and loss of strength. The fully drained state is critical, which must be modelled using effective strength parameters and a reasonable estimate of the long term water table conditions.

Slopes formed in granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

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 (SO_4), 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 is a mixture of hydrocarbons produced from the distillation of crude oil, and includes aliphatics (alkanes, alkenes and cycloalkanes), aromatics (benzene and derivatives) 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 C_6 to C_{10}). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C_{10} to C_{28})
- LRO - Lubricating Oil Range Organics (typically C_{28} to C_{40})
- MRO – Mineral Oil Range Organics (typically C_{18} to C_{44})

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 C_5-C_{40}, whereas others define TPH as C_{10}-C_{30}.

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 C_4 to C_5 range) that are volatile. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polycyclic aromatic 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).

Volatile Organic Compounds (VOCs) are organic chemicals, and most are liquids that readily evaporate on exposure to air. Examples include benzene, toluene, xylene, chloroform etc. Semi-Volatile Organic Compounds (sVOCs) include phenol and benzo(a)pyrene, and have relatively low boiling points. 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 (-OH) 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 an analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C_{10} to C_{40} (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a broad, 'banded' breakdown of the TPH results into gasoline range organics (GRO), diesel range organics (DRO) and heavier lubricating oil range organics (LRO), or fully speciated results with the reporting of hydrocarbon concentrations in 14 specific carbon bandings based upon behavioural characteristics, e.g. aliphatic C_6 to C_8, aromatic C_{10} to C_{12} etc.

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.

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 (1) and (2). Risk can only exist where all three elements combine to create a pollutant linkage. Risk assessment requires the formulation of a conceptual model which supports the identification and assessment of pollutant linkages.

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

Soil screening values used by Lithos

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

- Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software Handbook (Version 1.071), 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). 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

E – Importation of soil cover

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

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

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 (C4SLs) 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 C4SLs 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 C4SLs 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 five Scenarios A to E are presented below:

Inorganic contaminant	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
As	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	37	C4SL adopted
Cd	10	26	26		149	410	26	C4SL adopted
Cr			3,000		3,000	30,000	3,000	Assumes Cr is CrIII
Pb	450	200	200		310	2,330	200	C4SL adopted
Ni	130		127		127	1,700	127	Assessment of health risk only
Se	350		350		595	13,000	434	
Hg	170		169		238	3,640	199	Assumes in an inorganic compound
B			5		5	5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu			80-200		80-200	80-200	80-200	
Zn			200		200	200	200	

With respect to organic determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
Benzene	0.33	0.87	0.9	0.9	3.3	98	N/A	C4SL adopted
Toluene	610		600	3,000	2,700	5,000	N/A	Calculated value over 10,000
Ethyl Benzene	350		350	932	843	5,000	N/A	
Xylenes	240		246	327	321	5,000	N/A	
Phenol	420		412	2,400	519	5,000	N/A	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo(a)pyrene		5	5	25	5.3	76	5	C4SL adopted. Where source is not a coal tar
Naphthalene			8	9	9	1,000	12	
Gasoline Range Organics			30	34	34	5,000	45	See 3-step assessment of TPH below
Diesel Range Organics			151	156	154	5,000	219	
Lubricating Range Org			1,000	5,000	2,000	5,000	1,000	

* *For a residential end use*

The significance of PAHs can be determined by considering indicator compounds. In most cases benzo(a)pyrene (BaP) is adopted as an indicator due to the amount of toxicological data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. A surrogate marker approach can be used to estimate the toxicity of a mixture of PAHs in soil using toxicity data for individual indicator compounds within that mixture. Exposure to the surrogate marker is assumed to represent exposure to all PAHs in that matrix. The surrogate marker approach relies on a number of assumptions:

- Surrogate marker (bap) must be present in all soil samples
- Profile of the different pah relative to bap should be similar in all samples
- PAH profile in the soil samples should be similar to that used in the pivotal toxicity study[1]

[1] SP1010 Appendix E, Provisional C4SIs for benzo(a)pyrene as a surrogate marker for PAHs, CL:AIRE 2013

To assess the PAH profile in a soil sample, the ratio of the seven genotoxic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene), relative to BaP, should be calculated. The ratio relative to BaP should lie within an order of magnitude above and below the mean ratio to BaP.

Naphthalene should also be considered separately against its generic screen. Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than most other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach.

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 representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the 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	0.9	0.9	3.3	98
Toluene	600	3,000	2,700	5,000
Ethyl Benzene	350	932	843	5,000
Xylenes	246	327	321	5,000
Naphthalene	8	9	9	1,000
Benzo(a)pyrene	5	25	5.3	76

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	42	5,000^ per fraction
Aliphatic 6-8	GRO	125	125	125	
Aliphatic 8-10	GRO	31	31	32	
Aliphatic 10-12	DRO	151	156	154	
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	100	123	122	
Aromatic 7-8	GRO	30	34	34	
Aromatic 8-10	GRO	47	50	50	
Aromatic 10-12	DRO	215	287	266	
Aromatic 12-16	DRO	689	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

$$HI = \sum_{F_i=1}^{16} HQ\ F_i = \frac{Measured\ concentration\ F_i\ (mg\,kg^{-1})}{SGV\ F_i\ (mg\,kg^{-1})}$$

where HI = Hazard Index
HQ = Hazard Quotient
F_i = Fraction $_i$
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 (2007) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2015 – Code of Practice for the characterisation & remediation from ground gas in affected developments

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

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

With respect to the interpretation of the calorific values, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that: "*In general … it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn*".

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	EA Advice
Arsenic	50	10	50	
Selenium	10	10		
Cadmium	5	5	1.5	
Chromium	50	50	32	
Copper	50	2,000	28	
Lead	50	10	7.2	
Nickel		20	20	
Zinc	3,000		125	
Boron		1,000		
Mercury	1	1	0.07	
Petroleum Hydrocarbons				10
1,1,1-Trichloroethane			100	
1,1 Dichloroethane				100
1,2-Dichloroethane		3	10	
1,1-Dichloroethene				100
Benzene		1	10	
Ethylbenzene				10
Tetrachloroethene		10	10	
Toluene			50	
Trichloroethene		10	10	
Vinyl Chloride		0.5		
Trichloromethane			2.5	
Xylenes			30	
Chloroethane				100

Waste classification & WAC

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

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

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

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

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

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

Possible action in event of Tier 1 exceedance

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

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

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

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

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

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

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

Background

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

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

BRE Digest 365, DG365: 1991 describes design and construction procedures, explains how to calculate rainfall design values and soil infiltration rates, and gives design examples. Further advice is provided in NHBC Standards Chapter 5.3 (Section 9 & Appendix F), Building Regulations Section 3 of Approved Document H (Drainage & Waste Disposal), and Chapter 13 of CIRIA's SUDS Manual (C753:2015).

Soakaways should generally be built on land lower than or sloping away from buildings and be sited at least 5m from the foundations of a building.

BRE365 states that 'Groundwater should not rise to the level of the base of the soakaway during annual variations in the water table' this is further reinforced in Chapter 13 of CIRIA C753:2015 which states that: "*A minimum distance of 1m between the base of the infiltration system and the maximum likely groundwater level should always be adopted. This is to minimise the risk of groundwater rising into the infiltration component and reducing the available storage volume, to protect the functionality of the infiltration process by ensuring a sufficient depth of unsaturated material and to protect the groundwater from any contamination in the run-off*". There may be a requirement to install groundwater monitoring wells at a site in order to monitor seasonal variations in groundwater level at least over a wet winter period.

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

Made ground (and ground within 5m of deep fill) is not generally regarded as suitable for soakaways, due to the potential for inundation settlement and the leaching of contaminants.

Chalk: CIRIA C574:2002 notes that concentrated ingress of water into the chalk can initiate dissolution, particularly in low-density chalk. For this reason, soakaways should be sited well away from foundations for structures, roads or railways:-

- in areas where dissolution features are known to be prevalent, soakaways should be avoided but, if unavoidable, should be sited at least 20m away from foundations etc
- where the chalk is of low density (weak), or where density is not known, soakaways should be sited at least 10m away from foundations
- where the chalk is of medium density, or higher (moderately weak), soakaways should be sited at least 5m away from foundations

Test methodology

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

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

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

Infiltration rates

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

Soakaway design

Soakaway design should be carried out by a suitably qualified and experienced Drainage Engineer, in accordance with BRE Digest 365 using the infiltration rates calculated from soakaway testing during a ground investigation.

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

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

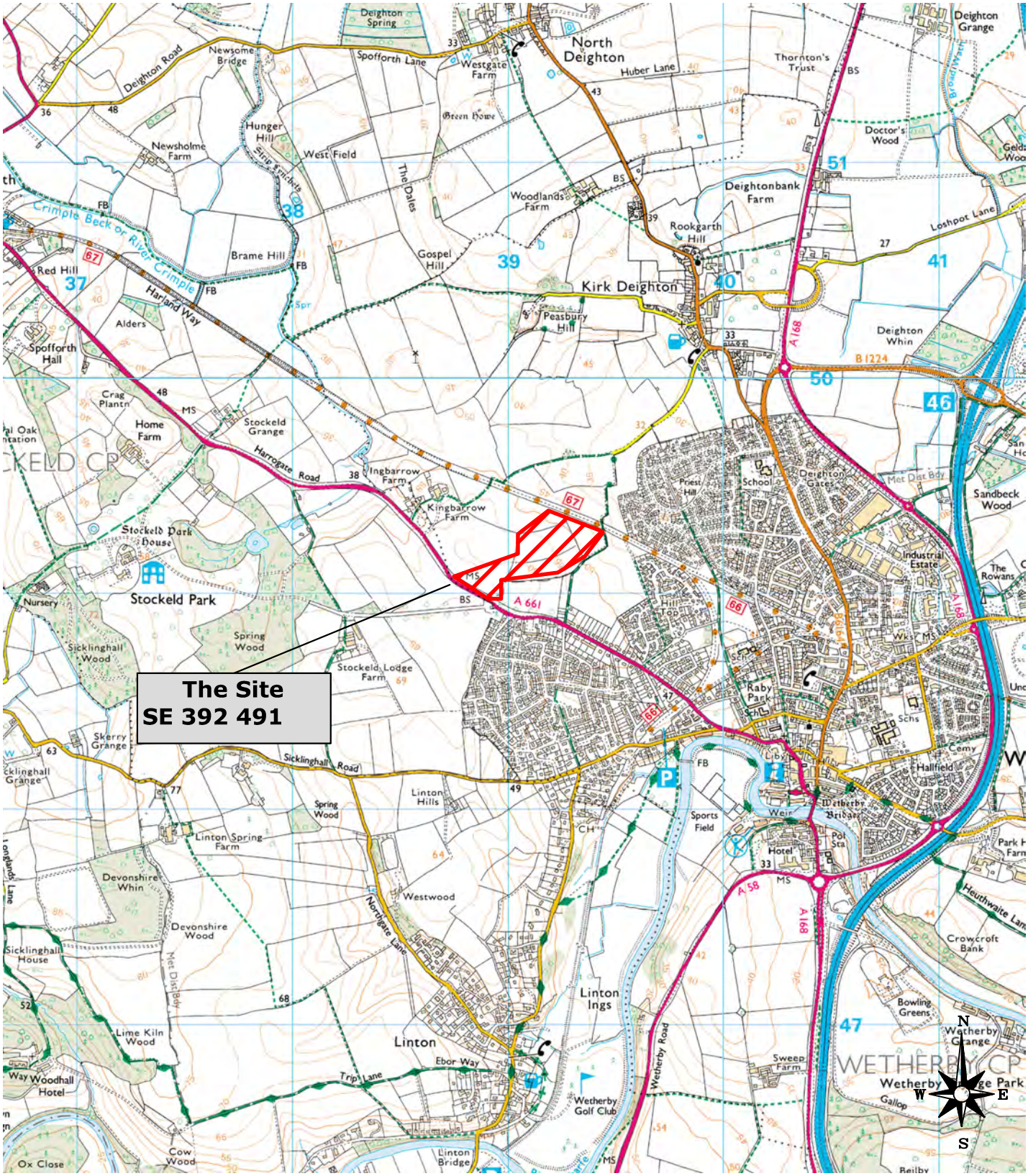
Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

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

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

Appendix B

Drawings



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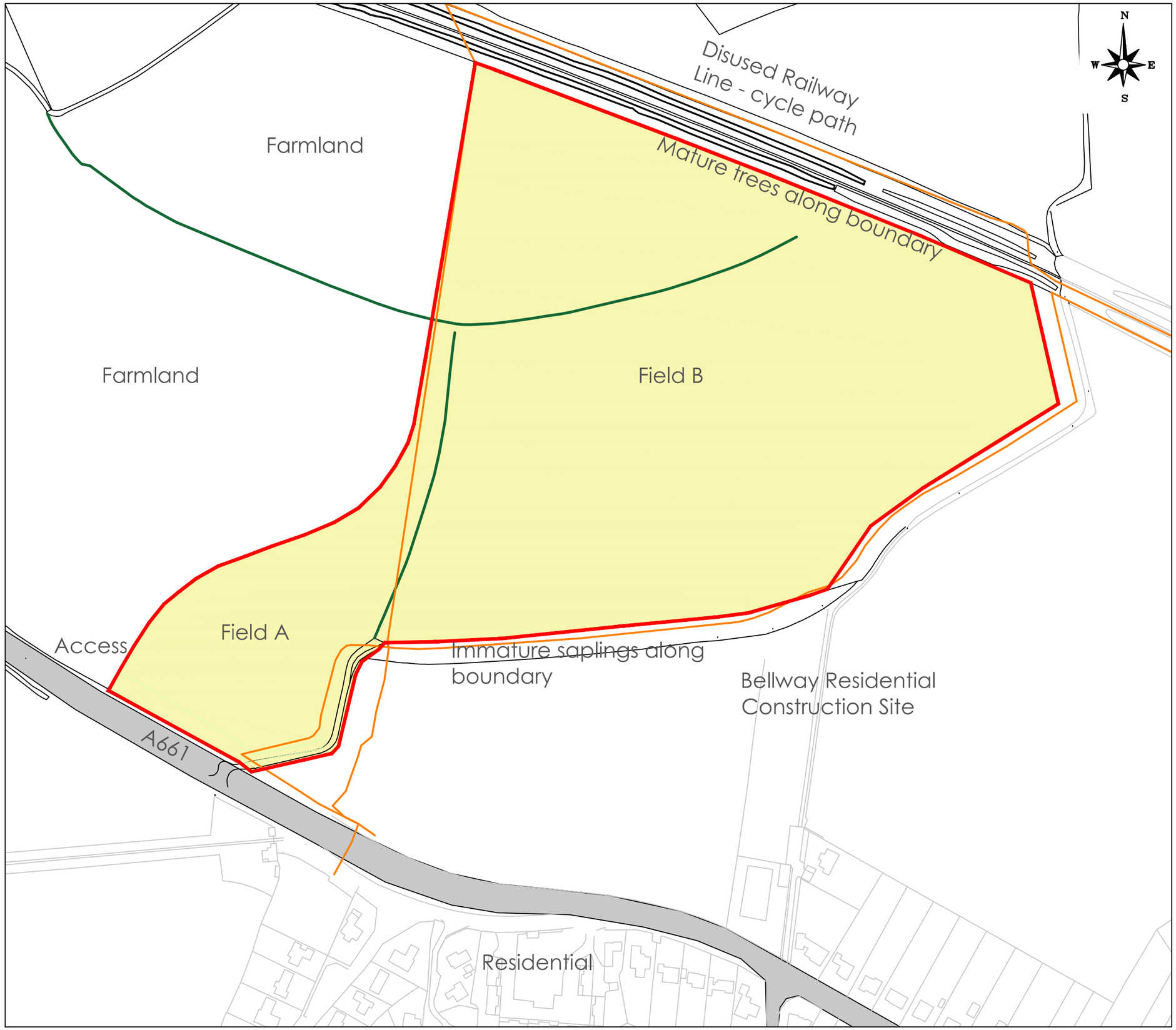
CLIENT	HALLAM LAND MANAGEMENT LIMITED
JOB TITLE	SPOFFORTH HILL, WETHERBY
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	FQ
DATE	01/10/2018
CHECKED	MJT
DATE	01/10/2018
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
SCALE	1:25,000
SHEET	A4
DRAWING NO.	2638/1
REVISION	



NOTES

PLOUGHED / CROPPED ARABLE FIELDS

HEDGEROW

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

HALLAM LAND MANAGEMENT LIMITED

JOB TITLE

SPOFFORTH HILL, WETHERBY

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
JEJ	01/10/2018	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	01/10/2018	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:2500	A3	2638/3	

NOTES

PLOUGHED / CROPPED ARABLE FIELDS

HEDGEROW

APPROXIMATE SITE BOUNDARY

LOCATION & ORIENTATION OF PHOTOGRAPH

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

HALLAM LAND MANAGEMENT LIMITED

JOB TITLE

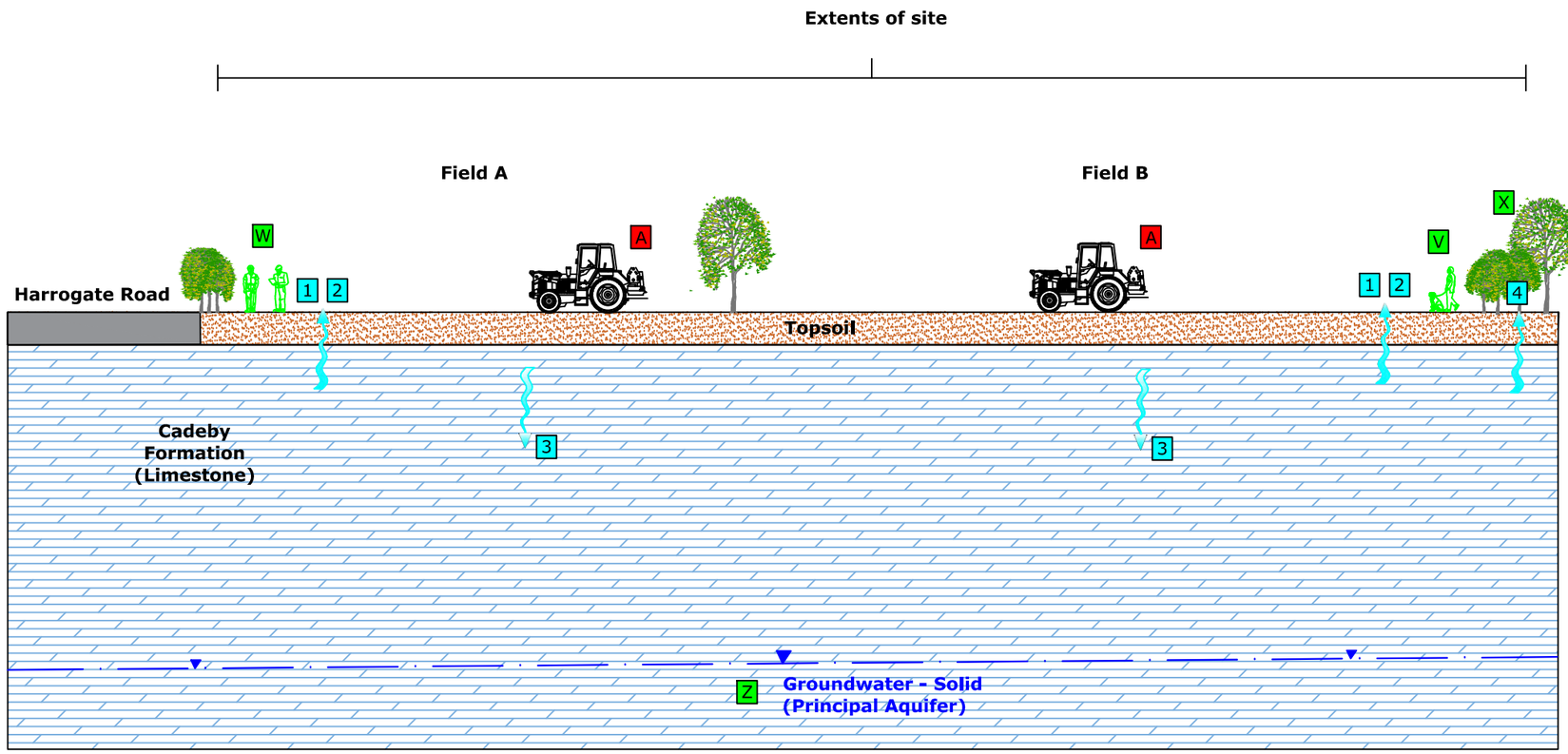
SPOFFORTH HILL, WETHERBY

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
FQ	13/02/17	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	16/02/17	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
NOT TO SCALE	A3	2638/4	



SOURCES	PATHWAYS	RECEPTORS
A LAND SPREADING	1 DERMAL CONTACT	V END USERS (RESIDENTS)
	2 INGESTION/INHALATION	W SITE WORKERS
	3 LEACHING OF CONTAMINANTS	X VEGETATION
	4 UPTAKE BY PLANTS	Z GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

HALLAM LAND MANAGEMENT LIMITED

JOB TITLE

SPOFFORTH HILL, WETHERBY

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
JEJ	13/02/17	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	16/02/17	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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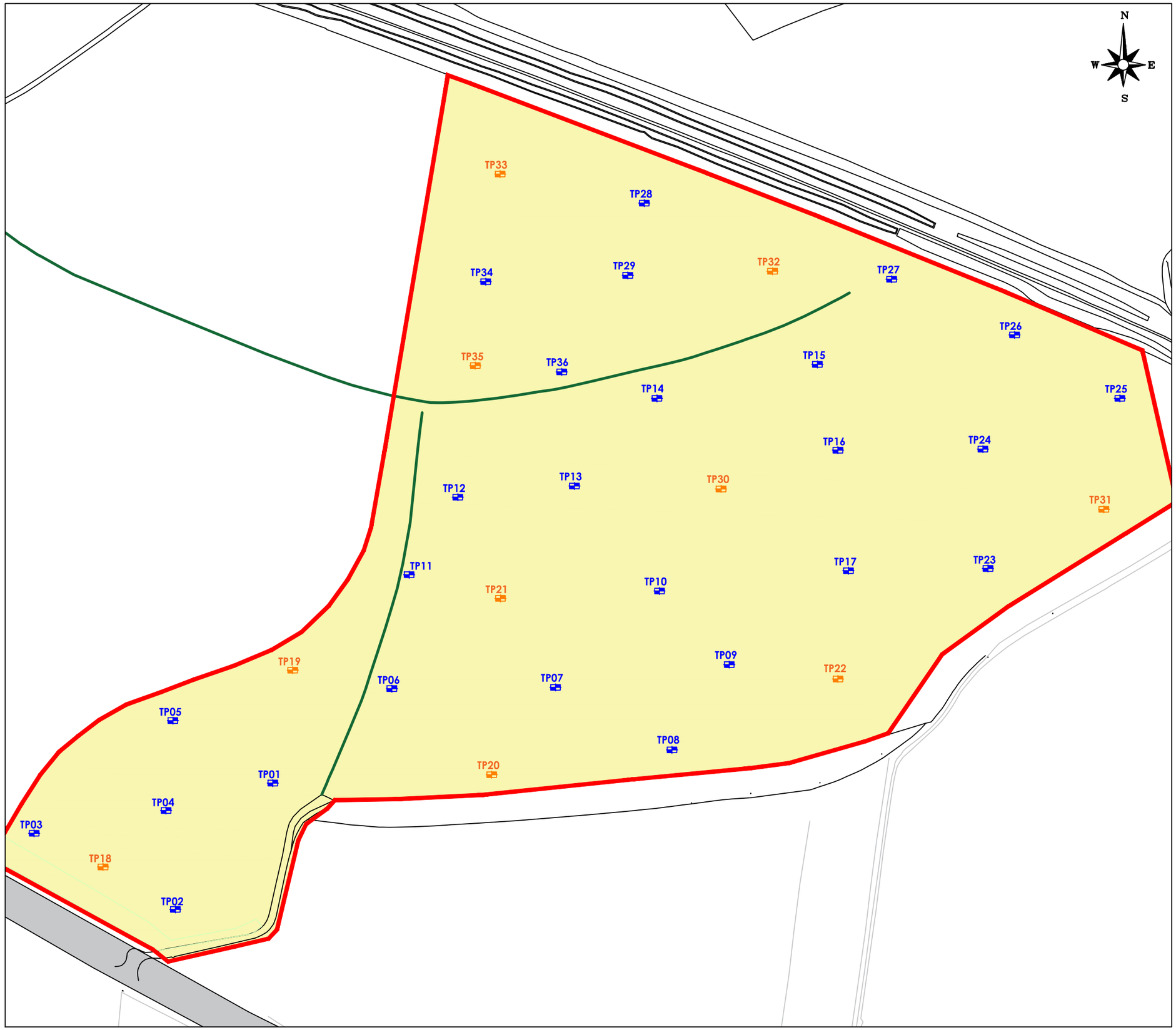

NOTES

TRIAL PIT LOCATION

SOAKAWAY PIT LOCATION

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

HALLAM LAND MANAGEMENT LIMITED

JOB TITLE

SPOFFORTH HILL, WETHERBY

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
JEJ	16 11 18	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	16 11 18	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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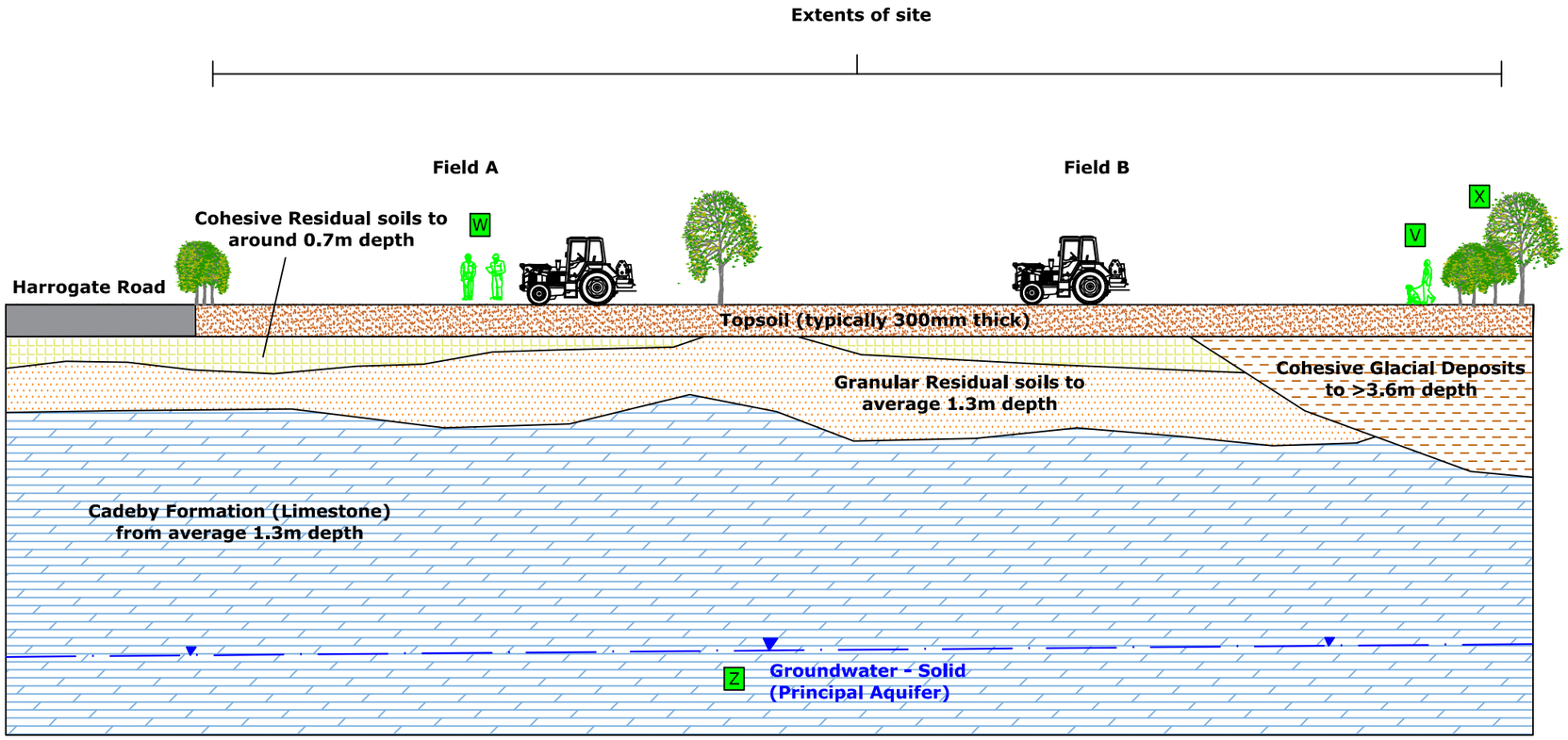


SOURCES	PATHWAYS	RECEPTORS
NO SOURCES IDENITIFIED	NO PLAUSIBLE LINKAGES	V END USERS (RESIDENTS) W SITE WORKERS X VEGETATION Z GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

HALLAM LAND MANAGEMENT LIMITED

JOB TITLE

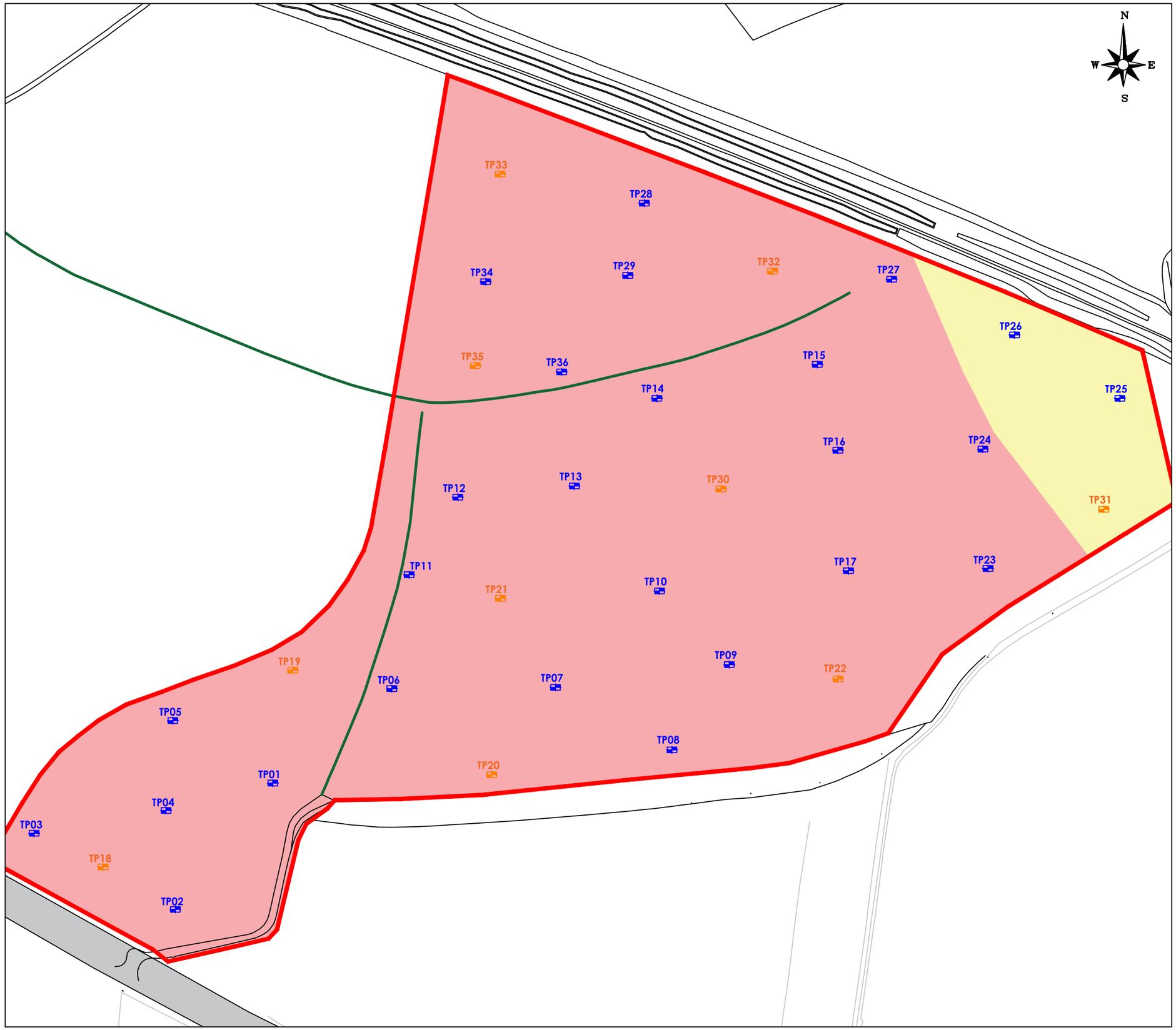
SPOFFORTH HILL, WETHERBY

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
JEJ	05 12 18	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	05 12 18	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2638/7	



NOTES

- TRIAL PIT LOCATION
- SOAKAWAY PIT LOCATION
- APPROXIMATE SITE BOUNDARY
- AREA 1 - RESIDUAL SOILS (GRANULAR & COHESIVE)
- AREA 2 - COHESIVE GLACIAL DEPOSITS

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

HALLAM LAND MANAGEMENT LIMITED

JOB TITLE

SPOFFORTH HILL, WETHERBY

DRAWING TITLE

SITE AREAS

DRAWN	DATE	STATUS
JEJ	03 12 18	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	03 12 18	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:2000	A3	2638/8	

Appendix C

Commission

008/2638/REG

31st July 2018

Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330

www.lithos.co.uk

Ms R Wasse
Hallam Land Management Limited
Park House
Park Square West
Leeds
LS1 2PW

Dear Rebecca

Spofforth Hill, Wetherby

Further to your recent invitation, please find attached our proposal for undertaking a site investigation on the above land. We understand that proposed development will include traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; although no layout is available yet.

Review of our earlier desk study report indicates that the site:

- consists of a single parcel of arable farmland of approximately 13 hectares.
- has remained undeveloped throughout its history;
- is not located within 250m of a known landfill site;
- is not within a groundwater source protection zone;
- is directly underlain by Cadeby Formation (limestone bedrock);
- is located beyond the Coal Authority's defined coalfields.

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, CLR11 etc). Our Report may not be 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. Our ground appraisal is intended to assist others as they proceed with design of the proposed development.

This proposal allows for the following works:

Fieldwork: We have allowed for 3 day's trial pitting using a tracked 360º excavator, with all pits to be supervised and logged by an experienced geoenvironmental engineer.

Based on anticipated ground, soakaways might provide a satisfactory solution for surface water drainage, and testing will also be carried out in at least 10 pits. Given the size of the site, if the initial soakaway tests yield satisfactory results, further soakaway tests to provide a tighter grid will be required; allow £****.

In line with current UK guidance, (most notably BRE365 and CIRIA C697:2007) soakaways should not be advocated where the seasonally high groundwater table lies within 1m of the soakaway base. Consequently, if the initial soakaway tests yield satisfactory results, it will be necessary to install groundwater monitoring wells to depths of around 5m in at least 5 boreholes.

Given the anticipated depth to bedrock, these boreholes will almost certainly need to be advanced by rotary probing. The wells should then be monitored on at least 6 occasions over about a year. At this stage, it would be prudent to allow £**** (drilling, well installation & monitoring).

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.

The mechanical excavator will be equipped with a breaker to enable excavation where necessary in bedrock (for soakaway tests).

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 site is greenfield and therefore highly unlikely to be underlain by significant thicknesses of made ground. Furthermore, we are not aware of any other sources of hazardous gas (shallow mine workings, landfill sites etc) within influencing distance of the site. Consequently, at this stage, we have not allowed for undertaking a hazardous gas risk assessment.

Testing: This will comprise routine geotechnical soils analysis, including 12 moisture content & Atterberg limits, and 12 pH & water-soluble sulphate.

This site is greenfield and therefore we could obtain in-situ CBR values from plate tests on site. However, at this stage routes, formation level and total length, of proposed estate roads are unknown. Consequently, we will simply estimate CBR values from strata descriptions and classification test results.

The site is 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 (9 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH; 6 samples will also be analysed for visible contaminants, sharps and the clay/sand/silt content to check compliance with BS3882 requirements.

Within in our proposal we have allowed for the screening (ID) of 9 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 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 include consideration of foundation types.

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 3 working days and therefore it is not considered reasonably practicable to provide formal welfare facilities, and our proposal makes no allowance for so doing.

Utility plans are required in order to protect operatives from the hazards associated with striking buried services and avoid potentially substantial disruption\repair costs. We will make every effort not to damage any services (including review of utility plans and use of a CAT detector). However, Lithos cannot accept liability for damage to any underground services that are not accurately marked on plans made available to us prior to commencement of our field investigation, or have not been accurately marked on the ground by a responsible third party (e.g. utility company, site owner).

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.

Under the CDM Regulations 2015, Lithos must be provided with pre-construction information already in your possession, or information that can reasonably be obtained through sensible enquiry. This information must be relevant to the project, have an appropriate level of detail, and be proportionate to the nature of the risks.

Terms & conditions: This work will be undertaken in accordance with our Standard Terms and Conditions, a copy of which are enclosed.

At the time of writing, we understand that our report is solely for Hallam's benefit. However, it is anticipated that eventually a third party (the Developer) will wish to rely on our report. We confirm that we will assign, free of charge, the benefit of our Report(s) to the Developer on receipt of an instruction from Hallam.

In the event that both Hallam and the Developer require reliance, or if more than one Developer requires reliance, a warranty will be required. We confirm that we will consent to a request from Hallam to enter a collateral warranty, provided it is our approved standard form, and subject to payment of a fee to cover our legal and incidental costs. We will require approval from our insurers if more than one beneficiary requires a warranty, or if the proposed warranty is not Lithos' approved standard form.

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

1 DEFINITIONS AND INTERPRETATION

1.1 In this Agreement, unless the context otherwise requires, the following words and expressions have the following meanings:

"Agreement" shall mean these Terms (entitled "Terms and Conditions for the Appointment of Lithos Consulting"), the Proposal, any document recording the Client's unequivocal acceptance of the Proposal and any other documents or parts of other documents expressly referred to in any of the foregoing:

"Client" shall mean the party for whom the Services are being provided by Lithos;

"Documents" shall mean all documents of any kind and includes plans, drawings, reports, programmes, specifications, Bills of Quantities, calculations, letters, e-mails, faxes, memoranda, films and photographs (including negatives), or any other form of record prepared or provided or received by, or on behalf of Lithos, and whether in paper form or stored electronically or on disk, or otherwise;

"Lithos" shall mean Lithos Consulting Limited whose registered office is at Parkhill, Walton Road, Wetherby, West Yorkshire, LS22 5DZ.

"Intellectual Property" includes all rights to, and any interests in, any patents, designs, trade marks, copyright, know-how, trade secrets and any other proprietary rights or forms of intellectual property (protectable by registration or not) in respect of any technology, concept, idea, data, programme or other software (including source and object codes), specification, plan, drawing, schedule, minutes, correspondence, scheme, programme, design, system, process logo, mark, style, or other matter or thing, existing or conceived, used, developed or produced by any person;

"Parties" shall mean the Client and Lithos

"Project" shall mean the project described in the Proposal and any enquiry from the Client on which Lithos has based its Proposal;

"Proposal" means the offer document prepared by Lithos in response to an enquiry or otherwise, in connection with the proposed provision of the Services;

"Services" means the work and services relating to the Project to be provided by Lithos pursuant to the Agreement and as set out in the Proposal and shall include any additions or amendments thereto made in accordance with these Terms;

"Terms" means these terms entitled "Lithos Consulting Terms of Appointment".

1.2 Words importing the singular only shall also include the plural and vice versa, where the context requires.

1.3 Words importing persons or parties shall include firms, corporations and any organisation having legal capacity and vice versa, where the context requires; and words importing a particular gender include all genders.

1.4 The sub-headings to the clauses of these Terms are for convenience only and shall not affect the construction of the Agreement.

1.5 A reference to legislation includes that legislation as from time to time amended, re-enacted or substituted and any Orders in Council, orders, rules, regulations, schemes, warrants, by-laws, directives or codes of practice issued under any such legislation.

1.6 In the event of conflict between the documents forming part of the Agreement, the Proposal shall prevail, followed by the Terms.

2 APPOINTMENT

2.1 The Client agrees to engage Lithos and Lithos agrees to provide the Services in accordance with the provisions of the Agreement.

3 OBLIGATIONS OF LITHOS

3.1 Lithos shall perform the Services using the reasonable standard of skill and care normally exercised by similar professional Environmental firms in performing similar services under similar conditions.

3.2 Lithos shall use all reasonable endeavours to perform the Services in accordance with all relevant environmental and safety legislation.

4 OBLIGATIONS OF THE CLIENT

4.1 Throughout the period of this Agreement the Client shall afford to Lithos or procure the affording to Lithos of access to any site where access is required for the performance of the Services.

4.2 The Client accepts responsibility for ensuring that Lithos is notified in writing of all special site and/or plant conditions, including without prejudice to the generality of the foregoing, the existence and precise location of all underground services, cables, pipes, drains or underground buildings, constructions or any hazards known or suspected by the Client, which the Client shall clearly mark on the ground or identify on accurate location plans supplied to Lithos prior to the commencement of the Services. The Client shall also inform Lithos in writing of any relevant operating procedures including any site safe operating procedures and any other regulations relevant to the carrying out of the Services. The Client shall indemnify Lithos against all costs, claims, demands and expenses arising as a result of any non-disclosure in this respect, including but not limited to indemnification against any action brought by the owner of the land or otherwise.

4.3 If the Client discovers any conflict, defect or other fault in the information or designs provided by Lithos pursuant to the Agreement, he will advise Lithos in writing of such defect, conflict or other fault and Lithos shall have the right to rectify the same or where necessary, to design the solution for rectification of any works carried out by others pursuant the conflicting, defective or in any other way faulty information or designs.

5 INTELLECTUAL PROPERTY

5.1 The copyright in all Intellectual Property prepared by or on behalf of Lithos in connection with the Project for delivery to the Client shall remain vested in Lithos.

5.2 The Client shall have a non-exclusive licence to copy and use such Intellectual Property for purposes directly related to the Project. Such licence shall enable the Client to copy and use the Intellectual Property but solely for its own purposes in connection with the Project and such use shall not include any licence to reproduce any conceptual designs or professional opinions contained therein nor shall it include any license to amend any drawing, design or other Intellectual Property produced by Lithos.

5.3 Should the Client wish to use such Intellectual Property in connection with any other works or for any other purpose not directly related to the Project or wish to pass any Intellectual Property to any third party, it must obtain the prior written consent of Lithos. The giving of such consent shall be at the discretion of Lithos and shall be upon such terms as may be required by Lithos. Lithos shall not be liable for the use by any person of such Intellectual Property for any purpose other than that for which the same were prepared by or on behalf of Lithos.

5.4 Ownership of any proposals submitted to the Client that are not subsequently confirmed as part of the Services to be provided for the Client remain with Lithos and such proposals must not be used as the basis for any future work undertaken by the Client or a third party and no liability can be accepted howsoever arising from such proposals.

5.5 In the event of the Client being in default of payment of any fees or other amounts due, Lithos may suspend further use of the licence on giving 2 days' notice of the intention to do so. Use of the licence may be resumed on receipt of the outstanding amounts.

6 TITLE

6.1 Lithos shall transfer only such title or rights in respect of the Documents as it has, and if any part is purchased from a third party Lithos shall transfer only such title or rights as that party had and has transferred to Lithos.

6.2 Title in the Documents shall remain with and shall not pass to the Client until the amount due under the invoice(s) (including interest and costs) has been paid in full.

6.3 Until title passes, the Client shall hold the Documents as bailee for Lithos and shall store or mark them so that they can at all times be identified as the property of Lithos.

6.4 At any time before title passes (save and except where payment is not due), but only after prior consultation with the Client, Lithos may without any liability to the Client repossess and use or sell all or any of part of the Documents and by doing so terminate the right of the Client to use, sell or otherwise deal in the Documents.

6.5 Lithos may maintain an action for the price of the Documents notwithstanding that title in them has not passed to the Client.

7 CONFIDENTIALITY AND DATA PROTECTION

7.1 Lithos undertakes not to divulge or disclose to any third party without the written consent of the Client information which is designated confidential by the Client or which can reasonably be considered to be confidential and arises during the performance of the Services unless required to do so by law or necessary in the proper performance of its duties in relation to the Project, or in order to make full frank and proper disclosure to its insurers or intended insurers, or to obtain legal or accounting advice.

7.2 Subject to the above and Lithos' Privacy Policy which can be found on www.lithos.co.uk, Lithos shall be permitted to use information related to the Services it provides in connection with the Project for the purposes of marketing its services and in proposals for work of a similar type.

8 THIRD PARTIES

8.1 The Agreement or any part thereof or any benefit or interest thereunder may not be assigned by the Client without the prior written consent of Lithos. The giving of such consent shall be at the discretion of Lithos and Lithos will only agree to an assignment on its terms and in return for payment of a fee by the Client to Lithos to cover Lithos' legal and other costs associated with any assignment.

8.2 The Agreement shall not confer and shall not purport to confer on any third party any benefit or any right to enforce any term of this Agreement for the purposes of the Contracts (Rights of Third Parties) Act 1999 or otherwise.

8.3 Lithos will consider and may consent to any request from the Client for Lithos to enter a collateral warranty with a third party with regard to the Services provided under the Agreement. The giving of such consent shall be at the discretion of Lithos and Lithos will only enter a collateral warranty on its terms and in return for payment of a fee by the Client to Lithos to cover Lithos' legal and other costs associated with any collateral warranty.

9 INSURANCE

9.1 Lithos warrants to the Client that there is in force a policy of Professional Indemnity insurance covering its liabilities for negligence under this Agreement, with a limit of indemnity of £5,000,000 (FIVE MILLION POUNDS) any one claim, save for pollution and contamination claims and asbestos claims both of which carry £2,000,000 (TWO MILLION) in the aggregate cover. This policy is annually renewable and whilst renewal is not automatic, Lithos agrees to use reasonable endeavours to maintain such insurance at all times until six years from the date of the completion (or termination) of the Services under the Agreement, provided such insurance is available at commercially reasonable rates having regard, inter alia, to premiums required and policy terms obtainable.

9.2 If for any period such insurance is not available at commercially reasonable rates, Lithos shall forthwith inform the Client and shall obtain in respect of such period such reduced level of Professional Indemnity insurance as is available and as would be fair and reasonable in the circumstances for Lithos to obtain.

10 LIMITATIONS ON LIABILITY

10.1 Unless otherwise agreed in writing, Lithos' liability under or in connection with the Agreement whether in contract, tort, negligence, breach of statutory duty or otherwise (other than in respect of personal injury or death) shall be limited to and shall not exceed the lesser of either five million pounds in the aggregate (unless it is a pollution, contamination or asbestos claim in which case it is two million pounds in the aggregate) or 10 times the total value of invoices issued to the Client for consultancy work instructed under the Agreement.

10.2 No action or proceedings under or in respect of the Agreement whether in contract, tort, negligence, under statute or otherwise shall be commenced against Lithos after the expiry of a period of six years from the date of the completion (or termination) of the Services under the Agreement.

10.3 Whilst Lithos will scan all potential exploratory locations with a Cable Avoidance Tool, Lithos shall not be liable for any damage to underground services, cables, pipes, drains or underground buildings, constructions and the like which were either not marked on site or for which accurate plans were not provided.

10.4 Lithos shall not be liable for the cost of rectifying any defect, conflict or other fault in the information or designs provided by Lithos or for the cost of designing a solution for and rectifying any subsequent works carried out by others pursuant to the conflicting, defective or in any other way faulty information or designs, unless Lithos has been advised in writing of the same by the Client and has been given the opportunity to rectify the same or where necessary, to design the solution for rectification of any subsequent works carried out by others pursuant to the same.

11 PAYMENT

11.1 Invoices for services rendered will be submitted for payment in accordance with the Proposal.

11.2 The due date for payment is the date of the invoice and the final date for payment is 28 days from the date of the invoice.

11.3 If the Client disputes the amount included for payment in an invoice a written notice must be served on Lithos by the Client not later than 14 days before the final date for payment. If no notice is given the amount due shall be the amount stated in the invoice.

11.4 In the event of failure on the part of the Client to pay any monies in accordance with the foregoing payment provisions, Lithos will be entitled to charge interest on any monies owed to it by the Client, such interest to be at a rate of 8% above the base rate of a clearing bank from time to time calculated from the final date for payment to the date of actual payment on a compound basis.

12 DELAY

12.1 Lithos will comply with any timescale agreed for completion of the Services unless delayed or prevented by circumstances beyond its reasonable control and in the event of any such circumstances arising Lithos undertakes to complete the Services within a reasonable period, but will not be liable to the Client for any delay as a result.

13 TERMINATION

13.1 The Agreement may be terminated by either party in the event of the other making a composition or arrangement with its creditors, becoming bankrupt, or being a company, making a proposal for a voluntary arrangement for a composition of debts, or has a provisional liquidator appointed, or has a winding-up order made, or passes a resolution for voluntary winding-up (except for the purposes of a bona fide scheme of amalgamation or reconstruction), or has an administrator or an administrative receiver appointed to the whole or any part of its assets. Notice of termination must be given to the party which is insolvent by the other party.

13.2 If for any reason the performance of the Services by Lithos is suspended for a period in excess of three calendar months then Lithos shall be entitled to terminate its appointment in respect of the Services by seven days written notice to the Client.

13.3 If the Client shall fail to pay in full any sum due under the terms of the Agreement by the final date for payment for that sum and no effective notice of intention to withhold payment has been issued, Lithos may serve written notice on the Client demanding payment within 14 days of such notice. If the Client shall fail to comply with such notice, Lithos shall be entitled to terminate its employment under the Agreement forthwith.

13.4 Any termination of the appointment of Lithos howsoever caused shall be without prejudice to the right of Lithos to require payment for all services performed up to the date of such termination including but not limited to payment of a fair and reasonable proportion of any figure identified in the Proposal or otherwise for fees in respect of a particular service which Lithos has started, but not completed.

14 NOTICES

14.1 Any notice provided for in the Agreement shall be in writing and shall be deemed to be properly given if delivered by hand or sent by first class post to the address of the relevant party as may have been notified by each party to the other or, in the absence of notification, to the address of Lithos set out above or to the registered address of the Client.

14.2 Such notice shall be deemed to have been received on the day of delivery if delivered by hand or on the second working day after the day of posting if sent by first class post.

15 ENTIRE AGREEMENT

15.1 The Agreement constitutes the complete and entire agreement between the Client and Lithos with respect to the Services and supersedes any prior oral and/or written warranties, terms, conditions, communications and representations, whether express or implied and any claim against Lithos in respect of the Services can only be made in contract under the provisions of the Agreement and not otherwise under the law or tort or otherwise.

15.2 No amendments, modifications or variation of the Agreement shall be valid unless made in writing and agreed to by both the Client and Lithos; such agreement must be recorded in writing by at least one of the Parties.

15.3 Lithos will not be bound by any standard or printed terms or conditions furnished by the Client in any of its documents unless Lithos specifically states in writing separately from such documents that it intends such terms and conditions to apply.

16 DISPUTES AND GOVERNING LAW

16.1 The Agreement shall be governed by and construed in accordance with English law and the Parties irrevocably and unconditionally submit to the jurisdiction of the English Courts.

16.2 Where the Housing Grants, Construction and Regeneration Act 1996 applies, any dispute between the Parties may be referred to adjudication in accordance with The Scheme for Construction Contracts Regulations 1998 or any amendment or modification thereof being in force at the time of the dispute, as applicable to England, Wales, Scotland and Northern Ireland.

From: Rebecca Wasse RWasse@hallamland.co.uk
To: Matt.thompson@lithos.co.uk; Reg@lithos.co.uk
Date: 12/11/2018
Time: 15:59

Dear Matt and Reg

Further to our discussions, Hallam Land Management would like to instruct you to carry out the Principal Designer and Principal Contractor roles under the CDM provisions, for the work that you are carrying out on site from 14 – 16 November, as outlined in your tender letter dated 31 July 2018.
You have

a. Acquired the necessary information to satisfy yourselves as to where the existing utilities are located;
b. I have previously confirmed to you where to gain access;
c. You have a copy of the Phase 1 Geotechnical Desk study that you previously carried out for Hallam Land Management.

You have confirmed that you are able to work as Principal Designer and Principal Contractor (roles defined under the CDM provisions), solely for the work that you are carrying out on site this week.

I look forward to receiving the report.

Kind regards

Rebecca

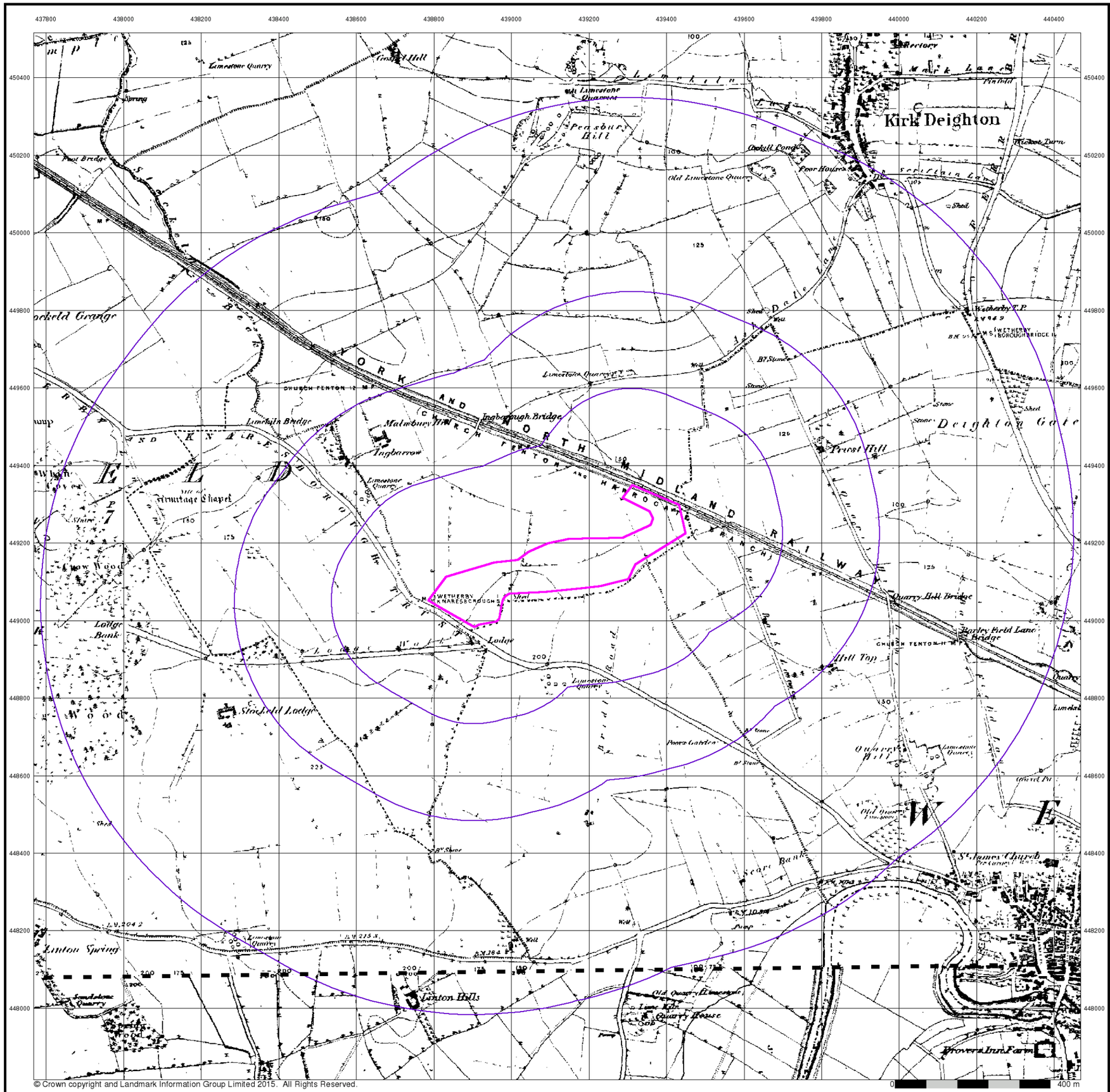
Rebecca Wasse | Director | Hallam Land Management Limited

Park House | Park Square West | Leeds | LS1 2PW

t: 0113 357 1195 | dd: 0113 357 1196 | m: 0780 955 1985

Appendix D

Historical OS Plans



0 400 m

LITHOS CONSULTING

Yorkshire

Published 1849 - 1850

Source map scale - 1:10,560

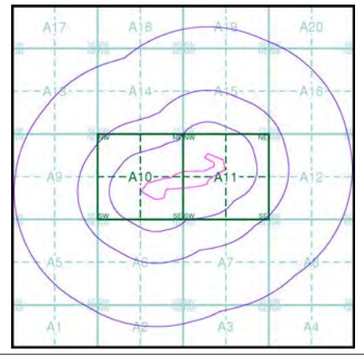
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some 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)

17200
1850
1:10,560

18900
1849
1:10,560

Historical Map - Slice A



Order Details

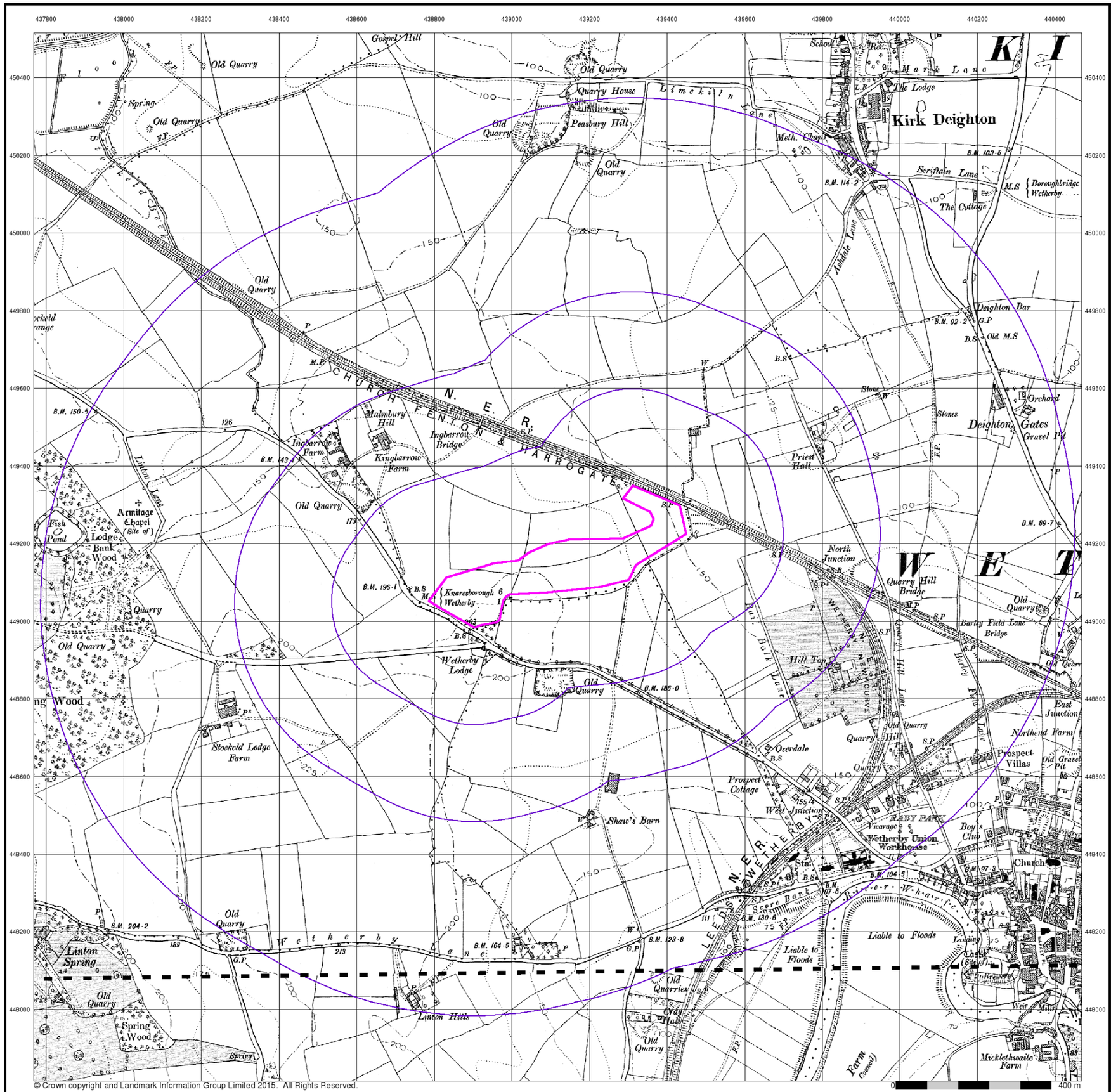
Order Number:	111719724_1_1
Customer Ref:	2638
National Grid Reference:	439130, 449160
Slice:	A
Site Area (Ha):	7.62
Search Buffer (m):	1000

Site Details

Spofforth Hill, WETHERBY, West Yorkshire, LS22 6SF

Landmark INFORMATION GROUP

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



LITHOS CONSULTING

Yorkshire

Published 1909 - 1910

Source map scale - 1:10,560

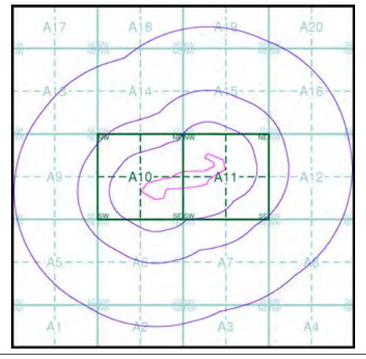
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some 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)

172SW
1910
1:10,560

189NW
1909
1:10,560

Historical Map - Slice A



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Order Details

Order Number:	111719724_1_1
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Slice:	A
Site Area (Ha):	7.62
Search Buffer (m):	1000

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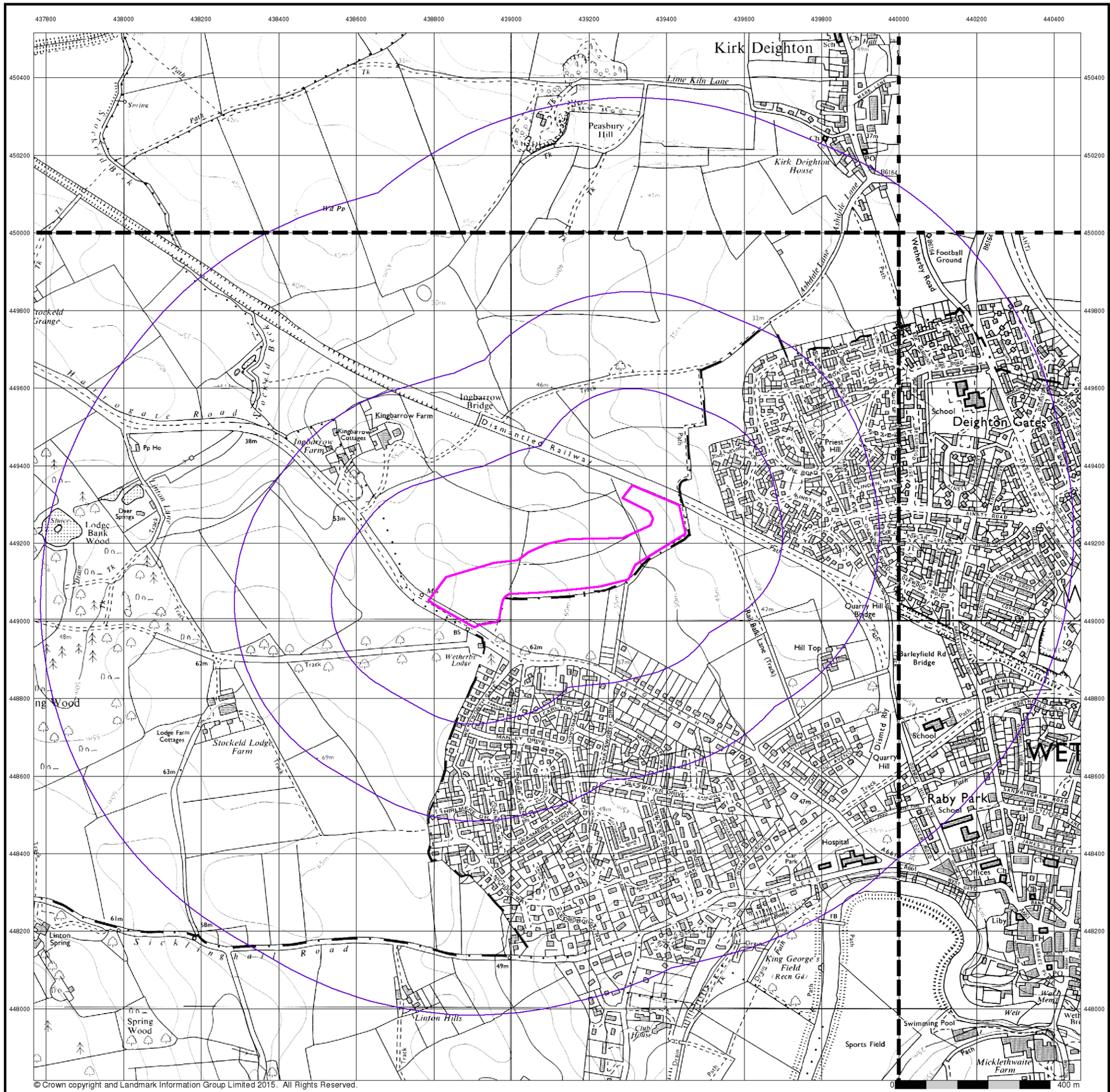


0 400 m

LITHOS CONSULTING

Ordnance Survey Plan

Published 1981 - 1989

Source map scale - 1:10,000

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.

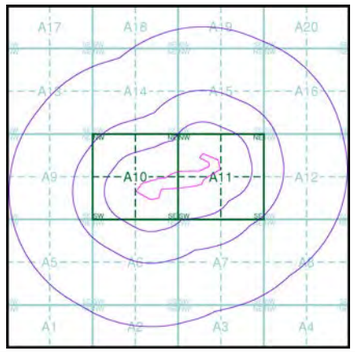
Map Name(s) and Date(s)

SE35SE
1987
1:10,000

SE34NE
1989
1:10,000

SE44NW
1981
1:10,000

Historical Map - Slice A



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National Grid Reference:	439130, 449160
Slice:	A
Site Area (Ha):	7.62
Search Buffer (m):	1000

Site Details

Spofforth Hill, WETHERBY, West Yorkshire, LS22 6SF

Landmark INFORMATION GROUP
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:
111719724_1_1

Customer Reference:
2638

National Grid Reference:
439130, 449160

Slice:
A

Site Area (Ha):
7.62

Search Buffer (m):
1000

Site Details:

Spofforth Hill
WETHERBY
West Yorkshire
LS22 6SF

Client Details:

Mrs L Hart
Lithos Consulting Ltd
Parkhill
Walton Road
Wetherby
LS22 5DZ

Contents

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

Natural England Copyright Notice

Ove Arup Copyright Notice

Peter Brett Associates Copyright Notice

Radon Potential dataset Copyright Notice

Report Version v50.0

LITHOS CONSULTING

Summary

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	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 1				5
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 2				Yes
Pollution Incidents to Controlled Waters	pg 2				4
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	pg 3		1		4 (*13)
Water Industry Act Referrals					
Groundwater Vulnerability	pg 7	Yes	n/a	n/a	n/a
Drift Deposits			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 7	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones	pg 7			1	3
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					n/a
Detailed River Network Offline Drainage					n/a

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites					
Historical Landfill Sites	pg 9				2
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)					
Local Authority Landfill Coverage	pg 9	2	n/a	n/a	n/a
Local Authority Recorded Landfill Sites	pg 9				1
Potentially Infilled Land (Non-Water)	pg 9		1	2	12
Potentially Infilled Land (Water)	pg 10				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					

LITHOS CONSULTING

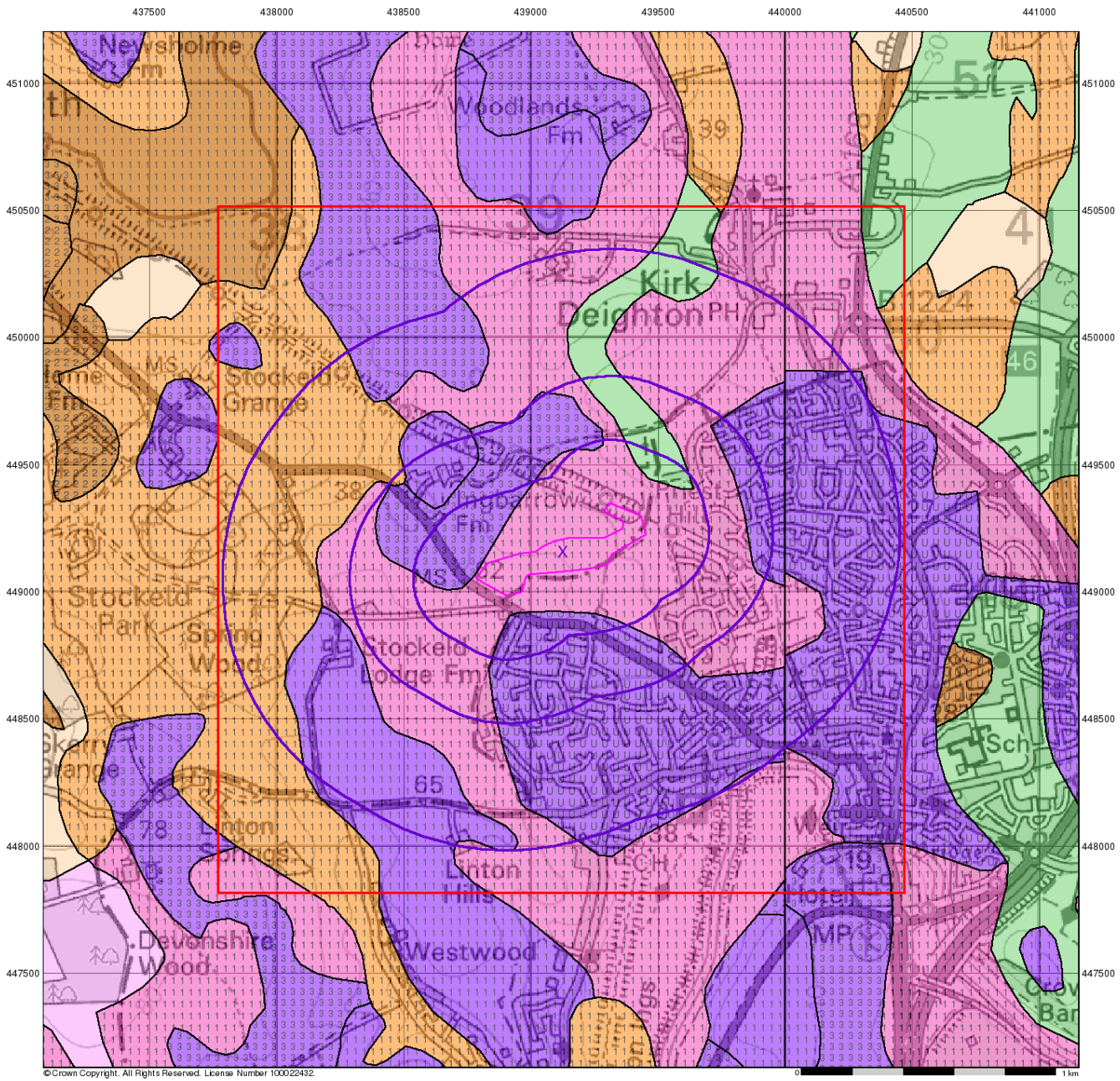
Summary

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 11	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 11	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 15		1	2	17
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas			n/a	n/a	n/a
Mining Instability			n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 19	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards				n/a	n/a
Potential for Ground Dissolution Stability Hazards	pg 19	Yes		n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 19	Yes		n/a	n/a
Potential for Running Sand Ground Stability Hazards				n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 19		Yes	n/a	n/a
Radon Potential - Radon Affected Areas	pg 19	Yes	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 20		2	3	11
Fuel Station Entries					
Points of Interest - Commercial Services	pg 21			2	4
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 21			2	3
Points of Interest - Public Infrastructure	pg 22				1
Points of Interest - Recreational and Environmental	pg 22			1	2
Gas Pipelines					
Underground Electrical Cables					

LITHOS CONSULTING

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland	pg 23				1
Areas of Adopted Green Belt	pg 23		1		1
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 23	3			
Ramsar Sites					
Sites of Special Scientific Interest	pg 23				1
Special Areas of Conservation	pg 23				1
Special Protection Areas					
World Heritage Sites					



LITHOS CONSULTING

Groundwater Vulnerability

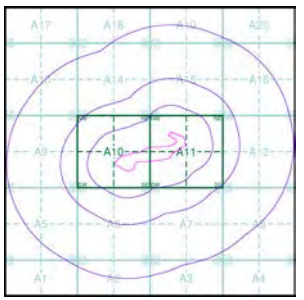
General

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

Agency and Hydrological

Geological Classes	Soil 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	

Site Sensitivity Context Map - Slice A



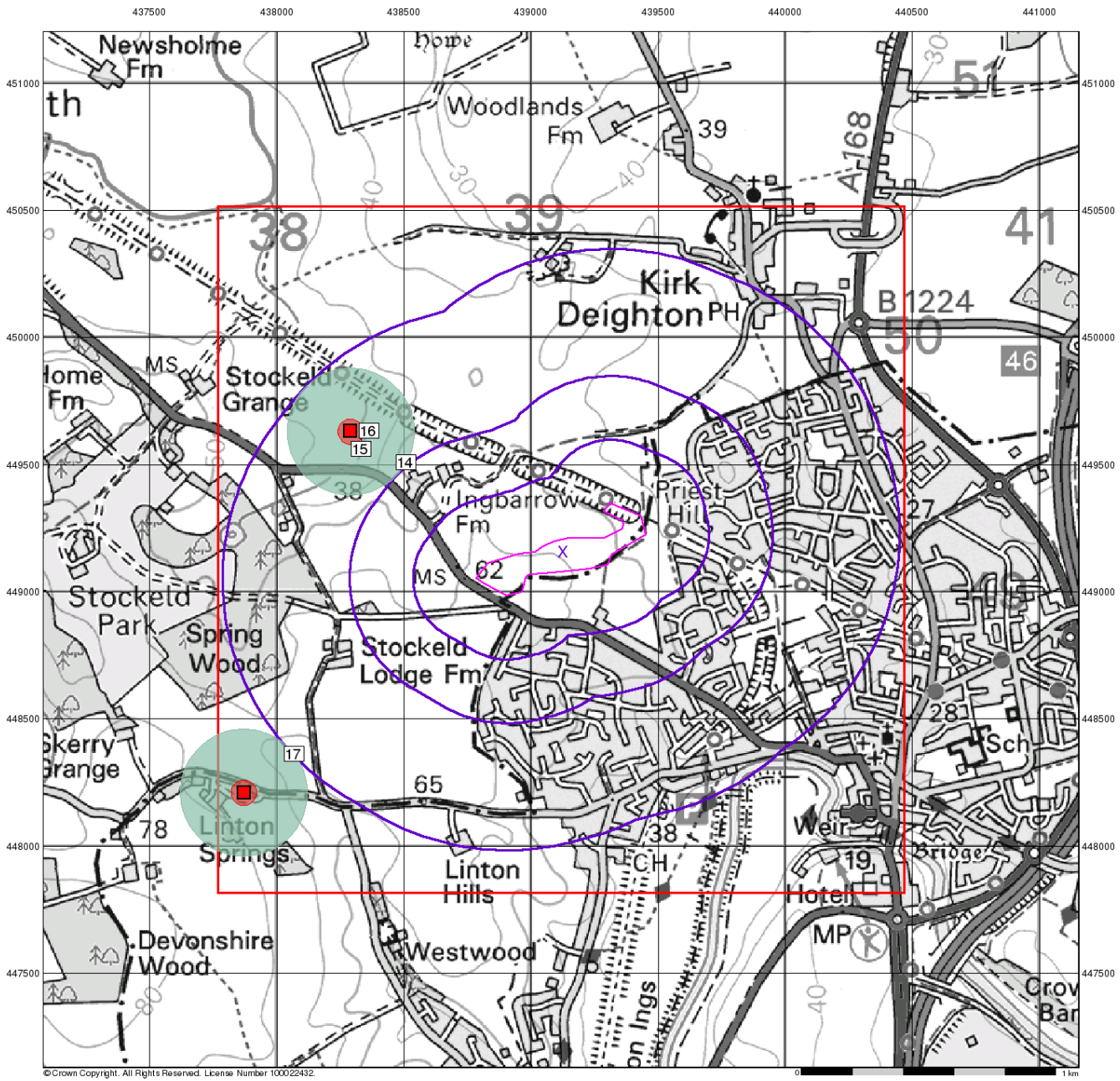
Order Details

Order Number:	111719724_1_1
Customer Ref:	2638
National Grid Reference:	439130, 449160
Slice:	A
Site Area (Ha):	7.62
Search Buffer (m):	1000

Site Details

Spofforth Hill, WETHERBY, West Yorkshire, LS22 6SF

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



LITHOS CONSULTING

Source Protection Zones

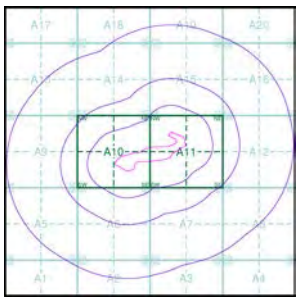
General

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

Agency and Hydrological

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

Site Sensitivity Context Map - Slice A



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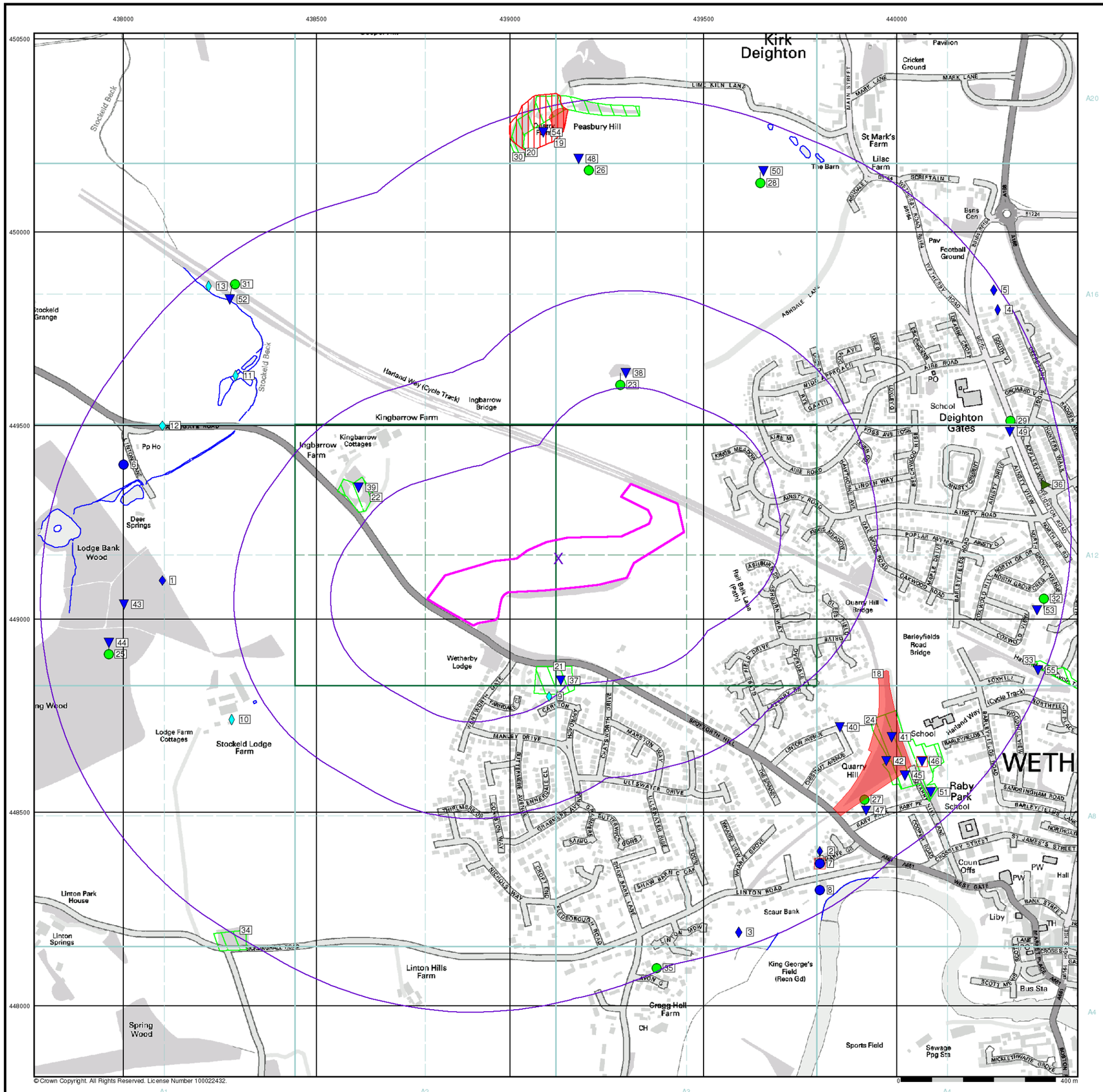


LITHOS CONSULTING

General

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

Several of Type at Location

Agency and Hydrological

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

Hazardous Substances

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

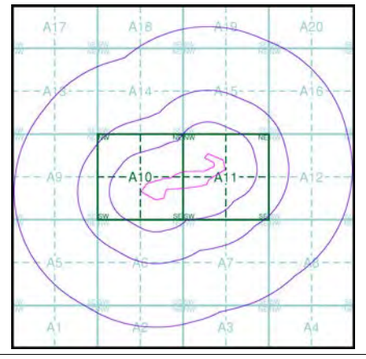
Geological

- BGS Recorded Mineral Site

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 (Non-water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Slice A



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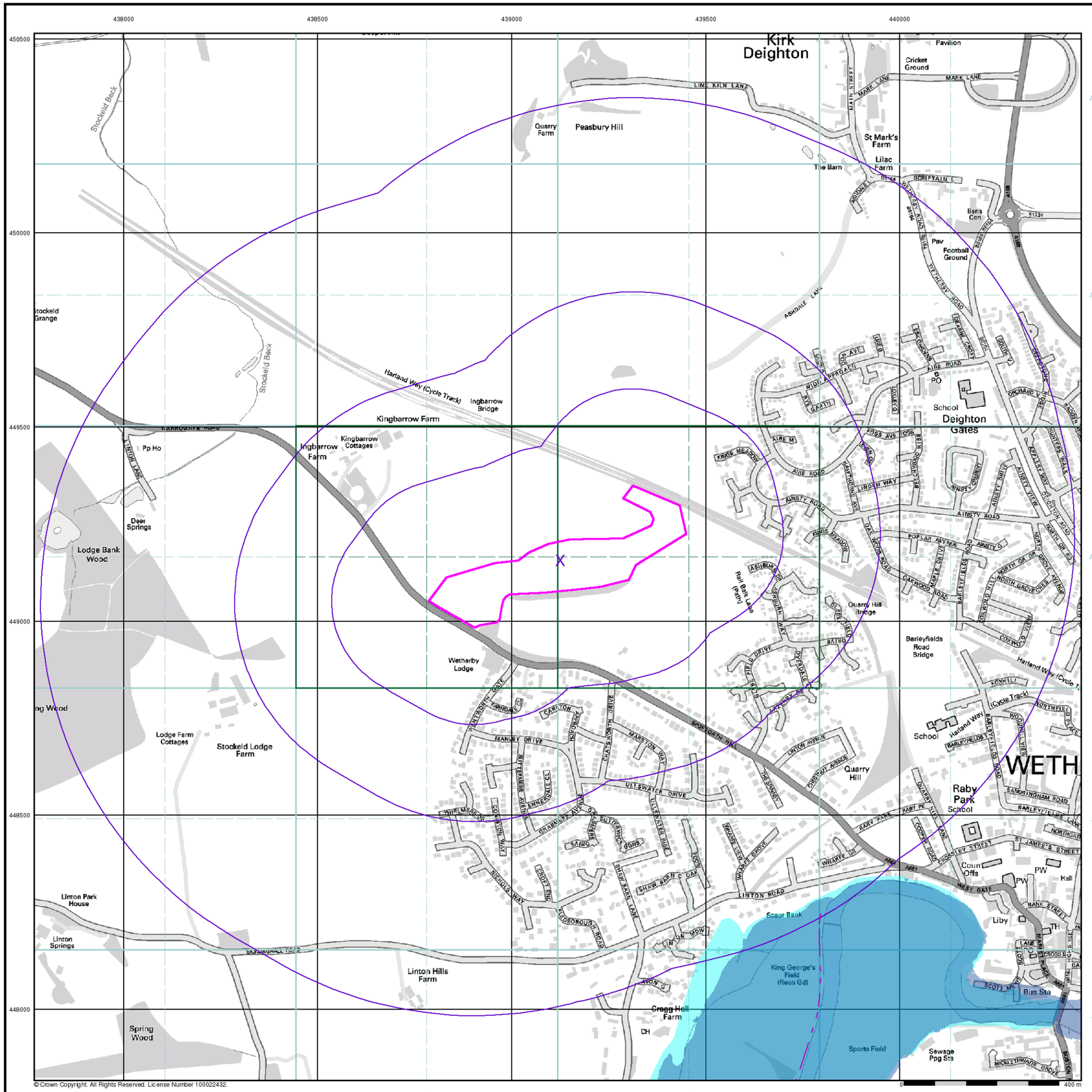


LITHOS CONSULTING

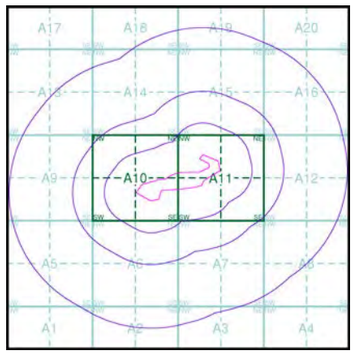
General

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

Agency and Hydrological (Flood)

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

Flood Map - Slice A



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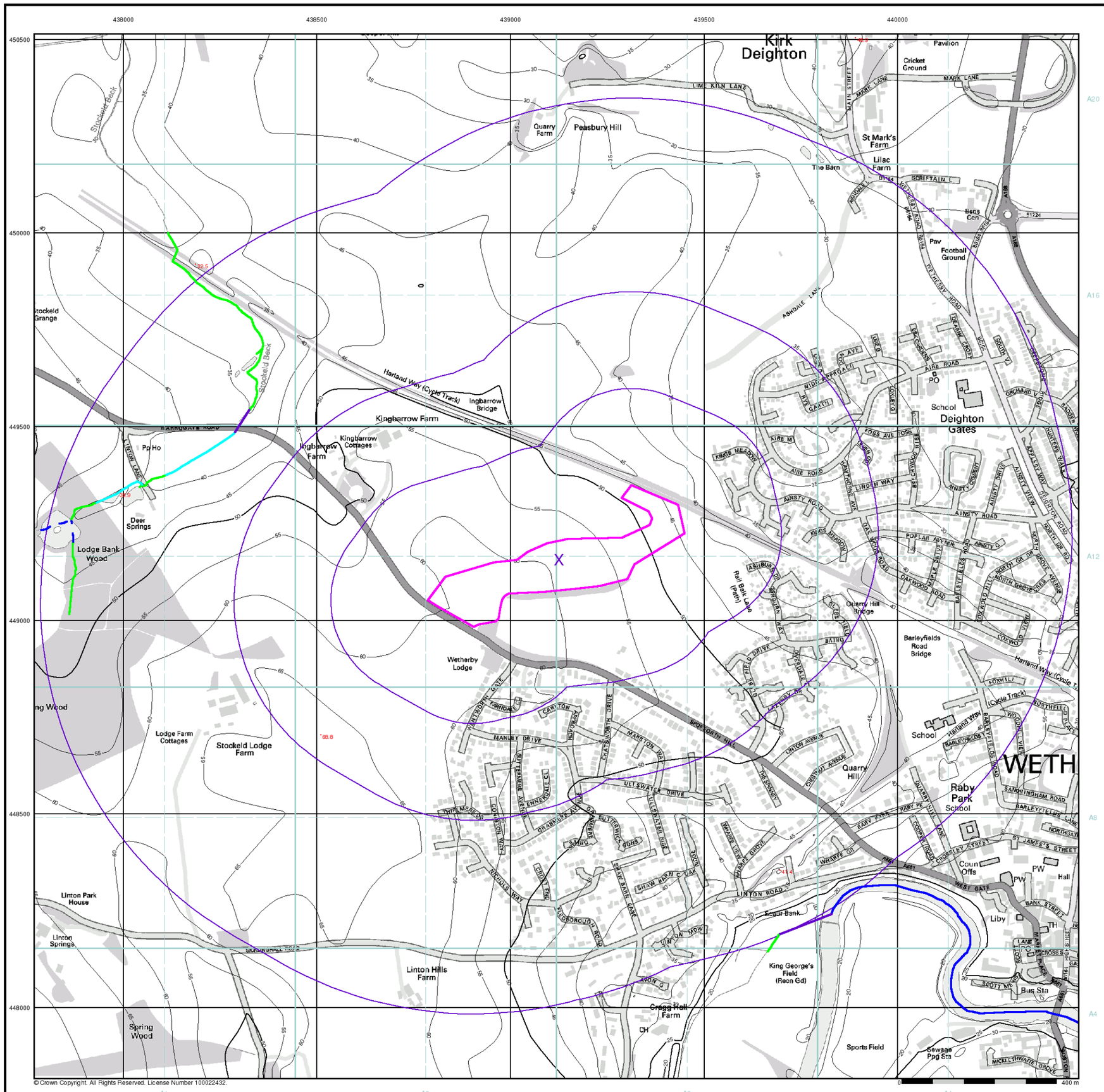


LITHOS CONSULTING

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 105 100 95

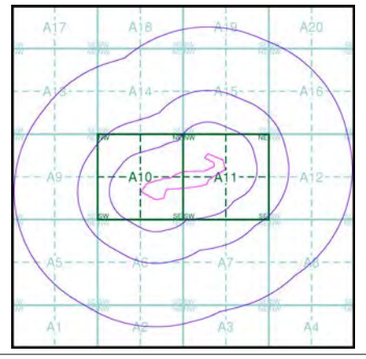
Master Contour

Spot Height *167.3

MLW Mean Low Water

MHW Mean High Water

EA/NRW Detailed River Network Map - Slice A



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

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

GeoReports

Lithos Consulting Ltd
Park Hill
Walton Road
Wetherby
LS22 5DZ

Natural Ground Stability report:

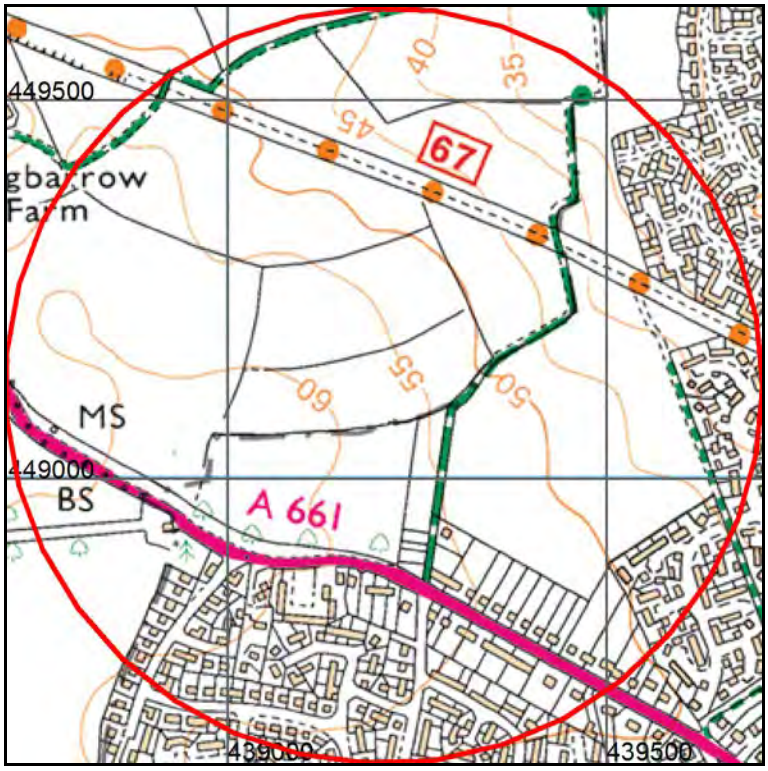
This report briefly describes any natural ground stability hazards ('subsidence') if they are found and gives an indication of their possible severity.

These could include swelling clay, landslip, ground dissolution, running sand, collapsible or compressible ground.

Report Id: ***GR_215425/1***

Client reference: Spofforth Hill

Search location



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Scale: 1:10 000 (1cm = 100 m)

Contains Ordnance Survey data © Crown Copyright and database right 2017
OS Street View: Scale: 1:10 000 (1cm = 100 m)

This report describes a site located at National Grid Reference 439207, 449123. Note that for sites of irregular shape, this point may lie outside the site boundary. Where the client has submitted a site plan the assessment will be based on the area given.

Search location indicated in red

Natural Subsidence Professional Search

This report provides an indication of the potential for any significant NATURAL ground instability to occur within the property extent and a surrounding 50 m buffer zone. It has been generated automatically from BGS's GeoSure dataset, which is based on 1:50 000 scale digital data. It is designed for use by professionals involved in conveyancing or development of low-rise domestic properties, but it may also be useful for private individuals to help them judge whether or not further professional advice should be sought. We recommend that members of the public should consult a qualified professional about the search results in this report before making any major decisions based on it.

Contents of the report:

- **Definitions and limitations:** an explanation of what this report provides.
- **Search Results:** The first part of the report presents and answers a series of questions about the natural geological hazards that could occur in the area, and their significance.
- **Maps:** The second part of the report provides maps of where the natural geological hazards indicated may occur, and their significance in terms of a range of indicative implications. A series of maps are also provided to show the underlying geology.
- **Explanation of hazard information:** The last part of the report provides further explanation of the geological hazards that have been identified in the search (if any). In particular, information on what to look for, what to do and what not to do, is provided.

Definitions to help you understand this report:

- **Natural Geological Hazards** are shrink-swell, landslides (slope instability), soluble rocks (dissolution), compressible ground, collapsible deposits and running sand. This does not include mining related subsidence. Note that these geological hazards may occur in either natural or man-made deposits.
- **Natural Ground Instability** refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards. Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale.
- **Significant** natural ground instability has the potential to cause damage to some weaker buildings and structures. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.
- Where significant natural ground instability is indicated, its relative **level** of significance is expressed on a scale of C to E ('low' to 'high'), relating to its potential to cause subsidence damage in low-rise buildings.

Limitations of the report:

- This report provides an indication of potential near-surface ground instability related to particular natural geological hazards. These are shrink-swell clay, landslides, soluble rocks (ground dissolution), compressible ground, collapsible deposits, and running sand. They do not give an indication of potential hazards at depth as might be encountered in a borehole, for example.
- The search does not cover any man-made hazards, such as contaminated land or mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: www.coalminingreports.co.uk.
- The results in this report are generated automatically from BGS's GeoSure dataset, based on 1:50 000 digital geological maps and the interpretation of other records in the possession of BGS at the time. Their scope and accuracy is limited by the methods used to create the dataset and they may differ from a geologist's interpretation of a wider array of geological information. The answer given should therefore only be treated as indicative for the search area.
- Other more specific and detailed information may be held by BGS for the site, and an assessment of this could result in a modified assessment of ground stability potential. This more detailed assessment is available via other BGS GeoReports.
- Further important information on the data used to provide information for this search is provided at the end of the report.
- The search in this report is carried out for a rectangle or circle (centred on the grid reference or address supplied, using the Ordnance Survey AddressPoint database) covering the extent of the property and its grounds, and including a 50 m zone around it, which takes into account the spatial accuracy of the geological hazards data described above.
- The information is intended for use by suitably-qualified professionals involved in conveyancing or development of low-rise domestic properties. If in doubt users should consult a suitably-qualified professional about the search results in this report before making any major decisions based upon it.
- An indication of natural ground instability does not necessarily mean that a building will be affected by subsidence. Such an assessment can be made only by inspection of the building itself by a suitably-qualified professional. This will take into account a variety of other contributing factors, such as building type and build quality, and nearby vegetation (in particular, the proximity and type of trees).

Search Results:

Important notes

- The term '**search area**' as used throughout this report means the property extent and a 50 m buffer zone. The property extent will be defined using the original details specified by the client

Question 1	Answer
Is significant natural ground instability possible in the area?	**YES**

Question 2	Answer
What is the level of hazard on a scale A to E (low to high)? **NOTE: Only levels C, D and E are shown and described below, as Levels A & B are considered insignificant**	**Level C**

Question 3	Answer
Which natural geological hazards could be contributing to the ground instability in the area? *How much ground instability each hazard may cause is indicated by the Level C to E in brackets.*	Clays that can swell when wet and shrink when dry, causing the ground to rise and fall ('Shrink-Swell') (LEVEL C)

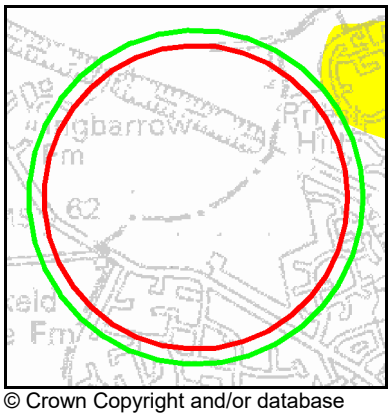
Question 4	Answer
What action should be taken?	If natural geological hazards at level C, D or E have been indicated this means there is potential ground instability in your area that may cause some properties to suffer subsidence damage. However, it does not necessarily mean that your property will be affected, and in order to find out if this is the case or not, you should obtain further advice from a qualified expert, such as a building surveyor. Show them this report and ask them to evaluate the property and its surroundings for any signs of existing subsidence damage and for advice on the likelihood for subsidence to occur in the future. The notes at the end of this report module may be useful in this regard. Note that the type of building and its surroundings (e.g. the presence of trees) are also very important when considering subsidence risk. Many types of properties, particularly newer ones, are well constructed and unlikely to be affected by subsidence, even in areas of significant ground movements.

Question 5	Answer
Where could the natural geological hazards occur in the area?	See the maps that follow.

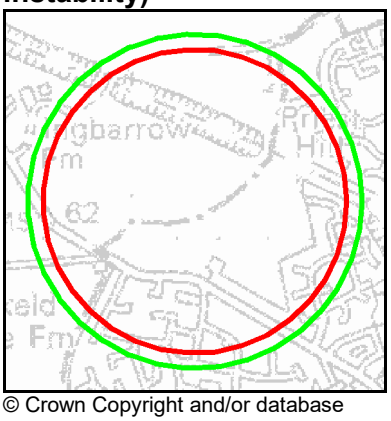
Automatically generated maps of near-surface natural geological hazards

The following maps show where significant natural ground instability at or near the surface could occur in relation to each of six geological hazards: shrink-swell, landslide (slope instability), soluble rocks (dissolution), compressible ground, collapsible deposits and running sand. The relative level of potential is indicated in colour and described in the key. Please note that a hazard is reported as significant for the property if it occurs within the specified site or the surrounding buffer zone.

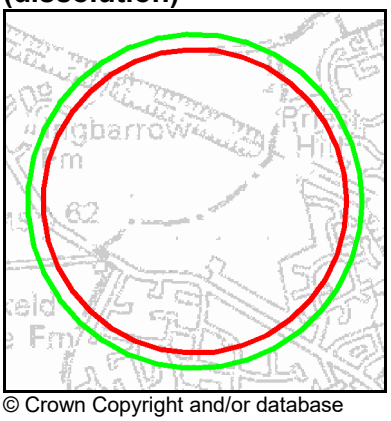
Shrink-Swell



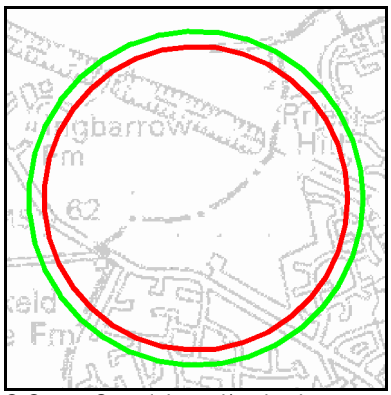
Landslides (slope instability)



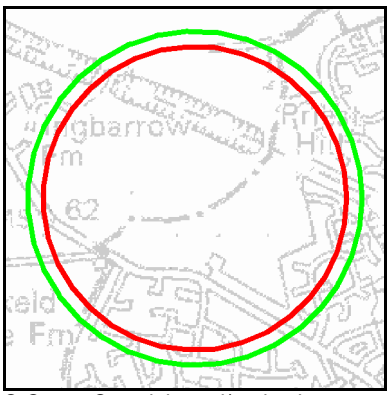
Soluble Rocks (dissolution)



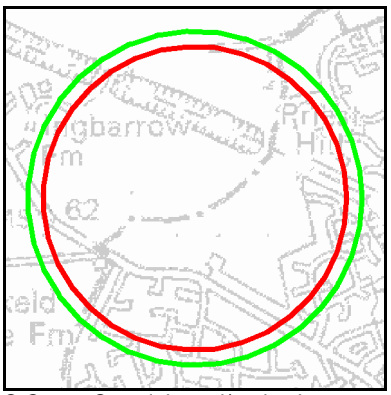
Compressible Ground



Collapsible Deposits



Running Sand



Search area indicated in red

50 m buffer indicated in green

For the key to relative level of potential for natural geological hazards see over the page

The unshaded (white) areas on the map (levels A, B or 'No hazard') represent areas where the conditions that cause natural ground movements due to the six natural geological hazards are considered to be absent or unlikely to be significant.

Key to Shrink-Swell Hazard:

Level	Hazard description	Advice for public	Advice for specialist
C	Ground conditions predominantly medium plasticity.	Do not plant trees with high soil moisture demands near to buildings. Avoid increased infiltration and seek specialist advice before disposing of large amounts of water to the ground through soakaways.	**New build** – Test for plasticity index is recommended. Possible increase in construction cost to remove potential shrink-swell problems. **Existing property** – Possible increase in insurance risk in droughts or where high moisture demand vegetation is present due to shrink-swell clay problems if foundations are not suitable.
D	Ground conditions predominantly high plasticity.	Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. Seek specialist advice before disposing of large amounts of water to the ground through soakaways.	**New build** – Test for plasticity index is necessary. Probable increase in construction cost to remove potential shrink-swell problems. **Existing property** – Probable increase in insurance risk in droughts or where high moisture demand vegetation is present due to shrink-swell clay problems if foundations are not suitable.
E	Ground conditions predominantly very high plasticity.	Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. Seek specialist advice before disposing of large amounts of water to the ground through soakaways.	**New build** – Test for plasticity index is essential. Definite increase in construction cost to remove potential shrink-swell problems. **Existing property** – Significant increase in insurance risk in droughts or where high moisture demand vegetation is present due to shrink swell clay problems if foundations are not suitable.

Key to Landslides (slope instability) Hazard:

Level	Hazard description	Advice for public	Advice for specialist
C	Slope instability problems may be present or anticipated. Site investigation should consider specifically the slope stability of the site.	Ask about implication for stability if large changes to drainage or excavations take place near to buildings. Seek specialist advice if major changes in ground conditions are likely and before disposing of large amounts of water to the ground through soakaways.	**New build** – Consider possibility of trench side or slope movement during excavations, or consequence of changes to drainage. Possible increase in construction cost to remove potential slope stability problems. **Existing property** – No significant increase in insurance risk due to natural slope instability problems.
D	Slope instability problems are probably present or have occurred in the past. Land use should consider specifically the stability of the site.	Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not undercut or place large amounts of material on slopes without technical advice.	**New build** – Assess slope stability of site and consequences of excavation, loading and water content changes during and after construction. **Existing property** – Probable increase in insurance risk due to natural slope instability after changes to ground conditions such as a very long, excessively wet winter.
E	Slope instability problems almost certainly present and may be active. Significant constraint on land use.	Seek expert advice about stability of the ground and its management to maintain and increase its stability.	**New build** – Slope stability assessment necessary, special design may be necessary, construction may not be possible. **Existing property** – Significant increase in insurance risk in some cases. Site-specific consideration is necessary to separate cases where landslide s are stabilised or ancient and stable from those that may be active or may fail.

Key to Soluble Rocks (dissolution) Hazard:

Level	Hazard description	Advice for public	Advice for specialist
C	Soluble rocks are present within the ground. Some dissolution features may be present. Potential for difficult ground conditions are at a level where they may be considered; localised subsidence need not be considered except in exceptional circumstances.	Consider implications for stability when changes to surface drainage or new construction are planned. Seek specialist advice before disposing of surface drainage to the adjacent ground.	**New build** – Site investigation should consider potential for dissolution problems on the site and its surroundings. Care should be taken with local drainage into the adjacent bedrock. **Existing property** – Possible increase in insurance risk due to soluble rocks. Some possibility of potential liability due to groundwater pollution may be present.
D	Soluble rocks are present within the ground. Many dissolution features may be present. Potential for difficult ground conditions are at a level where they should be considered. Potential for subsidence is at a level where it may need to be considered.	Consider obtaining specialist advice before loading the land or undertaking building work. Seek specialist advice before disposing of surface drainage to the adjacent ground. Maintain drainage infrastructure.	**New build** – Specialist site investigation and stability assessment may be necessary before construction. Construction work may cause subsidence. Isolate surface drainage from the karst system and groundwater. Increased construction costs are possible. **Existing property** – Possible increase in insurance risk due to soluble rocks. Some possibility of potential liability due to groundwater pollution may be present.
E	Soluble rocks are present within the ground. Numerous dissolution features may be present. Potential for difficult ground conditions should be investigated. Potential for localised subsidence is at a level where it should be considered.	Obtain specialist advice on need for stabilisation work and/or land management plan to maintain stability. Do not dispose of surface drainage into the adjacent ground. Maintain drainage infrastructure.	**New build** – Specialist land stability assessment necessary. Investigation, remediation and/or mitigation works may be necessary to stabilise the area. Construction work may cause subsidence. Isolate surface drainage from the karst system and groundwater. Increased construction costs. **Existing property** – Probable increase in insurance risk due to soluble rocks. Probable potential liability due to groundwater pollution.

Key to Compressible Ground Hazard:

Level	Hazard description	Advice for public	Advice for specialist
C	Compressibility and uneven settlement potential may be present. Land use should consider specifically the compressibility and variability of the site.	Take technical advice regarding settlement when planning extensions to existing property or when retrofitting soakaways.	**New build** – Consider possibility of settlement during construction due to compressible deposits. Unlikely to be increase in construction costs due to potential compressibility problems. **Existing property** – No significant increase in insurance risk due to compressibility problems.
D	Compressibility and uneven settlement hazards are probably present. Land use should consider the compressibility and variability of the site.	Avoid large differential loadings of ground. Do not drain or dewater ground near the property without specialist advice.	**New build** – Assess the variability and bearing capacity of the ground. May need special foundations to avoid excessive settlement during and after construction. Consider effects of changes to drainage regime and groundwater level. Extra construction costs are likely. **Existing property** – Possible increase in insurance risk from compressibility if groundwater levels drop due to drought or dewatering.
E	Highly compressible strata present. Significant constraint on land use depending on thickness.	Avoid large differential loadings of ground. Do not drain or dewater ground near the property without specialist advice.	**New build** – Assess the variability and bearing capacity of the ground. Probably needs special foundations to avoid excessive settlement during and after construction. Consider effects of changes to drainage regime and groundwater level. Construction may not be possible at economic cost. **Existing property** – Probable increase in insurance risk from compressibility due to drought or dewatering unless appropriate foundations are present.

Key to Collapsible Deposits Hazard:

Level	Hazard description	Advice for public	Advice for specialist
C	Deposits with potential to collapse when loaded and saturated are possibly present in places.	Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not increase loading on existing foundations without technical advice.	Contact local authorities for information on local occurrence of damage due to collapsible ground. **New build** – Assess the possibility of collapsible (loessic) deposits by ground investigation. If present do not exceed safe bearing capacity during or after construction and maintain site drainage, or carry out ground stabilisation. **Existing property** – Possible increase in insurance risk if collapsible deposits are present and if the load on the ground is increased or ground saturated by leakage or localised flooding.
D	Deposits with potential to collapse when loaded and saturated are probably present in places.	Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not increase loading on existing foundations without technical advice.	Contact local authorities for information on local occurrence of damage due to collapsible deposits. **New build** – Assess the possibility of collapsible deposits by ground investigation. If present do not exceed safe bearing capacity during or after construction and maintain site drainage, or carry out ground stabilisation. **Existing property** – Possible increase in insurance risk if collapsible deposits are present and if the load on the ground is increased or ground saturated by leakage or localised flooding.
E	Deposits with potential to collapse when loaded and saturated have been identified.	Avoid large amounts of water entering the ground through pipe leakage or soakaways. Do not increase loading on existing foundations without technical advice.	Contact local authorities for information on local occurrence of damage due to collapsible ground. **New build** – Assess the possibility of collapsible deposits by ground investigation. If present do not exceed safe bearing capacity during or after construction and maintain site drainage, or carry out ground stabilisation. **Existing property** – Possible increase in insurance risk if collapsible deposits are present and if the load on the ground is increased or ground saturated by leakage or localised flooding.

Key to Running Sand Hazard:

Level	Hazard description	Advice for public	Advice for specialist
C	Running sand conditions may be present. Constraints may apply to land uses involving excavation or the addition or removal of water.	Normal maintenance to avoid leakage of water-bearing services or water bodies (ponds, swimming pools) should avoid any problems due to running sands. Seek specialist advice before disposing of large amounts of water to the ground through soakaways.	**New build** – Consider possibility of running sands into trenches or excavations if water table is high. Avoid concentrated water inputs to site. Unlikely to be increase in construction costs due to potential for running sand problems. **Existing property** – No significant increase in insurance risk due to running sand problems.
D	Running sand conditions are probably present. Constraints may apply to land uses involving excavation or the addition or removal of water.	Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not dig (deep) holes into saturated ground near the property without technical advice.	**New build** – Assess the need for close-boarded sides to excavations and the consequences of soil and groundwater conditions during and after construction. **Existing property** – Possible increase in insurance risk from running conditions due to service leakage, high rainfall events or localised flooding.
E	Running sand conditions are almost certainly present. Constraints will apply to land uses involving excavation or the addition or removal of water.	Avoid large amounts of water entering the ground through pipe leakage or soakaways without specialist advice. Do not dig (deep) holes into saturated ground without technical advice.	**New build** – Assess the need for close-boarded sides to excavations and the consequences of soil and groundwater conditions during and after construction. Possible extra cost during construction and requirement for basements to be water proofed. **Existing property** – Possible increase in insurance risk from running conditions due to service leakage, high rainfall events or localised flooding.

Question 6	Answer
What is the geology of the area?	Please see the maps below, which show the geology underlying the area. You can compare these to the maps in Question 5 in order to understand the way that the underlying rocks and deposits are related to the potential natural geological hazards.

Geology maps

Geology maps for the area around your site are provided in this section, taken from the BGS Digital Geological Map of Great Britain at the 1:50,000 scale (DiGMapGB-50). The first two maps show separately the two main components of natural geology that may be present in an area – **superficial deposits** and **bedrock**. The third map, a "combined geology map", shows both layers superimposed.

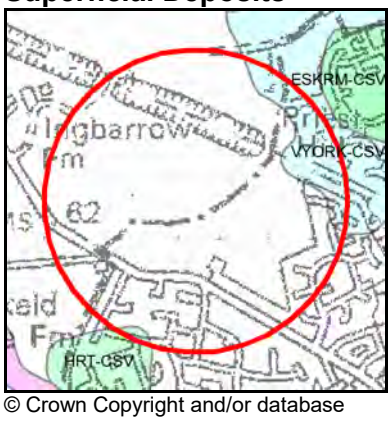
Superficial deposits: These include recent geological deposits, such as river sands and gravels, or glacial deposits, which lie on top of the bedrock in many areas (an alternative term for Superficial deposits is 'Drift Deposits')

Bedrock: Bedrock describes the rocks which underlie the whole of an area, upon which superficial deposits may lie (an alternative term for Bedrock is 'Solid Geology')

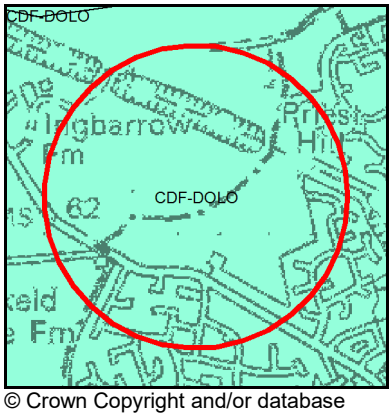
More information on DigMapGB-50 and how the various rock layers are classified can be found on the BGS website (www.bgs.ac.uk - search for DiGMap or the BGS Rock Classification Scheme). Further descriptions of the rocks listed in the map keys may also be obtained by searching against the Computer Code on the *BGS Lexicon of named Rock Units*, which is also on the BGS Website (follow the 'GeoData' link). The computer codes are labelled on the maps to try and help in their interpretation (with a dot at the bottom left hand corner of each label). However, please treat this with caution in areas of complex geology, where some of the labels may overlap several geological formations. If in doubt, please contact BGS enquiries.

The geological formations are listed broadly in order of age in the map keys (youngest first) but only to the formation level (a formation is a package of related rocks). Within formations, please be aware that individual members may not be ordered by age.

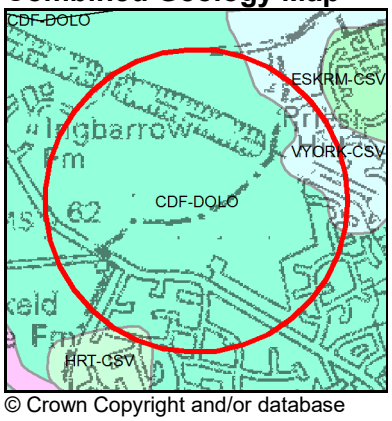
Superficial Deposits



Bedrock



Combined Geology Map



Site location indicated in red

Fault

Coal, ironstone or mineral vein

Note: Faults are shown for illustration and to aid interpretation of the map. Because these maps are generalised from more detailed versions not all such features are shown and their absence on the map face does not necessarily mean that none are present. Coals, ironstone beds and mineral veins occur only in certain rock types and regions of the UK.

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	ESKRM-CSV	ESCRICK MORAINE MEMBER	CLAY, SANDY, GRAVELLY
	VYORK-CSV	VALE OF YORK FORMATION	CLAY, SANDY, GRAVELLY
	HRT-CSV	HARROGATE TILL FORMATION	CLAY, SANDY, GRAVELLY
	GFDMP-XSV	GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE	SAND AND GRAVEL

Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	CDF-DOLO	CADEBY FORMATION	DOLOSTONE

What do the geological hazards mean?

The answer to Question 3 will have pointed to one or more natural geological hazards in the area. This section provides a brief explanation of these hazards to help you understand what they mean. This includes information on what you should look for in and around the property and what you should and should not do. The hazard is only reported below if it is shown as significant within the search area.

SHRINK-SWELL HAZARD

What is a shrink-swell?

A shrink-swell clay is one that changes volume according to how much water it contains. The clay particles that form the soil have a layered crystal structure that can absorb water within the layers as well as between the particles themselves. Some types of clay, such as smectite, can absorb very large amounts of water causing the crystals to expand like a concertina. When water is removed the clay particles shrink to their original size.

Why does shrink-swell cause a hazard?

All clay deposits change volume as their water content changes through the year, swelling in winter and shrinking in summer. Most foundations are designed and built to withstand seasonal changes. However, in exceptional circumstances, such as a drought or tree roots drying out the ground, houses may experience problems. If a house is built on a shrink-swell clay ground and the ground dries it will shrink and remove support from the foundations. If it becomes wetter it will expand causing heave or, if constrained, exert a swelling pressure.

What problems does shrink-swell cause?

If the ground below part of the foundations of a house shrinks or swells excessively it can cause the house to bend and crack. If the ground is confined the swelling pressure may cause walls or floors to bulge and crack.

What might I see?

Wide desiccation cracks in the ground in dry summers.
Distortion of buildings
Sticking doors and/or windows
Horizontal lines, such as courses of bricks, rising or falling
Cracking in walls, concrete floors, paths or roads.
Upward bulging of solid floors.
Tilting of walls or floors.

Some of these indicators may also be caused by other geohazards, such as landslides, but if they are noticed after a summer drought or where a large tree is growing (or has been removed) then a shrink/swell soil may be present.

What action should I take?
If active clay shrinkage/swelling appears to be affecting your property, inform your insurance company, mortgage lender, landlord or get specialist advice from a suitably qualified expert such as a structural surveyor, geotechnical engineer or chartered engineering geologist.
If active clay shrinkage/swelling is not affecting your property but the area has a potential for shrink/swell clay being present this should be taken into account before starting new buildings or changes in land use.

DO
Take specialist advice before starting major building work
Consider the effect of laying impermeable drives, paths, hard standing on the rainfall reaching the soil below and changing its moisture content.
Seek expert advice before planting trees near to the house. The safe planting distance will depend on the tree species, type of house foundation and soil composition.
Ensure foundations of new constructions or extensions are designed for the shrinkable clay soil conditions that are present.

DO NOT
Plant potentially large trees next to the house.
Remove mature trees that predate the construction of the house before taking advice. Tree management by crown reduction or thinning may be better than removal because it will maintain a stable soil moisture profile.

Contact Details

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Environmental Science Centre
Nicker Hill
Keyworth
Nottingham
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Fax: 0115 9363276
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Tel: 01491 838800
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General Terms & Conditions

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Important notes about this Report

- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

Report issued by
BGS Enquiry Service

Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP01
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438971.00 - 449076.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.10	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
	0.20	B		0.30			Light brown slightly clayey gravelly fine to medium SAND. Gravel is subangular to subrounded fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
	0.70	T		0.80			Yellowish brown slightly clayey sandy angular to subangular fine to coarse GRAVEL of limestone with a low cobble content. (GRANULAR RESIDUAL SOIL)
				1.60			Strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a high cobble content. (CADEBY FORMATION)
							Difficult to excavate beyond 2.1m.
				2.10			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 not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP02**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438920.00 - 449010.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.80	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of limestone. (TOPSOIL)
				0.40			
	0.50	D	HVP=65				Firm brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.60			Yellowish brown slightly clayey sandy subangular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL)
	1.10	T					*From 1.2m, low cobble content.*
				1.50			Strong light yellow thinly bedded LIMESTONE recovered as slightly sandy angular to subangular fine to coarse gravel with a low cobble content. (CADEBY FORMATION)
				1.80			*Unable to excavate beyond 1.8m.* End of pit at 1.80 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

Trial Pit Log

Trialpit No **TP03** Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438847.00 - 449050.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.00	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
	0.20	B					
				0.40			Firm brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=62				
				0.60			Yellow slightly clayey gravelly fine to medium SAND. Gravel is subangular fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
	0.90	T					*From 1.0m, low cobble content.*
				1.40			Strong thinly bedded light yellow LIMESTONE recovered as sandy angular tabular fine to coarse gravel with a medium cobble content. (CADEBY FORMATION)
							At 1.7m, thin <0.2m band of stiff greyish yellow gravelly CLAY.
							Unable to excavate beyond 2.0m.
				2.00			End of pit at 2.00 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP04**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438915.00 - 449062.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.20	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
				0.40			Yellowish brown slightly clayey sandy angular tabular fine to coarse GRAVEL with a low cobble content. (GRANULAR RESIDUAL SOIL)
	1.60	T		1.50			Strong thinly bedded light yellow LIMESTONE recovered as sandy angular tabular fine to coarse gravel with a medium cobble content. (CADEBY FORMATION)
				2.20			*Unable to excavate beyond 2.2m.* End of pit at 2.20 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP05
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438919.00 - 449108.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.60	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of limestone. (TOPSOIL)
				0.30			Yellowish brown slightly clayey sandy angular tabular fine to coarse GRAVEL of limestone with a low cobble content. (GRANULAR RESIDUAL SOIL)
	0.80	T					
				1.00			Strong light yellow thinly bedded LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a medium cobble content. (CADEBY FORMATION)
							Unable to excavate beyond 1.6m.
				1.60			End of pit at 1.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP06
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439033.00 - 449125.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.80	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
				0.60			Firm brown very gravelly CLAY. Gravel is subangular to subrounded fine to coarse of limestone. (COHESIVE RESIDUAL SOIL)
	0.90	T					Yellowish brown slightly clayey sandy subangular fine to coarse GRAVEL of limestone with a low cobble content. (GRANULAR RESIDUAL SOIL) *From 1.1m, medium cobble content.*
				1.40			Strong light yellow thinly bedded LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a high cobble content. (CADEBY FORMATION) *Unable to excavate beyond 1.8m.*
				1.80			End of pit at 1.80 m

1
2
3
4
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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP07
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439119.00 - 449126.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.60	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
				0.40			Yellowish brown slightly clayey sandy angular tabular fine to coarse GRAVEL of limestone with a high cobble content and low boulder content up to 500mm. (GRANULAR RESIDUAL SOIL) *From 0.5m, slight overbreak due to boulders.*
	1.20	T		1.00			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a high cobble content and a low boulder content. (CADEBY FORMATION)
				1.60			*Unable to excavate beyond 1.6m.* End of pit at 1.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.5m depth during excavation with some overbreak in the granular strata.

AGS

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Trial Pit Log

Trialpit No
TP08
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439179.00 - 449093.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.70	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
				0.40			Firm brown sandy CLAY. Locally very clayey fine to medium sand. (COHESIVE RESIDUAL SOIL)
	0.60	D	HVP=50	0.70			Yellowish brown slightly clayey sandy angular to subangular tabular fine to coarse GRAVEL of limestone with a low cobble content. (GRANULAR RESIDUAL SOIL)
	1.00	T		1.10			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel and cobbles with a low boulder content up to 600mm across. (CADEBY FORMATION)
							Difficult to excavate beyond 1.7m.
				1.70			End of pit at 1.70 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP09**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439210.00 - 449138.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.40	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
	0.20	B		0.30			Yellowish brown slightly clayey very gravelly fine to medium SAND. Gravel is subangular to subrounded fine to coarse of limestone with a low cobble content. (GRANULAR RESIDUAL SOIL)
							From 0.50 to 1.1m, slight spalling.
	1.30	T					*From 1.2m, medium cobble content.*
				1.70			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a medium cobble content and a low boulder content up to 400mm across. (CADEBY FORMATION)
							Difficult to excavate beyond 2.0m.
				2.40			End of pit at 2.40 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. Spalling of trial pit walls from 0.5m to 1.1m during excavation.

AGS

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Trial Pit Log

Trialpit No
TP10
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439173.00 - 449176.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.40	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.50	D		0.30			TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of limestone. (TOPSOIL)
				0.70			Firm brown sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse of limestone. (COHESIVE RESIDUAL SOIL) *From 0.3m to 0.8m, slight spalling.*
				1.00			Yellowish brown slightly clayey sandy angular to subangular fine to coarse GRAVEL of limestone with a medium cobble content. (GRANULAR RESIDUAL SOIL)
	1.30	T		1.40			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a medium cobble content. (CADEBY FORMATION) *Difficult to excavate from 1.2m.* End of pit at 1.40 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. Spalling of trial pit walls from 0.3m to 0.8m during excavation.

AGS

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Trial Pit Log

Trialpit No
TP11
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439043.00 - 449184.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.90	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of limestone. (TOPSOIL)
				0.30			Firm brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
	0.70	T		0.50			Yellow slightly clayey gravelly fine to medium SAND. Gravel is subangular to subrounded fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
							From 0.9m, very gravelly and a low cobble content.
				1.10			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse GRAVEL with a low cobble content. (CADEBY FORMATION)
							From 1.4m, medium cobble content.
							Difficult to excavate from 1.4m.
				1.90			End of pit at 1.90 m

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3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP12
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439068.00 - 449225.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.50	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10 0.20	J&T B		0.30			TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
				1.00			Yellowish brown slightly clayey sandy angular to subangular fine to coarse GRAVEL of limestone with a medium cobble content. (GRANULAR RESIDUAL SOIL)
	1.10	T					Strong thinly bedded light yellow LIMESTONE. Recovered a sandy angular tabular fine to coarse gravel with a medium cobble content. (CADEBY FORMATION)
				1.50			*Unable to excavate beyond 1.5m.* End of pit at 1.50 m

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

Trial Pit Log

Trialpit No **TP13** Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439128.00 - 449231.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.10	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.60	T		0.30			TOPSOIL: Dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
				0.80			Yellowish brown clayey sandy angular to subangular tabular fine to coarse GRAVEL of limestone with a medium cobble content. (GRANULAR RESIDUAL SOIL)
				1.30			Yellow slightly clayey gravelly fine to medium SAND with a medium cobble content. Gravel is angular to subangular tabular fine to coarse of limestone. (GRANULAR RESIDUAL SOIL) *Slight overbreak from 0.8m due to cobbles and boulders.*
				2.10			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a medium cobble content and a low boulder content up to 500mm across. (CADEBY FORMATION) *Difficult to excavate beyond 1.6m.* *From 1.8m, greyish yellow.* 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 not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.8m during excavation with some overbreak in the granular strata due to cobbles and boulders.

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Trial Pit Log

Trialpit No
TP14
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439172.00 - 449276.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.50	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10 0.20	J&T B		0.30			TOPSOIL: Dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
							Yellowish brown clayey sandy angular to subangular fine to coarse GRAVEL of limestone with a medium cobble content. (GRANULAR RESIDUAL SOIL)
							To 0.6m, locally reddish brown clayey matrix.
							From 1.2m, high boulder content.
							From 1.3m, slight overbreak.
				1.40			Strong light yellow thinly bedded LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a high cobble content. (CADEBY FORMATION)
							Difficult to excavate beyond 2.5m.
				2.50			End of pit at 2.50 m

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 1.3m during excavation with some overbreak in the granular strata.

AGS

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Trial Pit Log

Trialpit No **TP15** Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439255.00 - 449294.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 2.50	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.90	T		0.30			TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
							Yellowish brown clayey fine to medium SAND and subangular to subrounded fine to coarse GRAVEL of limestone with a low cobble content. (GRANULAR RESIDUAL SOIL)
							From 1.1m, slight overburden from 1.1m.
				1.30			Strong thinly bedded light yellow LIMESTONE. Recovered as slightly clayey sandy gravelly angular tabular COBBLES with a low boulder content up to 400mm across. (CADEBY FORMATION)
							Difficult to excavate beyond 2.5m.
				1.80			Strong thinly bedded light yellow LIMESTONE. Recovered as very sandy angular tabular fine to coarse gravel with a low cobble content. (CADEBY FORMATION)
				2.50			End of pit at 2.50 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 1.1m during excavation with some overbreak in the granular strata.

AGS

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Trial Pit Log

Trialpit No **TP16** Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439266.00 - 449249.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.70	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of limestone. (TOPSOIL)
							Yellowish brown slightly clayey sandy angular tabular fine to coarse GRAVEL of limestone with a medium cobble content. (GRANULAR RESIDUAL SOIL) *From 0.5m, slight overbreak.*
				1.40			Strong thinly bedded light yellow LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a high cobble content. (CADEBY FORMATION)
				1.70			End of pit at 1.70 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.5m during excavation with some overbreak in the granular strata.

AGS

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Trial Pit Log

Trialpit No
TP17
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439272.00 - 449187.00 Level:	Date 14/11/2018
Location: Wetherby		Dimensions (m): Depth 1.90	Scale 1:25
Client: Hallam Land Management Limited			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30			TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of limestone. (TOPSOIL)
				0.50			Firm brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
	0.60	T					Yellowish brown slightly clayey sandy angular tabular fine to coarse GRAVEL of limestone with a medium cobble content. (GRANULAR RESIDUAL SOIL)
							Slight overbreak from 0.7m.
				0.90			Strong light yellow thinly bedded LIMESTONE. Recovered as sandy angular tabular fine to coarse gravel with a medium cobble content. (CADEBY FORMATION)
							Difficult to excavate beyond 1.3m.
	1.40	T					*From 1.5m, low boulder content up to 400mm.*
				1.90			End of pit at 1.90 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.7m during excavation with some overbreak in the granular strata.

AGS

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Trial Pit Log

Trialpit No
TP18
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438882.00 - 449032.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 2.6 × 0.6 Depth 1.50	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown sandy CLAY with occasional rootlets. (TOPSOIL)
	0.40	D		0.30			Firm reddish brown gravelly slightly sandy CLAY. Gravel is angular to subangular fine to coarse of limestone. (COHESIVE RESIDUAL SOIL)
				0.50			Yellowish brown sandy clayey angular to subangular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL)
				0.80			Weak becoming medium strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy angular gravel and cobbles. (CADEBY FORMATION) *Overbreak 0.8m to 1.5m due to cobbles.*
				1.50			*Unable to excavate beyond 1.5m.* End of pit at 1.50 m

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4
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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable between 0.8m and 1.5m depth during excavation with some overbreak in the granular strata.

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Trial Pit Log

Trialpit No
TP19
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 438982.00 - 449135.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 2.8 × 0.6 Depth 1.90	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown sandy CLAY with occasional rootlets. (TOPSOIL)
				0.30			Firm orangish brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.40			Yellowish brown and white gravelly SAND. Gravel is angular to subangular fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
	0.90	T					
				1.10			Yellowish brown sandy angular to subangular fine to coarse GRAVEL of limestone with low cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL)
				1.40			*Slight overbreak from 1.1m due to cobbles.* Medium strong yellowish brown thinly bedded LIMESTONE. Recovered as angular tabular gravel and cobbles. (CADEBY FORMATION)
				1.90			*Unable to excavate beyond 1.9m.* End of pit at 1.90 m

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 1.1m depth during excavation with some overbreak in the granular strata.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP20
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439085.00 - 449080.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3.4 × 0.6 Depth 1.60	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown slightly gravelly CLAY. Gravel is rounded fine of mudstone and limestone. (TOPSOIL)
				0.30			Stiff dark reddish brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.40			Yellowish brown clayey slightly sandy angular fine to coarse GRAVEL with low cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL)
	0.70	T					*Occasional pockets of light purple sandy clay 0.1m by 0.1m between 0.4m and 0.8m.*
				0.80			Weak becoming medium strong yellowish brown thinly bedded LIMESTONE. Recovered as slightly sandy slightly clayey angular tabular gravel and cobbles. (CADEBY FORMATION)
	1.20	T					
				1.60			*Unable to excavate beyond 1.6m.* End of pit at 1.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP21
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439090.00 - 449172.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 2.6 × 0.6, Depth 1.80	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30			TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
	0.80	T		0.90			Yellowish brown and dark reddish brown clayey slightly sandy angular fine to coarse GRAVEL of limestone with medium cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL) *Overbreak 0.4m to 1.8m due to cobbles.*
	1.60	T		1.80			Strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy angular tabular gravel and cobbles. (CADEBY FORMATION) *Unable to excavate beyond 1.8m.* End of pit at 1.80 m

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4
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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.4m depth during excavation with some overbreak in the granular strata.

AGS

Trial Pit Log

Trialpit No **TP22** Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439260.00 - 449130.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 2.7 × 0.6, Depth 2.20	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			TOPSOIL: Dark brown sandy CLAY with occasional rootlets. (TOPSOIL)
				0.90			Yellowish brown clayey angular fine to coarse GRAVEL of limestone with medium cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL) *Overbreak due to cobbles from 0.3m.*
	1.20	T		2.20			Weak yellowish brown thinly bedded LIMESTONE. Recovered as clayey slightly sandy gravel and cobbles. (CADEBY FORMATION) *Becoming less clayey with depth from 1.6m.* *Unable to excavate beyond 2.2m.* 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. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.3m depth during excavation with some overbreak in the granular strata.

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP23**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439344.00 - 449188.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3.1 × 0.6, Depth 1.60	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					TOPSOIL: Dark brown slightly gravelly CLAY. Gravel is rounded fine of limestone. (TOPSOIL)
				0.30			
	0.40	D					Stiff dark reddish brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.50			Yellowish brown clayey angular fine to coarse GRAVEL of limestone with low cobble content. Cobbles are angular tabular of limestone. Clay is reddish brown. (GRANULAR RESIDUAL SOIL)
				0.80			*Overbreak due to cobbles from 0.5m.* Weak becoming medium strong yellowish brown thinly bedded LIMESTONE. Recovered as clayey slightly sandy gravel and cobbles. (CADEBY FORMATION)
	1.40	T					
				1.60			End of pit at 1.60 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.5m depth during excavation with some overbreak in the granular strata.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP24
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439342.00 - 449250.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3.4 × 0.6, Depth 1.00	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30			TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
				0.40			Firm reddish brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.50			Yellowish brown slightly sandy angular to subangular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL) *Overbreak due to cobbles from 0.4m.*
				1.00			Medium strong yellowish brown thinly bedded LIMESTONE. Recovered as clayey angular tabular gravel and cobbles. (CADEBY FORMATION) *Unable to excavate beyond 1.0m.* End of pit at 1.00 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.4m depth during excavation with some overbreak in the granular strata.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP25
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439413.00 - 449277.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3.4 × 0.6, Depth 3.60	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
			HVP=130				Stiff dark reddish brown mottled grey slightly gravelly CLAY. Gravel is angular to rounded fine to coarse of limestone, mudstone and sandstone. (COHESIVE GLACIAL DEPOSITS)
	0.90	D					
			HVP=140				*No blocks for vane from 1.5m.*
				2.00			Stiff dark grey gravelly CLAY. Gravel is subangular to rounded fine to medium of limestone, mudstone and sandstone. (COHESIVE GLACIAL DEPOSITS)
	2.50	D					
				3.60			End of pit at 3.60 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP26
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439358.00 - 449310.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3.3 × 0.6 Depth 2.90	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B		0.30			TOPSOIL: Dark brown CLAY with occasional rootlets. (TOPSOIL)
			HVP=120				Stiff reddish brown gravelly CLAY. Gravel is subangular to rounded fine to medium of limestone, mudstone and sandstone. (COHESIVE GLACIAL DEPOSITS) *Granular residual soil at 0.7m depth in E trial pit end, 1.2m in centre and 1.6m in W trial pit end.*
	1.20	D	HVP=130	1.60			Yellowish brown clayey angular tabular fine to coarse GRAVEL of limestone with medium cobble content. Cobbles are angular tabular and blocky of limestone. (GRANULAR RESIDUAL SOIL)
	2.40	T		2.00			Weak yellowish brown thinly to thickly bedded LIMESTONE. Recovered as sandy gravel and cobbles. (CADEBY FORMATION)
				2.90			*Unable to excavate beyond 2.9m depth.* End of pit at 2.90 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP27
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439294.00 - 449339.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3 × 0.6 Depth 2.30	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
	0.80	D	HVP=100				Stiff dark reddish brown occasionally mottled grey slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of limestone. (COHESIVE RESIDUAL SOIL)
			HVP=120	1.30			
	1.60	T		1.90			Yellowish brown sandy angular to subangular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL)
				2.30			Medium strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy gravel and cobbles. (CADEBY FORMATION) *Unable to excavate beyond 2.3m depth.* 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 not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP28
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439165.00 - 449378.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3.2 × 0.6, Depth 2.30	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30			TOPSOIL: Dark brown slightly sandy CLAY. (TOPSOIL)
	1.10	T		1.20			Yellowish brown sandy angular to subangular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL)
	2.10	T		2.30			Weak becoming medium strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy gravel and cobbles. (CADEBY FORMATION) *Difficult to excavate beyond 2.3m depth.* 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 not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.6m depth during excavation with some overbreak in the granular strata.

AGS

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Trial Pit Log

Trialpit No **TP29**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439156.00 - 449340.00 Level:	Date 15/11/2018
Location: Wetherby		Dimensions (m): 3 × 0.6 Depth 2.70	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			TOPSOIL: Dark brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of limestone. (TOPSOIL)
	0.90	T		1.10			Yellowish brown very gravelly SAND. Gravel is angular to subangular fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
				2.10			Yellowish brown sandy angular to subangular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL)
	2.40	D	HVP=90	2.60			Stiff buff slightly gravelly CLAY. Gravel is angular to subrounded of limestone. (COHESIVE RESIDUAL SOIL)
				2.70			Medium strong yellowish brown thinly bedded LIMESTONE. Recovered as angular tabular cobbles. (CADEBY FORMATION) *Unable to excavate beyond 2.7m depth.* End of pit at 2.70 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP30
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439205.00 - 449229.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 2.7 × 0.6 Depth 1.60	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown sandy CLAY with occasional rootlets. (TOPSOIL)
				0.40			Firm dark orangish brown gravelly slightly sandy CLAY. Gravel is subangular fine to coarse of limestone. (COHESIVE RESIDUAL SOIL)
				0.50			Yellowish brown sandy clayey angular fine to coarse GRAVEL of limestone. (GRANULAR RESIDUAL SOIL)
	1.00	T		1.00			Medium strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy gravel and cobbles. (CADEBY FORMATION)
				1.60			*Unable to excavate beyond 1.6m depth.* End of pit at 1.60 m

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.5m depth during excavation with some overbreak in the granular strata.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP31
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439405.00 - 449219.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 3.1 × 0.6 Depth 3.00	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine of mudstone and limestone. (TOPSOIL)
				0.30			Stiff reddish brown gravelly CLAY. Gravel is angular to subrounded fine to coarse of limestone, mudstone and sandstone. (COHESIVE GLACIAL DEPOSITS)
							Terracotta land drain at 0.5m running E-W, 100mm diameter.
	0.90	D	HVP=120				
				1.30			Stiff reddish brown gravelly slightly sandy CLAY. Gravel is angular to subangular fine to coarse of mudstone and limestone. (COHESIVE GLACIAL DEPOSITS)
			HVP=90				
				2.00			Stiff greyish brown gravelly CLAY. Gravel is angular to subrounded fine of mudstone and limestone. (COHESIVE GLACIAL DEPOSITS)
	2.60	D	HVP=140				
				3.00			End of pit at 3.00 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP32
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439231.00 - 449343.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 2.6 × 0.6 Depth 2.30	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded of limestone. (TOPSOIL)
			HVP=60	0.30			Firm reddish brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
	0.70	T		0.50			Yellowish brown very sandy clayey angular fine to coarse GRAVEL of limestone with low cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL)
				1.50			Weak yellowish brown thinly bedded LIMESTONE. Recovered as clayey sandy gravel and cobbles. (CADEBY FORMATION)
				2.00			Medium strong light yellowish brown thinly bedded. Recovered as sandy clayey cobbles. (CADEBY FORMATION)
				2.30			*Unable to excavate beyond 2.3m depth.* 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 not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP33**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439090.00 - 449394.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 2.6 × 0.6, Depth 2.70	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					TOPSOIL: Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
				0.40			Firm dark reddish brown sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of limestone. (COHESIVE RESIDUAL SOIL)
	0.80	D	HVP=60				
				0.90			Yellowish brown gravelly clayey SAND. Gravel is angular to subangular fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
	2.00	T					
				2.70			End of pit at 2.70 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP34**

Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439082.00 - 449337.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 3.1 × 0.6 Depth 2.70	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					TOPSOIL: Dark brown gravelly CLAY with occasional rootlets. Gravel is subrounded fine of limestone. (TOPSOIL)
			HVP=60	0.30			Firm reddish brown sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.40			Yellowish brown gravelly slightly clayey SAND. Gravel is angular to subangular fine to coarse of limestone. (GRANULAR RESIDUAL SOIL)
	1.10	T					
				2.50			Medium strong yellowish brown thinly bedded LIMESTONE. Recovered as sandy gravel. (CADEBY FORMATION)
				2.70			*Unable to excavate beyond 2.7m depth.* End of pit at 2.70 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP35
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439077.00 - 449293.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 2.7 × 0.6 Depth 2.20	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.70	T		0.40			TOPSOIL: Dark brown gravelly CLAY. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (TOPSOIL)
				1.40			Yellowish brown very sandy clayey angular fine to coarse GRAVEL of limestone with low cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL)
				2.20			Weak becoming medium strong yellowish brown thinly bedded LIMESTONE. Recovered as angular tabular clayey sandy cobbles and boulders. (CADEBY FORMATION)
							Unable to excavate beyond 2.2m depth. End of pit at 2.20 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP36
Sheet 1 of 1

Project Name: Spofforth Hill	Project No. 2638	Co-ords: 439122.00 - 449290.00 Level:	Date 16/11/2018
Location: Wetherby		Dimensions (m): 3 × 0.6 Depth 2.10	Scale 1:25
Client: Hallam Land Management Limited			Logged JEJ

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							TOPSOIL: Dark brown sandy CLAY with occasional rootlets. (TOPSOIL)
				0.30			Yellowish brown sandy angular fine to coarse GRAVEL of limestone with medium cobble content. Cobbles are angular tabular of limestone. (GRANULAR RESIDUAL SOIL)
				0.60			Weak yellowish brown thinly bedded LIMESTONE. Recovered as angular tabular cobbles and boulders. (CADEBY FORMATION)
				2.10			*Unable to excavate beyond 2.1m depth.* 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 not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit were unstable from 0.5m depth during excavation with some overbreak in the granular strata.

AGS

Appendix G

Chemical Results

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	18-36368-1
Initial Date of Issue:	26-Nov-2018
Client	Lithos Consulting
Client Address:	Walton Road Wetherby LS22 5DZ
Contact(s):	Josh Jones Martin Thompson
Project	2683 - Spofforth Hill

Quotation No.:		**Date Received:**	20-Nov-2018
Order No.:	PO13843/2638/JEJ	**Date Instructed:**	20-Nov-2018
No. of Samples:	31		
Turnaround (Wkdays):	5	**Results Due:**	26-Nov-2018
Date Approved:	26-Nov-2018		

Approved By:

Details: Martin Dyer, Laboratory Manager

Chemtest
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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting				**Chemtest Job No.:**	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368
Quotation No.:				**Chemtest Sample ID.:**	727811	727813	727815	727816	727818	727819	727821	727822	727823
				Client Sample ID.:	2	1	2	2	3	1	2	3	1
				Sample Location:	TP30	TP07	TP22	TP10	TP23	TP04	TP28	TP26	TP13
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	1.00	1.20	1.20	1.30	1.40	1.60	2.10	2.40	0.60
				Date Sampled:	16-Nov-2018	14-Nov-2018	15-Nov-2018	14-Nov-2018	15-Nov-2018	14-Nov-2018	15-Nov-2018	15-Nov-2018	14-Nov-2018
				Asbestos Lab:									
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
ACM Type	U	2192		N/A									
Asbestos Identification	U	2192	%	0.001									
Moisture	N	2030	%	0.020	12	11	13	12	7.6	10	11	8.8	11
Clay Content	N		%	N/A									
Visible Contaminants >2mm	N		%	N/A									
Silt Content	N		%	N/A									
Sand Content	N		%	N/A									
pH	U	2010		N/A	9.0	9.1	8.7	8.8	8.9	8.8	9.0	9.2	9.0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Total Organic Carbon	U	2625	%	0.20									
Arsenic	U	2450	mg/kg	1.0									
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40									
Cadmium	U	2450	mg/kg	0.10									
Chromium	U	2450	mg/kg	1.0									
Chromium (Trivalent)	N	2490	mg/kg	1.0									
Chromium (Hexavalent)	N	2490	mg/kg	0.50									
Copper	U	2450	mg/kg	0.50									
Lead	U	2450	mg/kg	0.50									
Mercury	U	2450	mg/kg	0.10									
Nickel	U	2450	mg/kg	0.50									
Selenium	U	2450	mg/kg	0.20									
Zinc	U	2450	mg/kg	0.50									
Acenaphthene	U	2800	mg/kg	0.10									
Acenaphthylene	N	2800	mg/kg	0.10									
Anthracene	U	2800	mg/kg	0.10									
Benzo[a]anthracene	U	2800	mg/kg	0.10									
Benzo[a]pyrene	U	2800	mg/kg	0.10									
Benzo[b]fluoranthene	U	2800	mg/kg	0.10									
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10									
Benzo[k]fluoranthene	U	2800	mg/kg	0.10									
Chrysene	U	2800	mg/kg	0.10									
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10									
Fluoranthene	U	2800	mg/kg	0.10									
Fluorene	U	2800	mg/kg	0.10									
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10									
Naphthalene	U	2800	mg/kg	0.10									
Phenanthrene	U	2800	mg/kg	0.10									

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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting													
Quotation No.:			**Chemtest Job No.:**		18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368
			Chemtest Sample ID.:		727811	727813	727815	727816	727818	727819	727821	727822	727823
			Client Sample ID.:		2	1	2	2	3	1	2	3	1
			Sample Location:		TP30	TP07	TP22	TP10	TP23	TP04	TP28	TP26	TP13
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		1.00	1.20	1.20	1.30	1.40	1.60	2.10	2.40	0.60
			Date Sampled:		16-Nov-2018	14-Nov-2018	15-Nov-2018	14-Nov-2018	15-Nov-2018	14-Nov-2018	15-Nov-2018	15-Nov-2018	14-Nov-2018
			Asbestos Lab:										
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Pyrene	U	2800	mg/kg	0.10									
Total Of 16 PAH's	N	2800	mg/kg	2.0									

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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting					18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368
Quotation No.:					727827	727829	727832	727836	727838	727842	727843	727844	727845
					2	1	3	2	2	3	3	1	1
					TP20	TP35	TP03	TP29	TP02	TP27	TP33	TP23	TP26
					SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					0.70	0.70	0.90	0.90	1.10	1.60	2.00	0.10	0.10
					15-Nov-2018	16-Nov-2018	14-Nov-2018	15-Nov-2018	14-Nov-2018	15-Nov-2018	16-Nov-2018	15-Nov-2018	15-Nov-2018
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
ACM Type	U	2192		N/A									
Asbestos Identification	U	2192	%	0.001									
Moisture	N	2030	%	0.020	12	11	8.8	13	8.3	13	13		
Clay Content	N		%	N/A								19	21
Visible Contaminants >2mm	N		%	N/A								0.000	0.000
Silt Content	N		%	N/A								31	26
Sand Content	N		%	N/A								50	53
pH	U	2010		N/A	9.1	8.7	9.2	8.8	9.1	8.9	9.2		
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
Total Organic Carbon	U	2625	%	0.20									
Arsenic	U	2450	mg/kg	1.0									
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40									
Cadmium	U	2450	mg/kg	0.10									
Chromium	U	2450	mg/kg	1.0									
Chromium (Trivalent)	N	2490	mg/kg	1.0									
Chromium (Hexavalent)	N	2490	mg/kg	0.50									
Copper	U	2450	mg/kg	0.50									
Lead	U	2450	mg/kg	0.50									
Mercury	U	2450	mg/kg	0.10									
Nickel	U	2450	mg/kg	0.50									
Selenium	U	2450	mg/kg	0.20									
Zinc	U	2450	mg/kg	0.50									
Acenaphthene	U	2800	mg/kg	0.10									
Acenaphthylene	N	2800	mg/kg	0.10									
Anthracene	U	2800	mg/kg	0.10									
Benzo[a]anthracene	U	2800	mg/kg	0.10									
Benzo[a]pyrene	U	2800	mg/kg	0.10									
Benzo[b]fluoranthene	U	2800	mg/kg	0.10									
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10									
Benzo[k]fluoranthene	U	2800	mg/kg	0.10									
Chrysene	U	2800	mg/kg	0.10									
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10									
Fluoranthene	U	2800	mg/kg	0.10									
Fluorene	U	2800	mg/kg	0.10									
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10									
Naphthalene	U	2800	mg/kg	0.10									
Phenanthrene	U	2800	mg/kg	0.10									

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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting													
Quotation No.:			**Chemtest Job No.:**		18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368
			Chemtest Sample ID.:		727827	727829	727832	727836	727838	727842	727843	727844	727845
			Client Sample ID.:		2	1	3	2	2	3	3	1	1
			Sample Location:		TP20	TP35	TP03	TP29	TP02	TP27	TP33	TP23	TP26
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.70	0.70	0.90	0.90	1.10	1.60	2.00	0.10	0.10
			Date Sampled:		15-Nov-2018	16-Nov-2018	14-Nov-2018	15-Nov-2018	14-Nov-2018	15-Nov-2018	16-Nov-2018	15-Nov-2018	15-Nov-2018
			Asbestos Lab:										
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Pyrene	U	2800	mg/kg	0.10									
Total Of 16 PAH's	N	2800	mg/kg	2.0									

Chemtest
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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting					**Chemtest Job No.:**	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368
Quotation No.:					**Chemtest Sample ID.:**	727846	727848	727849	727850	727852	727853	727856	727857	727858
					Client Sample ID.:	1	2	2	2	1	1	1	1	1
					Sample Location:	TP33	TP03	TP09	TP12	TP01	TP03	TP09	TP12	TP14
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.10	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.10
					Date Sampled:	19-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018
					Asbestos Lab:					DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
ACM Type	U	2192		N/A						-	-	-	-	-
Asbestos Identification	U	2192	%	0.001						No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020						13	14	14	15	14
Clay Content	N		%	N/A	19	19	21	18						
Visible Contaminants >2mm	N		%	N/A	0.000	0.000	0.000	0.000						
Silt Content	N		%	N/A	18	29	27	31						
Sand Content	N		%	N/A	63	52	52	52						
pH	U	2010		N/A						8.3	8.2	8.0	8.1	8.0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010										
Total Organic Carbon	U	2625	%	0.20						2.1	1.9	1.3	2.1	1.6
Arsenic	U	2450	mg/kg	1.0						12	11	9.8	11	11
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40						0.86	0.96	0.62	0.89	0.88
Cadmium	U	2450	mg/kg	0.10						0.30	0.37	0.31	0.30	0.28
Chromium	U	2450	mg/kg	1.0						18	18	17	16	18
Chromium (Trivalent)	N	2490	mg/kg	1.0						18	18	17	16	18
Chromium (Hexavalent)	N	2490	mg/kg	0.50						< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Copper	U	2450	mg/kg	0.50						18	18	13	12	16
Lead	U	2450	mg/kg	0.50						28	32	24	26	33
Mercury	U	2450	mg/kg	0.10						0.11	0.11	< 0.10	< 0.10	< 0.10
Nickel	U	2450	mg/kg	0.50						20	20	19	17	21
Selenium	U	2450	mg/kg	0.20						< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Zinc	U	2450	mg/kg	0.50						50	58	45	42	46
Acenaphthene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10						< 0.10	0.13	< 0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Naphthalene	U	2800	mg/kg	0.10						< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10						< 0.10	0.15	< 0.10	< 0.10	< 0.10

Chemtest
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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting					**Chemtest Job No.:**	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368	18-36368
Quotation No.:					**Chemtest Sample ID.:**	727846	727848	727849	727850	727852	727853	727856	727857	727858
					Client Sample ID.:	1	2	2	2	1	1	1	1	1
					Sample Location:	TP33	TP03	TP09	TP12	TP01	TP03	TP09	TP12	TP14
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.10	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.10
					Date Sampled:	19-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018	14-Nov-2018
					Asbestos Lab:					DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Pyrene	U	2800	mg/kg	0.10						< 0.10	0.14	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0						< 2.0	< 2.0	< 2.0	< 2.0	< 2.0

Chemtest
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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting			**Chemtest Job No.:**		18-36368	18-36368	18-36368	18-36368
Quotation No.:			**Chemtest Sample ID.:**		727863	727864	727865	727868
			Client Sample ID.:		1	1	1	1
			Sample Location:		TP25	TP27	TP29	TP34
			Sample Type:		SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.10	0.10	0.10	0.10
			Date Sampled:		15-Nov-2018	15-Nov-2018	16-Nov-2018	16-Nov-2018
			Asbestos Lab:		DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
ACM Type	U	2192		N/A	-	-	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	16	14	15	15
Clay Content	N		%	N/A				
Visible Contaminants >2mm	N		%	N/A				
Silt Content	N		%	N/A				
Sand Content	N		%	N/A				
pH	U	2010		N/A	8.0	7.9	8.1	8.0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010				
Total Organic Carbon	U	2625	%	0.20	1.1	1.3	1.7	1.7
Arsenic	U	2450	mg/kg	1.0	9.1	8.3	10	11
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.66	0.86	0.72	0.78
Cadmium	U	2450	mg/kg	0.10	0.34	0.29	0.31	0.31
Chromium	U	2450	mg/kg	1.0	21	15	17	15
Chromium (Trivalent)	N	2490	mg/kg	1.0	21	15	17	15
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50
Copper	U	2450	mg/kg	0.50	16	14	14	12
Lead	U	2450	mg/kg	0.50	24	20	22	22
Mercury	U	2450	mg/kg	0.10	< 0.10	< 0.10	0.14	0.10
Nickel	U	2450	mg/kg	0.50	27	16	20	17
Selenium	U	2450	mg/kg	0.20	0.24	0.22	< 0.20	< 0.20
Zinc	U	2450	mg/kg	0.50	50	44	51	47
Acenaphthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Naphthalene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10

Chemtest
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Results - Soil

Project: 2683 - Spofforth Hill

Client: Lithos Consulting					**Chemtest Job No.:**	18-36368	18-36368	18-36368	18-36368
Quotation No.:					**Chemtest Sample ID.:**	727863	727864	727865	727868
					Client Sample ID.:	1	1	1	1
					Sample Location:	TP25	TP27	TP29	TP34
					Sample Type:	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.10	0.10	0.10	0.10
					Date Sampled:	15-Nov-2018	15-Nov-2018	16-Nov-2018	16-Nov-2018
					Asbestos Lab:	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**					
Pyrene	U	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0		< 2.0	< 2.0	< 2.0	< 2.0

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS

Chemtest
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Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Appendix H

Geotechnical Test Results

LABORATORY REPORT

4043

Contract Number: PSL18/6113

Report Date: 05 December 2018

Client's Reference: 2638

Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Matt Thompson/Josh Jones

Contract Title: Spofforth Hill

Date Received: 20/11/2018
Date Commenced: 20/11/2018
Date Completed: 5/12/2018

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 other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
L Knight (Senior Technician)	L Pavey (Senior/Quality Technician)	S Wilson (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

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth	Description of Sample
TP25	2	D	0.90		Brown slightly gravelly sandy CLAY.
TP25	3	D	2.50		Brown slightly gravelly sandy CLAY.
TP26	2	D	1.20		Brown slightly gravelly very sandy CLAY.
TP31	1	D	0.90		Brown slightly gravelly very sandy CLAY.
TP31	2	D	2.60		Brown slightly gravelly sandy CLAY.
TP02	1	D	0.50		Brown slightly gravelly very sandy CLAY.
TP08	2	D	0.60		Brown slightly gravelly slightly sandy CLAY.
TP10	1	D	0.50		Brown slightly gravelly sandy CLAY.
TP18	2	D	0.40		Brown slightly gravelly sandy CLAY.
TP27	2	D	0.80		Brown slightly gravelly sandy CLAY.
TP29	3	D	2.40		Light brown slightly sandy CLAY.
TP33	2	D	0.80		Brown slightly gravelly very sandy CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP25	2	D	0.90		18			44	20	24	97	Intermediate plasticity CI.
TP25	3	D	2.50		19			47	21	26	96	Intermediate plasticity CI.
TP26	2	D	1.20		14			32	16	16	97	Low plasticity CL.
TP31	1	D	0.90		13			31	16	15	96	Low plasticity CL.
TP31	2	D	2.60		18			44	22	22	96	Intermediate plasticity CI.
TP02	1	D	0.50		16			32	15	17	98	Low plasticity CL.
TP08	2	D	0.60		19			62	25	37	97	High plasticity CH.
TP10	1	D	0.50		24			48	22	26	96	Intermediate plasticity CI.
TP18	2	D	0.40		19			46	21	25	96	Intermediate plasticity CI.
TP27	2	D	0.80		19			45	20	25	98	Intermediate plasticity CI.
TP29	3	D	2.40		20			61	27	34	100	High plasticity CH.
TP33	2	D	0.80		14			33	16	17	97	Low plasticity CL.

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL Professional Soils Laboratory

Spofforth Hill

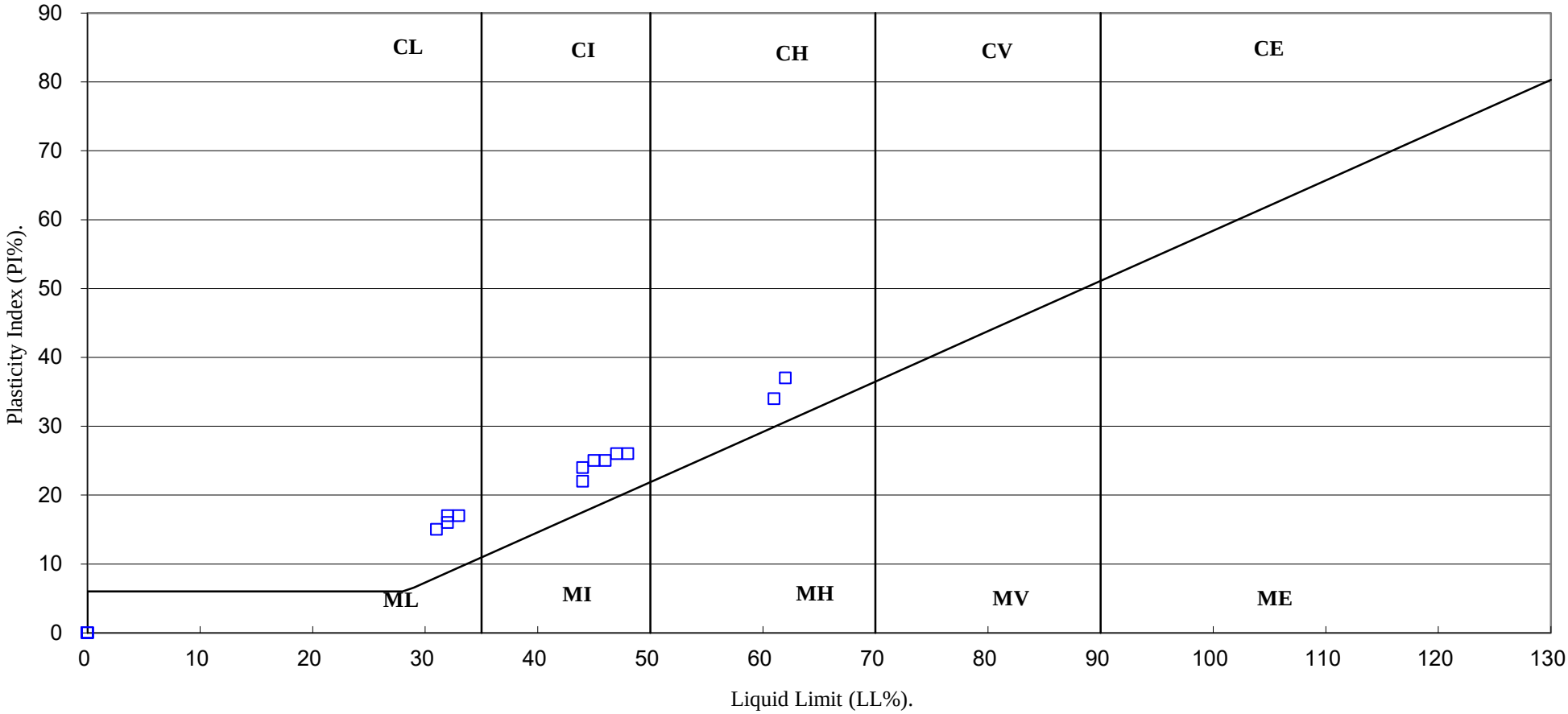
Contract No:

PSL18/6113

Client Ref:

2638

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Spofforth Hill**	**Contract No:**
			PSL18/6113
			Client Ref:
			2638

Certificate of Analysis

Certificate Number 18-28088

03-Dec-18

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 18-28088

Client Reference PSL18/6113

Order No (not supplied)

Contract Title Spofforth Hill

Description 6 Soil samples.

Date Received 28-Nov-18

Date Started 28-Nov-18

Date Completed 03-Dec-18

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

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

Approved By

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 18-28088
Client Ref PSL18/6113
Contract Title Spofforth Hill

			Lab No	1427022	1427023	1427024	1427025	1427026	1427027
			Sample ID	TP25	TP26	TP31	TP31	TP29	TP33
			Depth	0.90	1.20	0.90	2.60	2.40	0.80
			Other ID	2	2	1	2	3	2
			Sample Type	D	D	D	D	D	D
			Sampling Date	20/11/18	20/11/18	20/11/18	20/11/18	20/11/18	20/11/18
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Inorganics									
pH	DETSC 2008#			8.2	8.2	8.2	8.3	8.5	8.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	98	18	23	11	12	12

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 18-28088
Client Ref PSL18/6113
Contract Spofforth Hill

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1427022	TP25 0.90 SOIL	20/11/18	No containers logged	pH + Conductivity (7 days)	Cannot evaluate
1427023	TP26 1.20 SOIL	20/11/18	No containers logged	pH + Conductivity (7 days)	Cannot evaluate
1427024	TP31 0.90 SOIL	20/11/18	No containers logged	pH + Conductivity (7 days)	Cannot evaluate
1427025	TP31 2.60 SOIL	20/11/18	No containers logged	pH + Conductivity (7 days)	Cannot evaluate
1427026	TP29 2.40 SOIL	20/11/18	No containers logged	pH + Conductivity (7 days)	Cannot evaluate
1427027	TP33 0.80 SOIL	20/11/18	No containers logged	pH + Conductivity (7 days)	Cannot evaluate

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 I
Soakaway Test Results

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Engineer	A Taylor
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Date:	15/11/2018
Trial Pit No.	18
Test No.	1

Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
08:55	0	0.68	680
08:56	1	0.89	890
08:57	2	1.00	1000
08:58	3	1.09	1090
08:59	4	1.17	1170
09:00	5	1.24	1240
09:01	6	1.29	1290
09:02	7	1.34	1340
09:03	8	1.39	1390

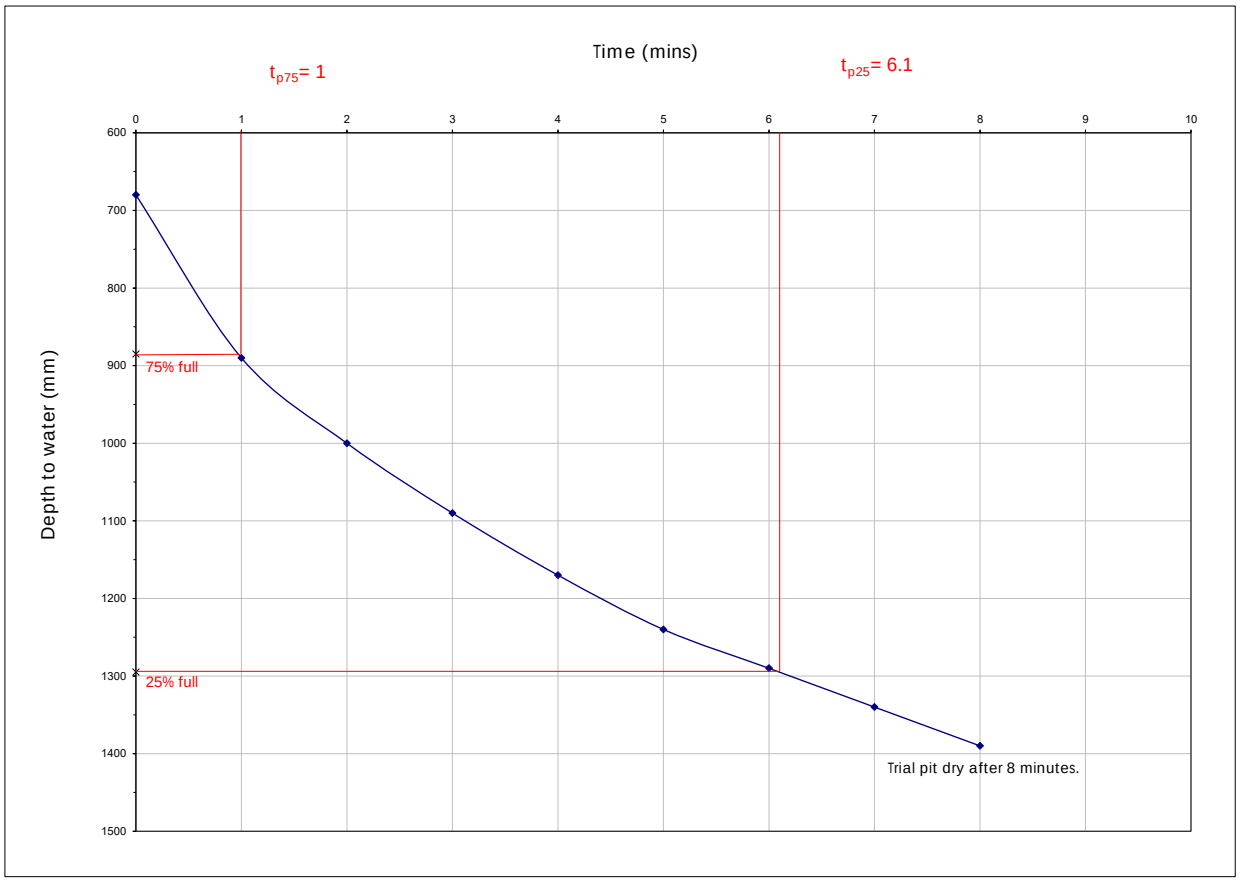
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	1.50	1500

Effective Depth (% full)		(mm)	(m)
0.25	=	1295	1.30
0.50	=	1090	1.09
0.75	=	885	0.89

Depth at start of test (mm)	=	680
Depth at end of test (mm)	=	1390

Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	4.184
V_{p75-25} - Volume 75 - 25%	=	0.6396

Read from the graph:		
$t_{p\ 75}$ (min)	=	1
$t_{p\ 25}$ (min)	=	6.1



Soil infiltration rate, f, (m/s) = 5.00E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP18
Test No.	2

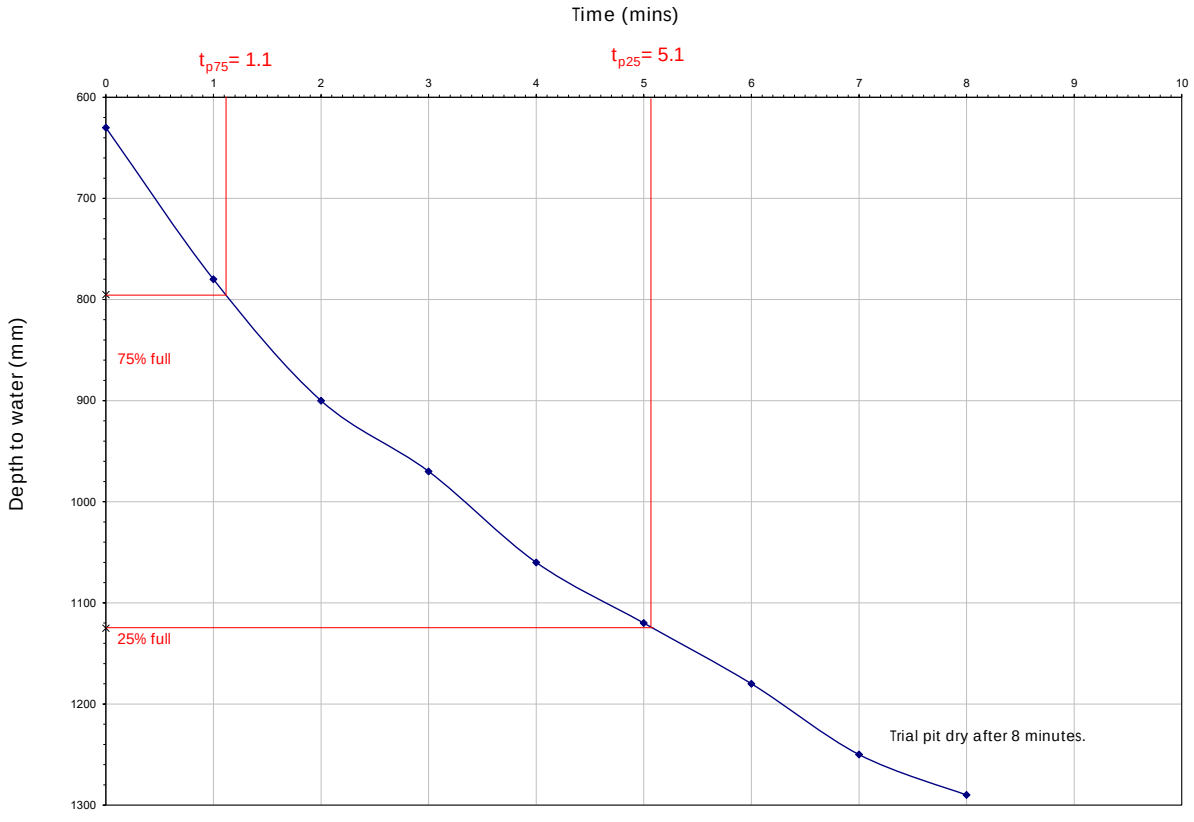
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:07	0	0.63	630
09:08	1	0.78	780
09:09	2	0.90	900
09:10	3	0.97	970
09:11	4	1.06	1060
09:12	5	1.12	1120
09:13	6	1.18	1180
09:14	7	1.25	1250
09:15	8	1.29	1290

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	1.29	1290

Effective Depth (% full)		(mm)	(m)
0.25	=	1125	1.13
0.50	=	960	0.96
0.75	=	795	0.80

Depth at start of test (mm)	=	630
Depth at end of test (mm)	=	1290
Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	3.672
V_{p75-25} - Volume 75 - 25%	=	0.5148

Read from the graph:		
$t_{p\ 75}$ (min)	=	1.10
$t_{p\ 25}$ (min)	=	5.10



Soil infiltration rate, f, (m/s) = 5.84E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP18
Test No.	3

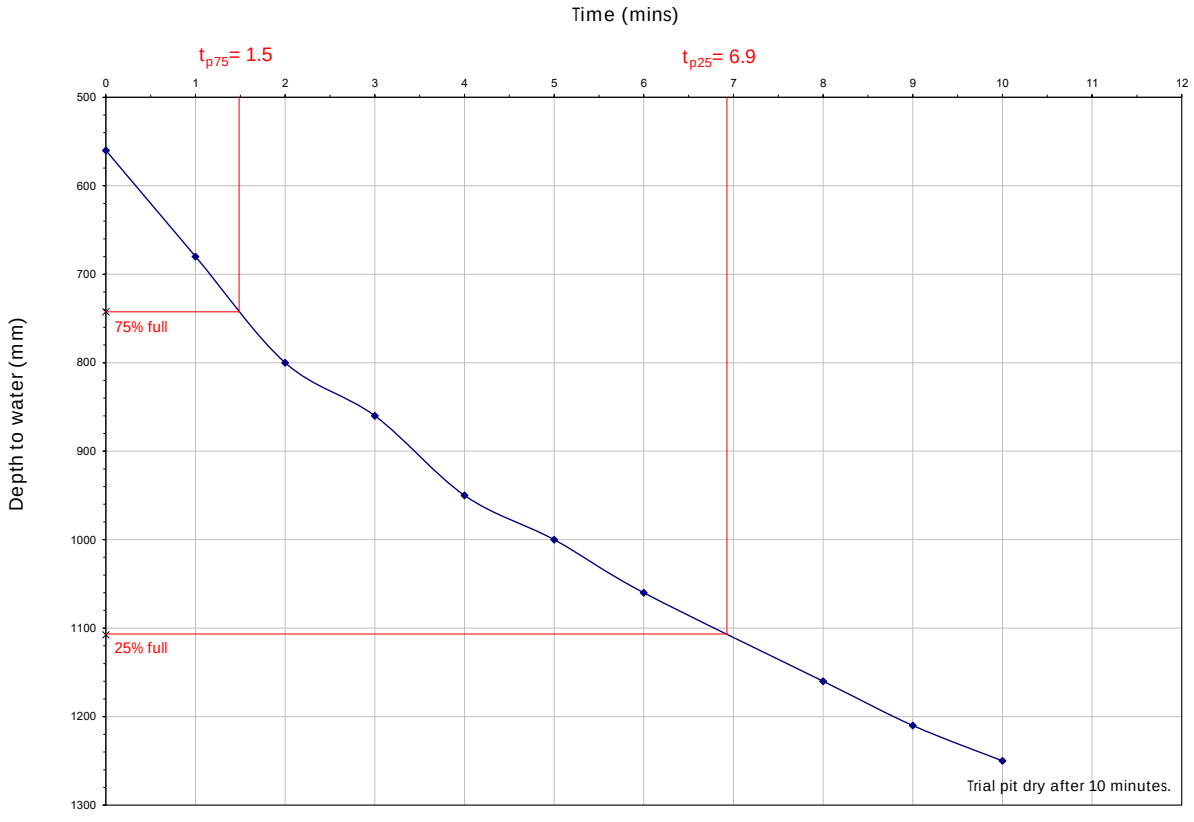
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:18	0	0.56	560
09:19	1	0.68	680
09:20	2	0.80	800
09:21	3	0.86	860
09:22	4	0.95	950
09:23	5	1.00	1000
09:24	6	1.06	1060
09:25	8	1.16	1160
09:26	9	1.21	1210
09:27	10	1.25	1250

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	1.29	1290

Effective Depth (% full)		(mm)	(m)
0.25	=	1107.5	1.11
0.50	=	925	0.93
0.75	=	742.5	0.74

Depth at start of test (mm)	=	560
Depth at end of test (mm)	=	1250
Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	3.896
V_{p75-25} - Volume 75 - 25%	=	0.5694

Read from the graph:		
$t_{p\ 75}$ (min)	=	1.50
$t_{p\ 25}$ (min)	=	6.90



Soil infiltration rate, f, (m/s) = 4.51E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP19
Test No.	T1

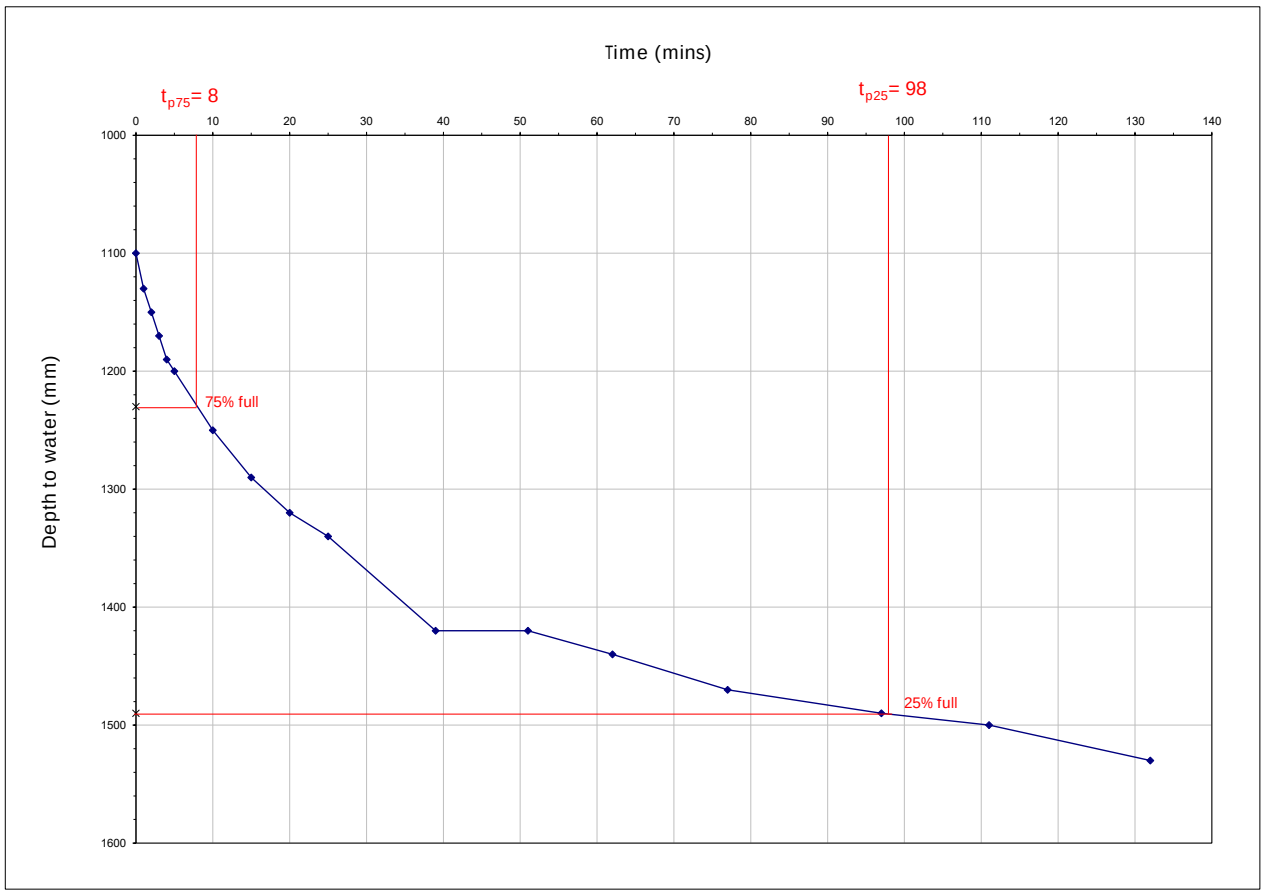
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:33	0	1.10	1100
09:34	1	1.13	1130
09:35	2	1.15	1150
09:36	3	1.17	1170
09:37	4	1.19	1190
09:38	5	1.20	1200
09:43	10	1.25	1250
09:48	15	1.29	1290
09:53	20	1.32	1320
09:58	25	1.34	1340
10:12	39	1.42	1420
10:24	51	1.42	1420
10:35	62	1.44	1440
10:50	77	1.47	1470
11:10	97	1.49	1490
11:24	111	1.50	1500
11:45	132	1.53	1530

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.80	2800
Width	=	0.60	600
Depth	=	1.62	1620

Effective Depth (% full)		(mm)	(m)
0.25	=	1490	1.49
0.50	=	1360	1.36
0.75	=	1230	1.23

Depth at start of test (mm)	=	1100
Depth at end of test (mm)	=	1530
Base area of pit	=	1.68
a_{p50} - 50% internal surface area inc. base	=	3.448
V_{p75-25} - Volume 75 - 25%	=	0.4368

Read from the graph:		
$t_{p\ 75}$ (min)	=	8.00
$t_{p\ 25}$ (min)	=	98.00



Soil infiltration rate, f, (m/s) = 2.35E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP19
Test No.	T2

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:48	0	1.08	1080
11:49	1	1.12	1120
11:50	2	1.15	1150
11:51	3	1.17	1170
11:52	4	1.20	1200
11:53	5	1.22	1220
12:03	15	1.31	1310
12:08	20	1.34	1340
12:13	25	1.36	1360
13:05	77	1.47	1470
13:38	110	1.51	1510
14:14	146	1.58	1580
14:47	179	1.61	1610

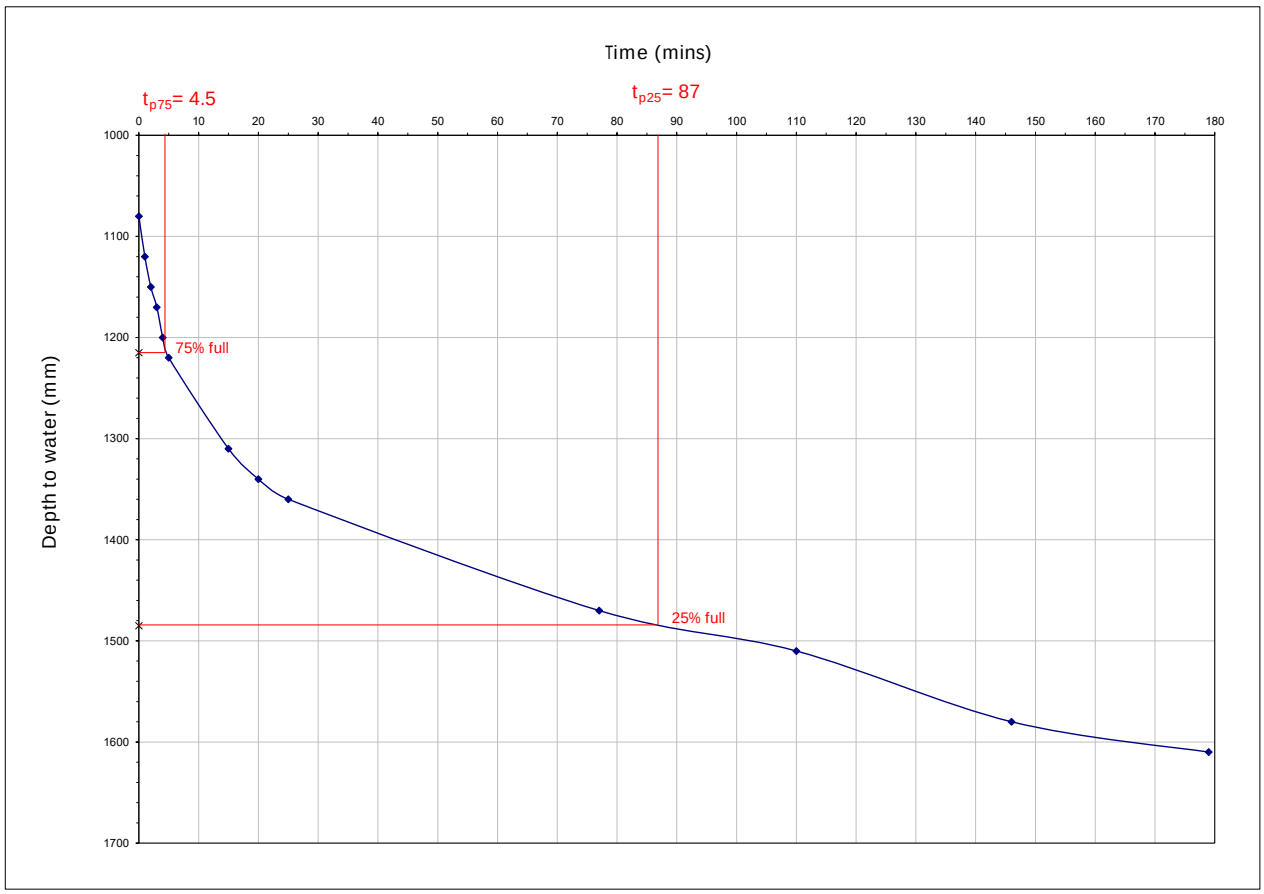
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.80	2800
Width	=	0.60	600
Depth	=	1.62	1620

Effective Depth (% full)		(mm)	(m)
0.25	=	1485	1.49
0.50	=	1350	1.35
0.75	=	1215	1.22

Depth at start of test (mm)	=	1080
Depth at end of test (mm)	=	1610

Base area of pit	=	1.68
a_{p50} - 50% internal surface area inc. base	=	3.516
V_{p75-25} - Volume 75 - 25%	=	0.4536

Read from the graph:		
$t_{p\ 75}$ (min)	=	4.50
$t_{p\ 25}$ (min)	=	87.00



Soil infiltration rate, f, (m/s) = 2.61E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP20
Test No.	T1

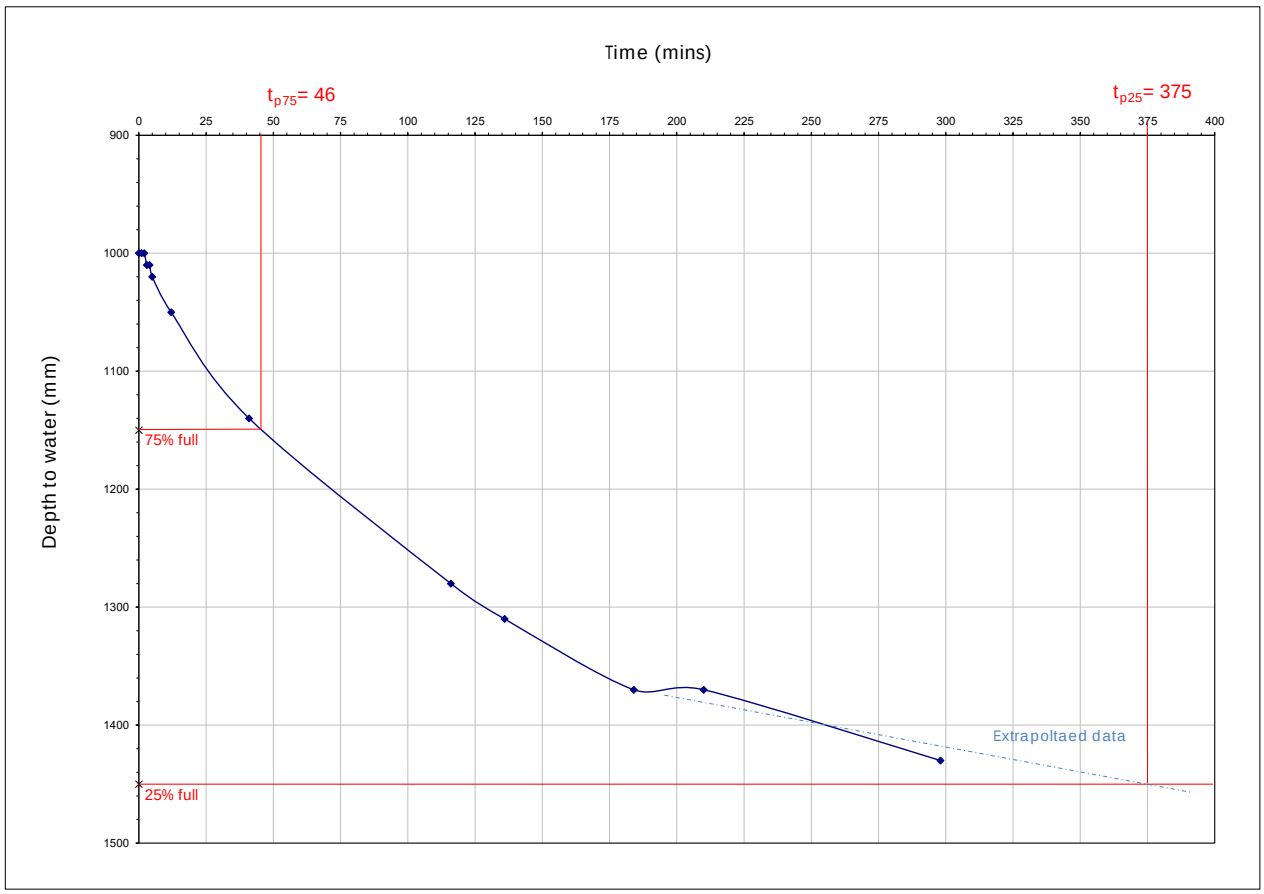
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:04	0	1.00	1000
10:05	1	1.00	1000
10:06	2	1.00	1000
10:07	3	1.01	1010
10:08	4	1.01	1010
10:09	5	1.02	1020
10:16	12	1.05	1050
10:45	41	1.14	1140
12:00	116	1.28	1280
12:20	136	1.31	1310
13:08	184	1.37	1370
13:34	210	1.37	1370
15:02	298	1.43	1430

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	3.40	3400
Width	=	0.60	600
Depth	=	1.60	1600

Effective Depth (% full)		(mm)	(m)
0.25	=	1450	1.45
0.50	=	1300	1.30
0.75	=	1150	1.15

Depth at start of test (mm)	=	1000
Depth at end of test (mm)	=	1430
Base area of pit	=	2.04
a_{p50} - 50% internal surface area inc. base	=	4.44
V_{p75-25} - Volume 75 - 25%	=	0.612

Read from the graph:		
$t_{p\ 75}$ (min)	=	46.00
$t_{p\ 25}$ (min)	=	375.00



Soil infiltration rate, f, (m/s) = 6.98E-06

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP21
Test No.	1

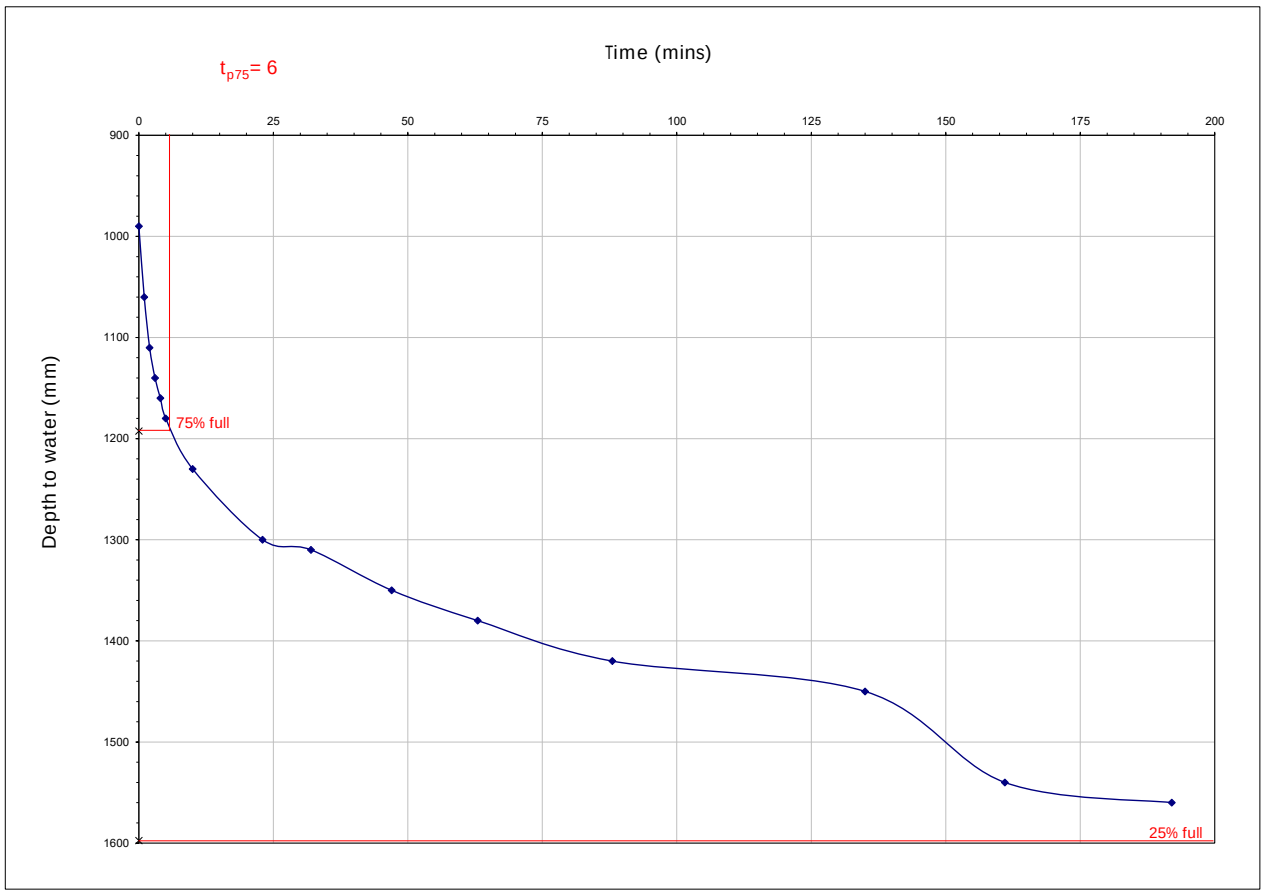
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:55	0	0.99	990
10:56	1	1.06	1060
10:57	2	1.11	1110
10:58	3	1.14	1140
10:59	4	1.16	1160
11:00	5	1.18	1180
11:05	10	1.23	1230
11:18	23	1.30	1300
11:27	32	1.31	1310
11:42	47	1.35	1350
11:58	63	1.38	1380
12:23	88	1.42	1420
13:10	135	1.45	1450
13:36	161	1.54	1540
15:07	192	1.56	1560

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	1.80	1800

Effective Depth (% full)		(mm)	(m)
0.25	=	1597.5	1.60
0.50	=	1395	1.40
0.75	=	1192.5	1.19

Depth at start of test (mm)	=	990
Depth at end of test (mm)	=	1560
Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	4.152
V_{p75-25} - Volume 75 - 25%	=	0.6318

Read from the graph:		
$t_{p\ 75}$ (min)	=	6.00
$t_{p\ 25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP22
Test No.	1

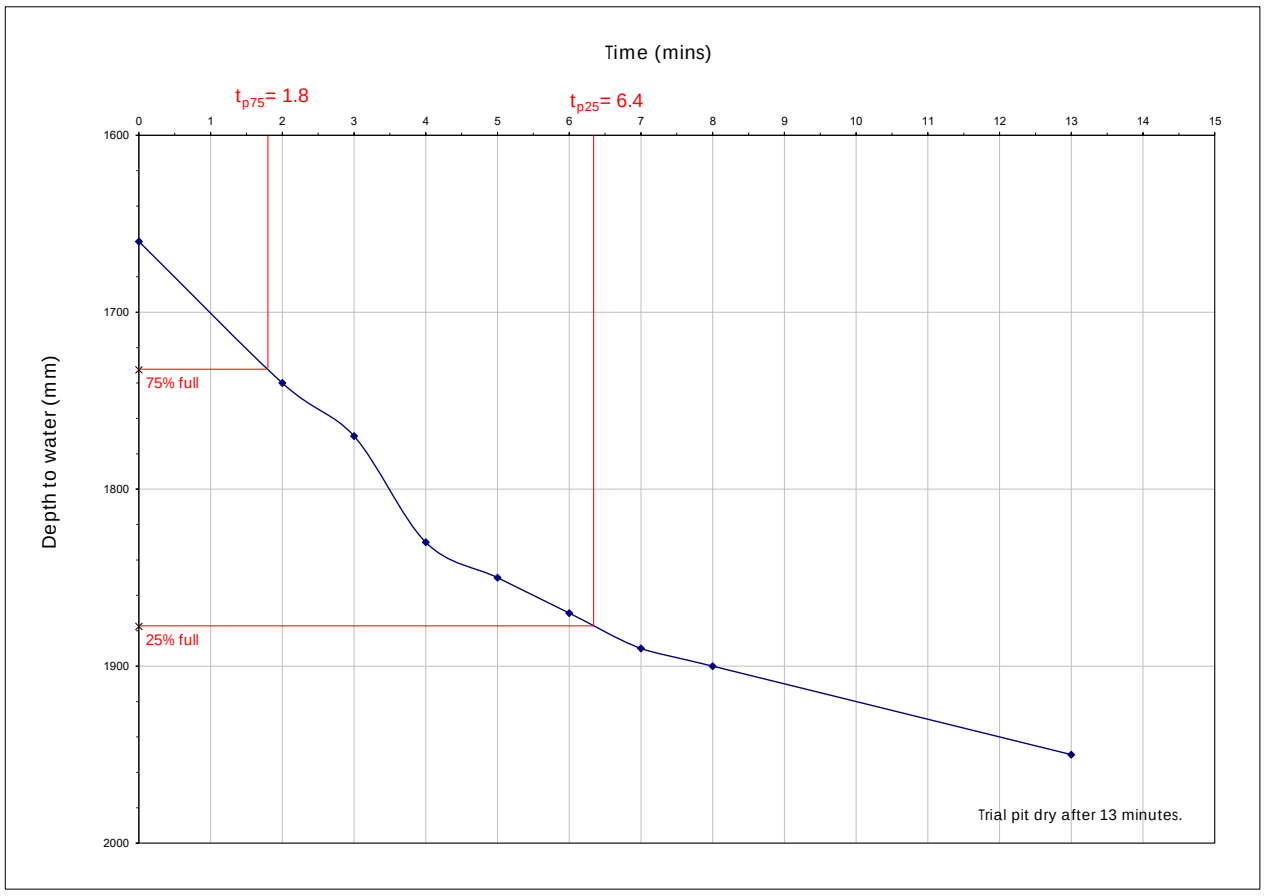
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
12:37	0	1.66	1660
12:39	2	1.74	1740
12:40	3	1.77	1770
12:41	4	1.83	1830
12:42	5	1.85	1850
12:43	6	1.87	1870
12:44	7	1.89	1890
12:45	8	1.90	1900
12:50	13	1.95	1950

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.95	1950

Effective Depth (% full)		(mm)	(m)
0.25	=	1877.5	1.88
0.50	=	1805	1.81
0.75	=	1732.5	1.73

Depth at start of test (mm)	=	1660
Depth at end of test (mm)	=	1950
Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	2.577
V_{p75-25} - Volume 75 - 25%	=	0.2349

Read from the graph:		
$t_{p\ 75}$ (min)	=	1.80
$t_{p\ 25}$ (min)	=	6.40



Soil infiltration rate, f, (m/s) = 3.30E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP22
Test No.	T1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
13:16	0	1.62	1620
13:17	1	1.66	1660
13:18	2	1.69	1690
13:19	3	1.71	1710
13:20	4	1.74	1740
13:21	5	1.78	1780
13:26	10	1.88	1880
13:29	13	1.94	1940

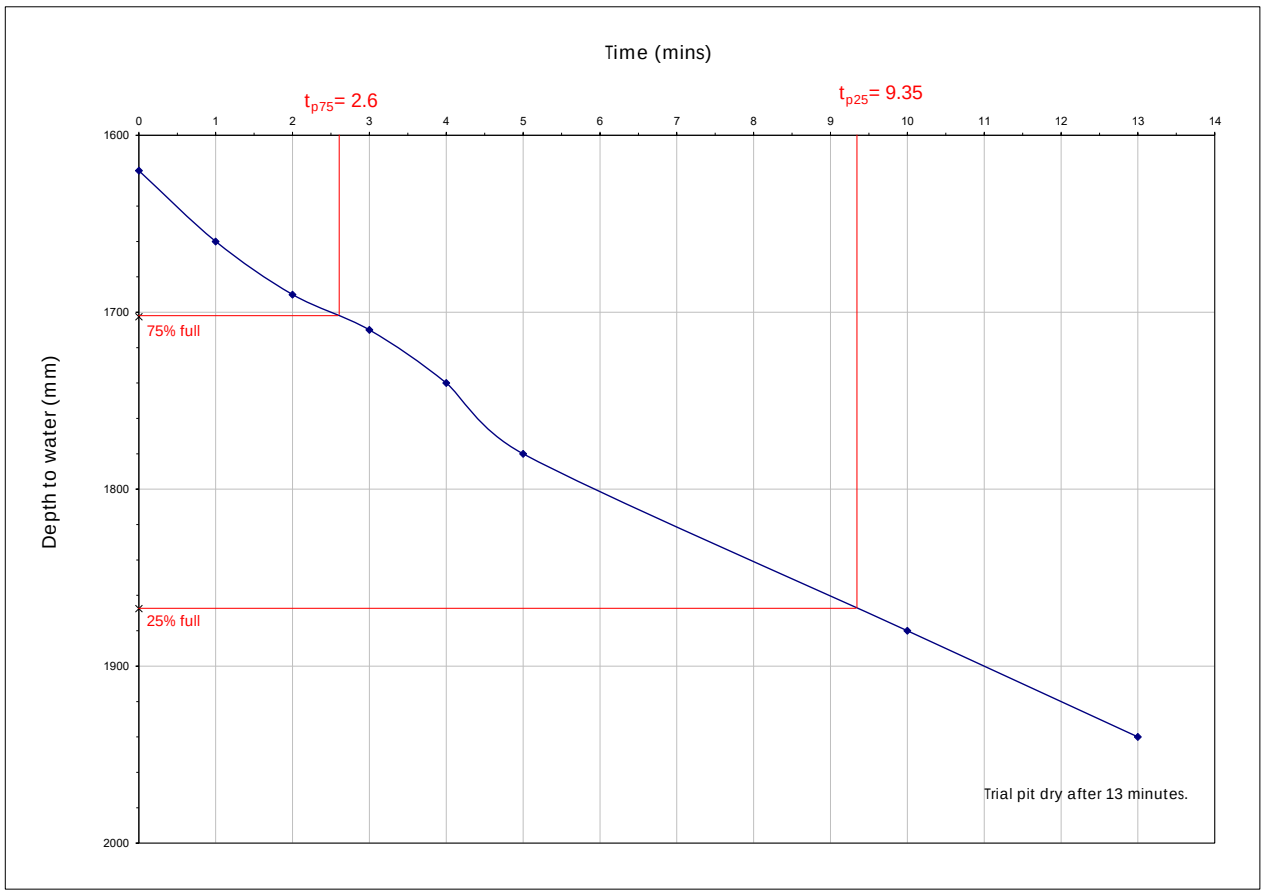
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.95	1950

Effective Depth (% full)		(mm)	(m)
0.25	=	1867.5	1.87
0.50	=	1785	1.79
0.75	=	1702.5	1.70

Depth at start of test (mm)	=	1620
Depth at end of test (mm)	=	1940

Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	2.709
V_{p75-25} - Volume 75 - 25%	=	0.2673

Read from the graph:		
$t_{p\ 75}$ (min)	=	2.60
$t_{p\ 25}$ (min)	=	9.35



Soil infiltration rate, f, (m/s) = 2.44E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP22
Test No.	3

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
13:47	0	1.66	1660
13:48	1	1.70	1700
13:49	2	1.72	1720
13:50	3	1.76	1760
13:52	5	1.79	1790
13:57	10	1.90	1900
14:01	14	1.98	1980

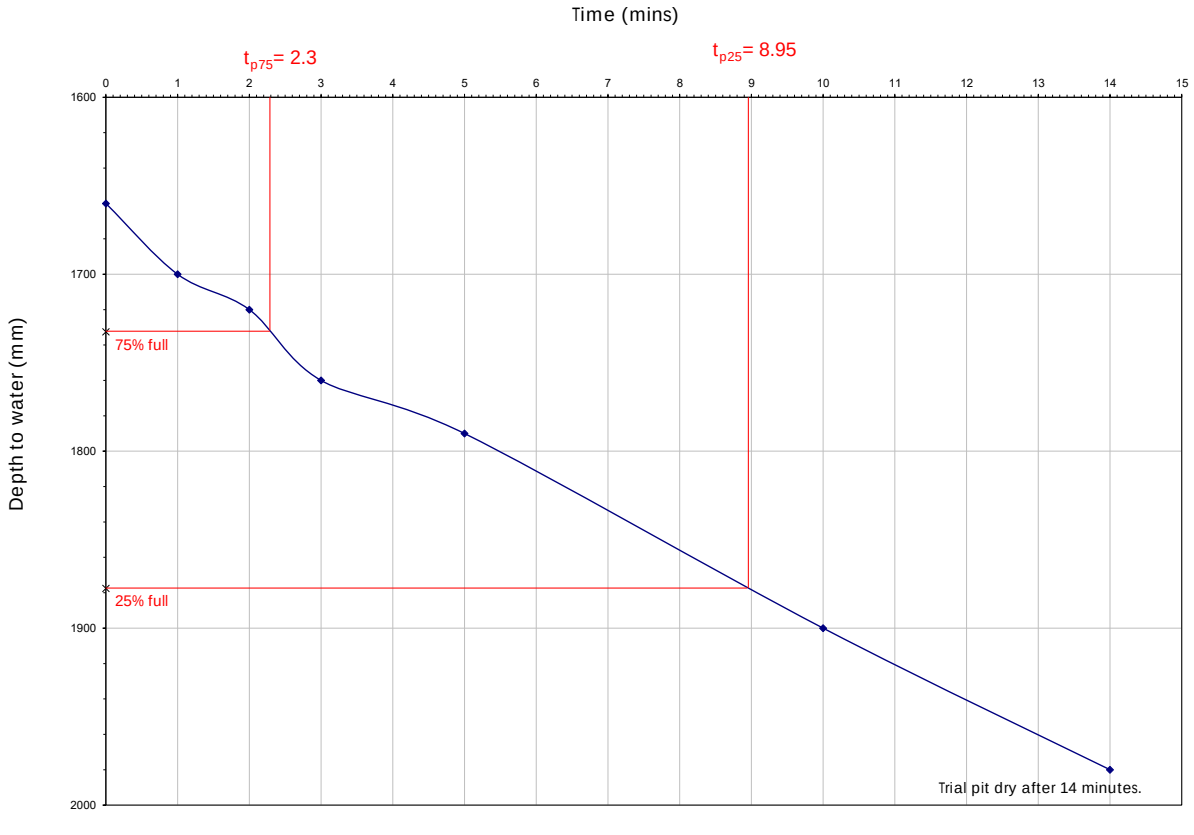
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.95	1950

Effective Depth (% full)		(mm)	(m)
0.25	=	1877.5	1.88
0.50	=	1805	1.81
0.75	=	1732.5	1.73

Depth at start of test (mm)	=	1660
Depth at end of test (mm)	=	1980

Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	2.577
V_{p75-25} - Volume 75 - 25%	=	0.2349

Read from the graph:		
$t_{p\ 75}$ (min)	=	2.30
$t_{p\ 25}$ (min)	=	8.95



Soil infiltration rate, f, (m/s) = 2.28E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Engineer	A Taylor
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Date:	16/11/2018
Trial Pit No.	TP30
Test No.	1

Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
08:52	0	0.83	830
08:53	1	0.87	870
08:54	2	0.92	920
08:55	3	0.95	950
08:56	4	0.97	970
08:57	5	0.99	990
09:02	10	1.08	1080
09:14	22	1.20	1200
09:17	25	1.22	1220

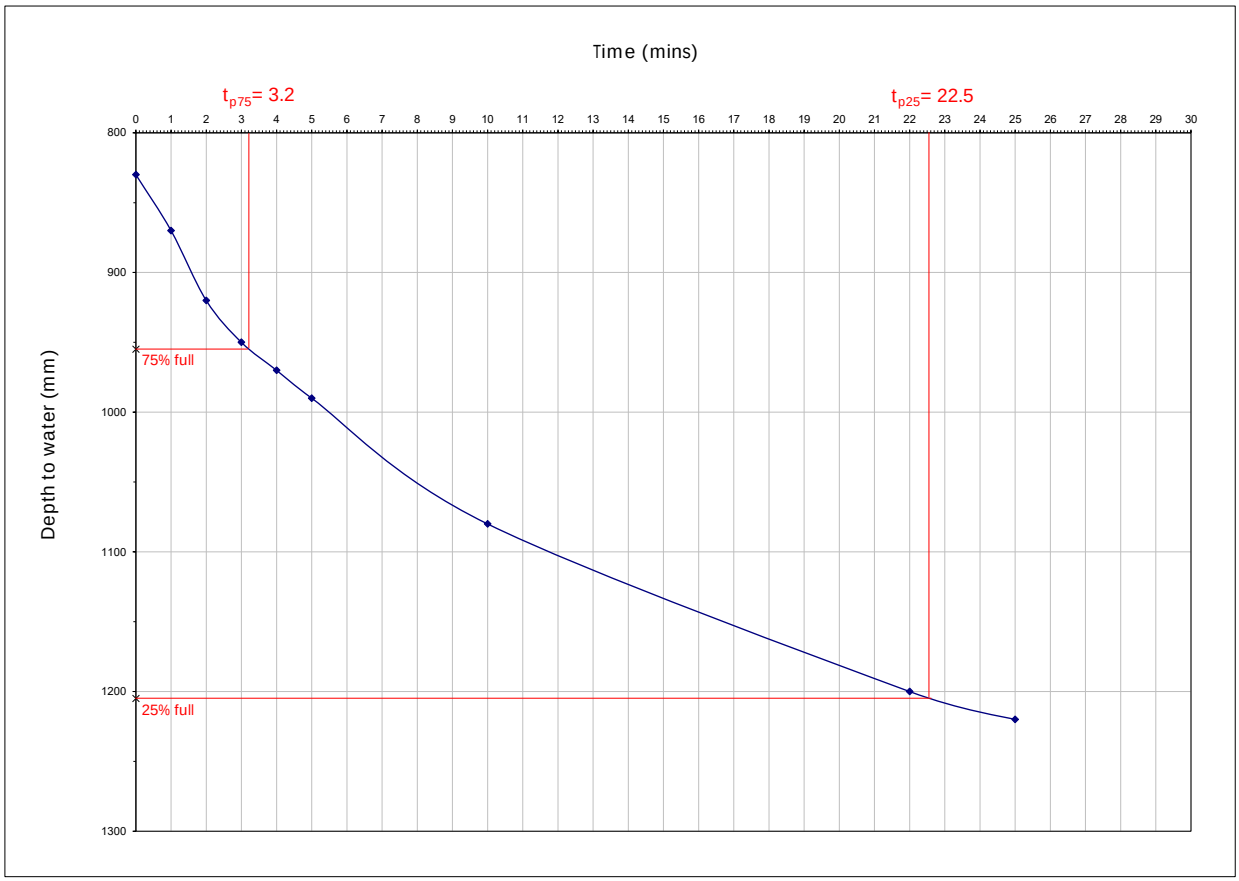
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.33	1330

Effective Depth (% full)		(mm)	(m)
0.25	=	1205	1.21
0.50	=	1080	1.08
0.75	=	955	0.96

Depth at start of test (mm)	=	830
Depth at end of test (mm)	=	1220

Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	3.27
V_{p75-25} - Volume 75 - 25%	=	0.405

Read from the graph:		
$t_{p\ 75}$ (min)	=	3.2
$t_{p\ 25}$ (min)	=	22.5



Soil infiltration rate, f, (m/s) = 1.07E-04

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP30
Test No.	T2

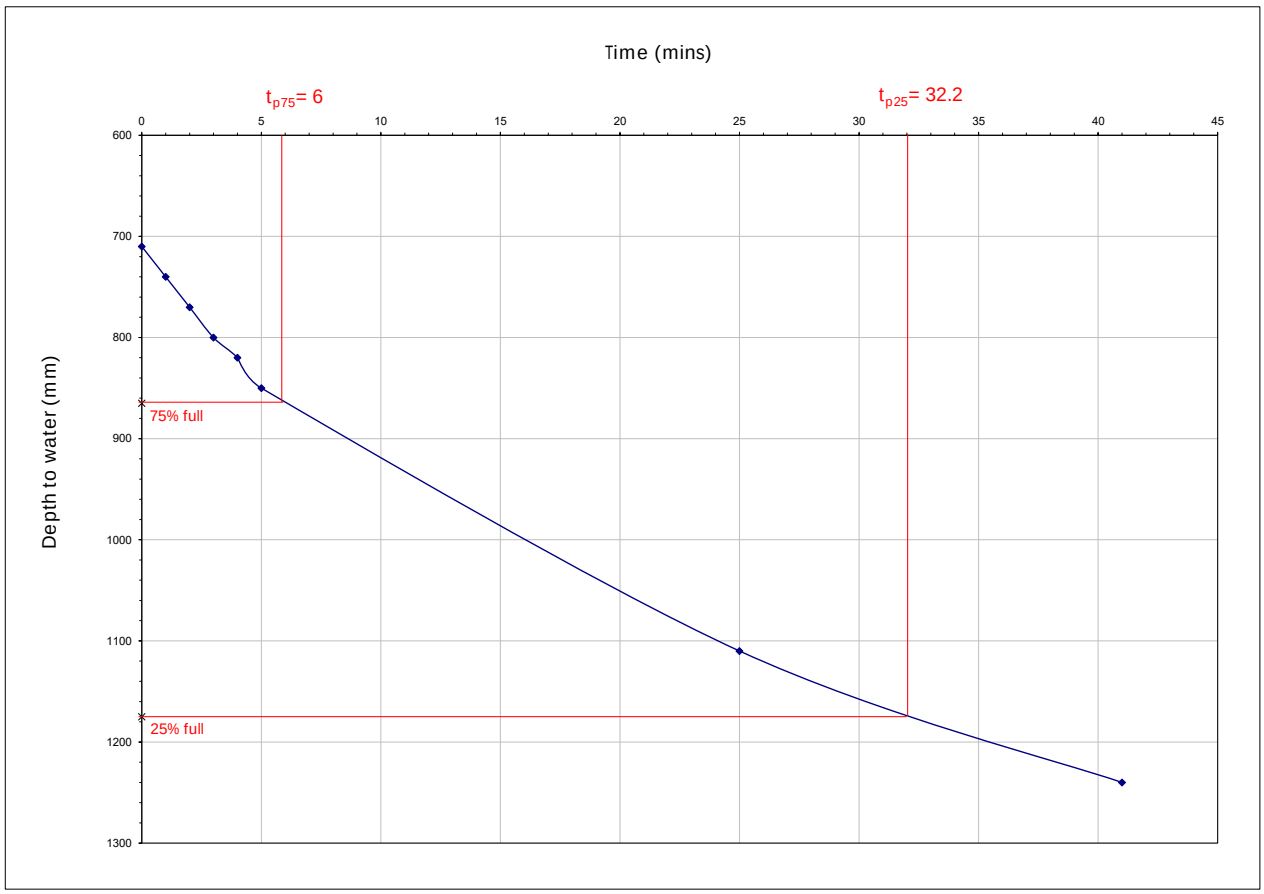
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:18	0	0.71	710
09:19	1	0.74	740
09:20	2	0.77	770
09:21	3	0.80	800
09:22	4	0.82	820
09:23	5	0.85	850
09:43	25	1.11	1110
09:59	41	1.24	1240

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.33	1330

Effective Depth (% full)		(mm)	(m)
0.25	=	1175	1.18
0.50	=	1020	1.02
0.75	=	865	0.87

Depth at start of test (mm)	=	710
Depth at end of test (mm)	=	1240
Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	3.666
V_{p75-25} - Volume 75 - 25%	=	0.5022

Read from the graph:		
$t_{p\ 75}$ (min)	=	6.00
$t_{p\ 25}$ (min)	=	32.20



Soil infiltration rate, f, (m/s) = 8.71E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP30
Test No.	T3

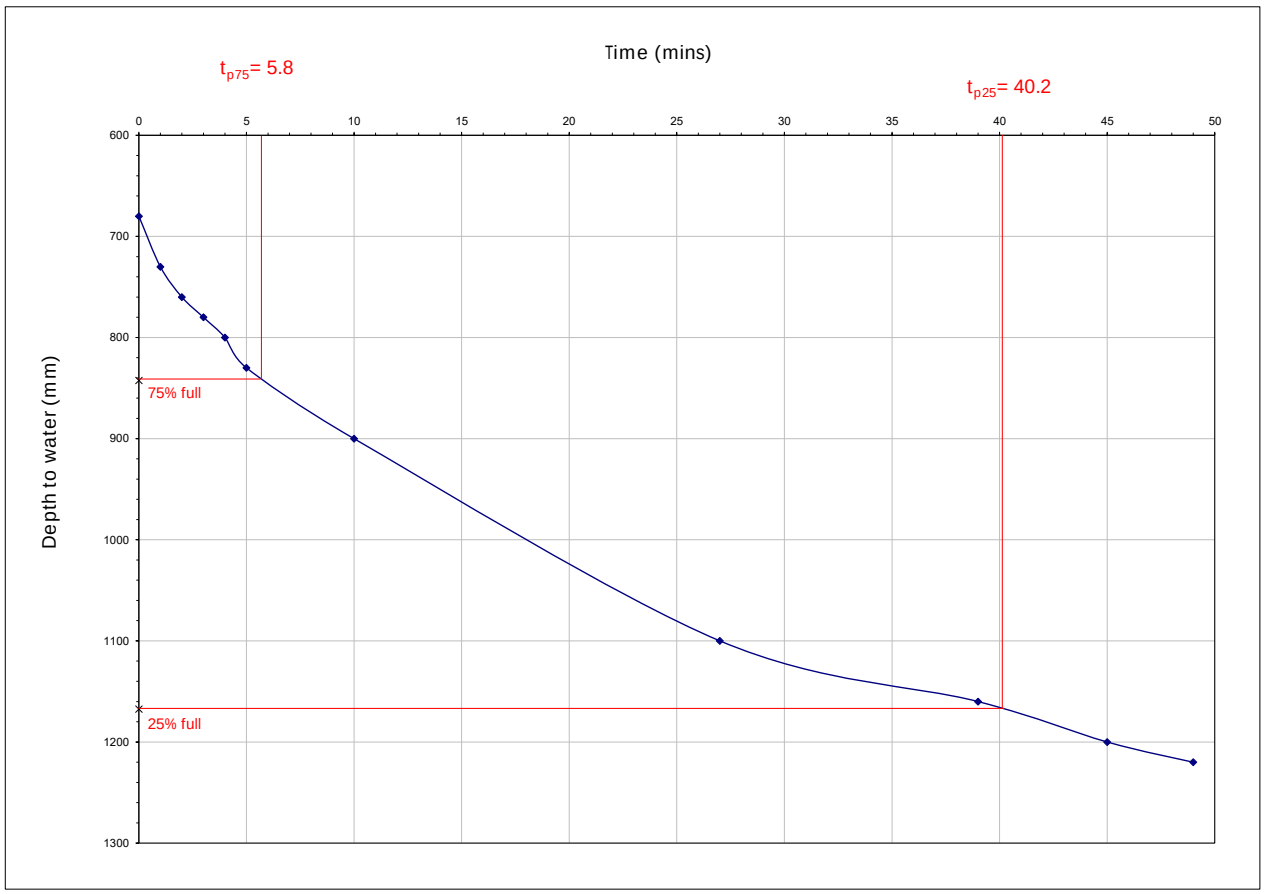
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:38	0	0.68	680
11:39	1	0.73	730
11:40	2	0.76	760
11:41	3	0.78	780
11:42	4	0.80	800
11:43	5	0.83	830
11:48	10	0.90	900
12:05	27	1.10	1100
12:17	39	1.16	1160
12:23	45	1.20	1200
12:27	49	1.22	1220

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.33	1330

Effective Depth (% full)		(mm)	(m)
0.25	=	1167.5	1.17
0.50	=	1005	1.01
0.75	=	842.5	0.84

Depth at start of test (mm)	=	680
Depth at end of test (mm)	=	1220
Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	3.765
V_{p75-25} - Volume 75 - 25%	=	0.5265

Read from the graph:		
$t_{p\ 75}$ (min)	=	5.80
$t_{p\ 25}$ (min)	=	40.20



Soil infiltration rate, f, (m/s) = 6.78E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP31
Test No.	1

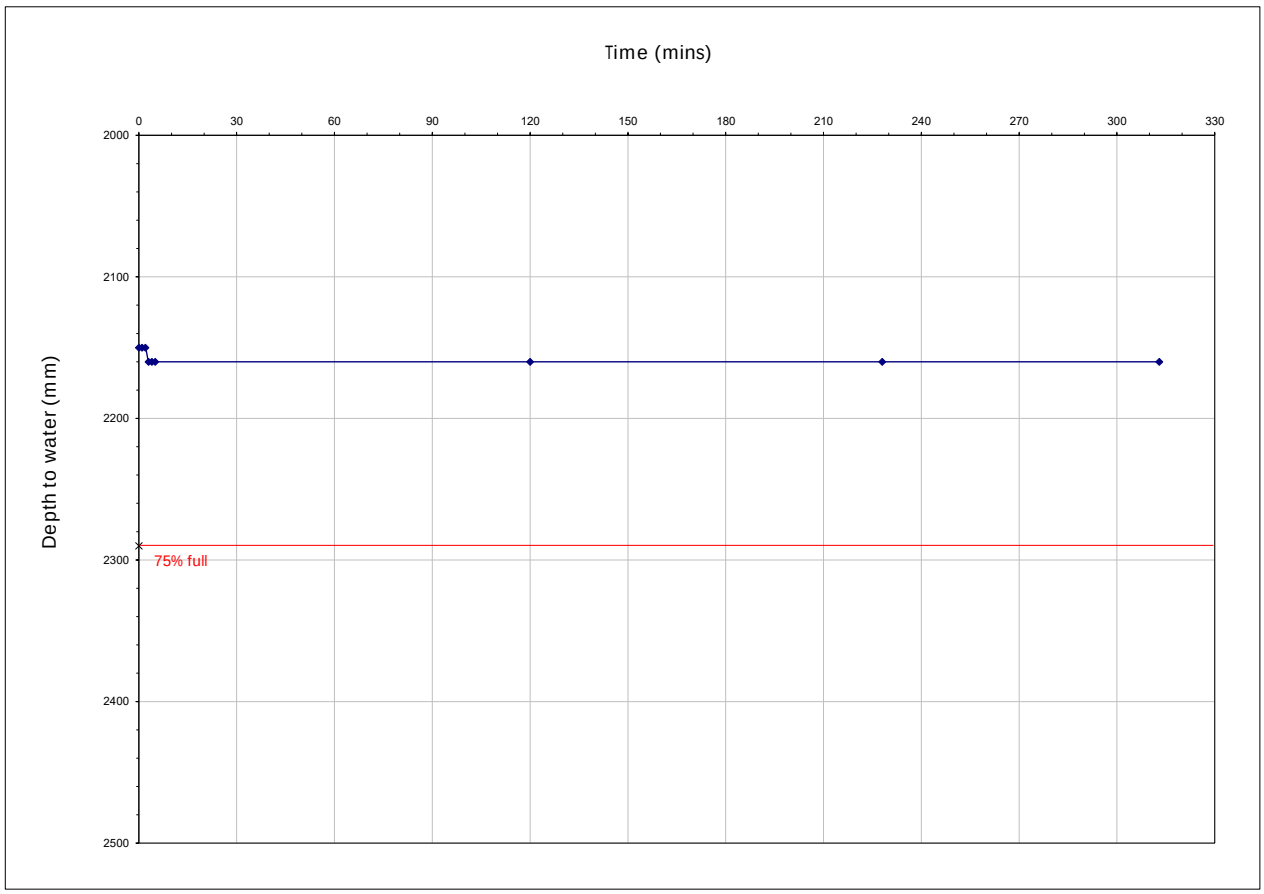
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:32	0	2.15	2150
09:33	1	2.15	2150
09:34	2	2.15	2150
09:35	3	2.16	2160
09:36	4	2.16	2160
09:37	5	2.16	2160
11:32	120	2.16	2160
13:20	228	2.16	2160
14:45	313	2.16	2160

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	3.10	3100
Width	=	0.60	600
Depth	=	2.71	2710

Effective Depth (% full)		(mm)	(m)
0.25	=	2570	2.57
0.50	=	2430	2.43
0.75	=	2290	2.29

Depth at start of test (mm)	=	2150
Depth at end of test (mm)	=	2160
Base area of pit	=	1.86
a_{p50} - 50% internal surface area inc. base	=	3.932
V_{p75-25} - Volume 75 - 25%	=	0.5208

Read from the graph:		
$t_{p\ 75}$ (min)	=	N/A
$t_{p\ 25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP32
Test No.	1

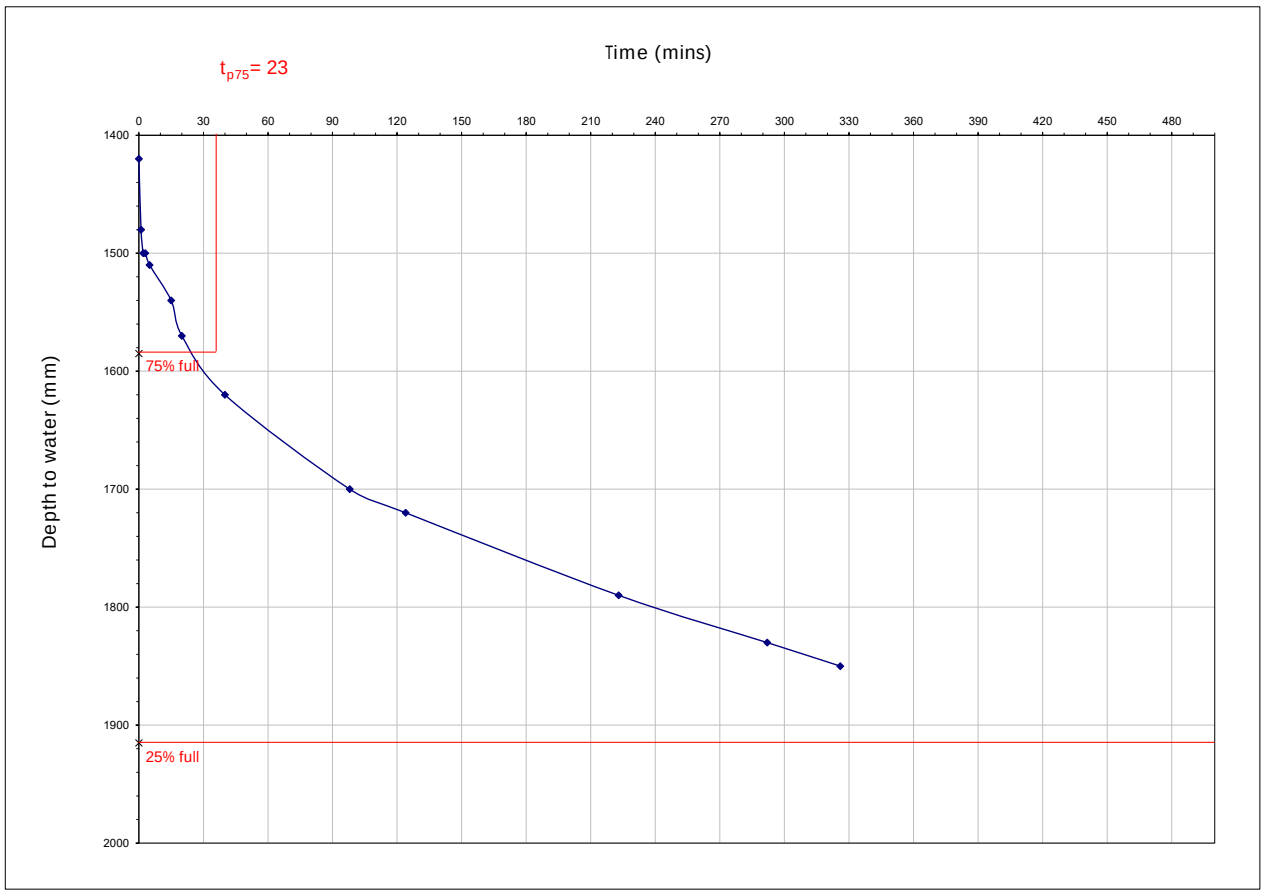
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:49	0	1.42	1420
09:50	1	1.48	1480
09:51	2	1.50	1500
09:52	3	1.50	1500
09:54	5	1.51	1510
10:04	15	1.54	1540
10:09	20	1.57	1570
10:29	40	1.62	1620
11:27	98	1.70	1700
11:53	124	1.72	1720
13:32	223	1.79	1790
14:41	292	1.83	1830
15:15	326	1.85	1850

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	2.08	2080

Effective Depth (% full)		(mm)	(m)
0.25	=	1915	1.92
0.50	=	1750	1.75
0.75	=	1585	1.59

Depth at start of test (mm)	=	1420
Depth at end of test (mm)	=	1850
Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	3.672
V_{p75-25} - Volume 75 - 25%	=	0.5148

Read from the graph:		
$t_{p\ 75}$ (min)	=	23.00
$t_{p\ 25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP33
Test No.	1

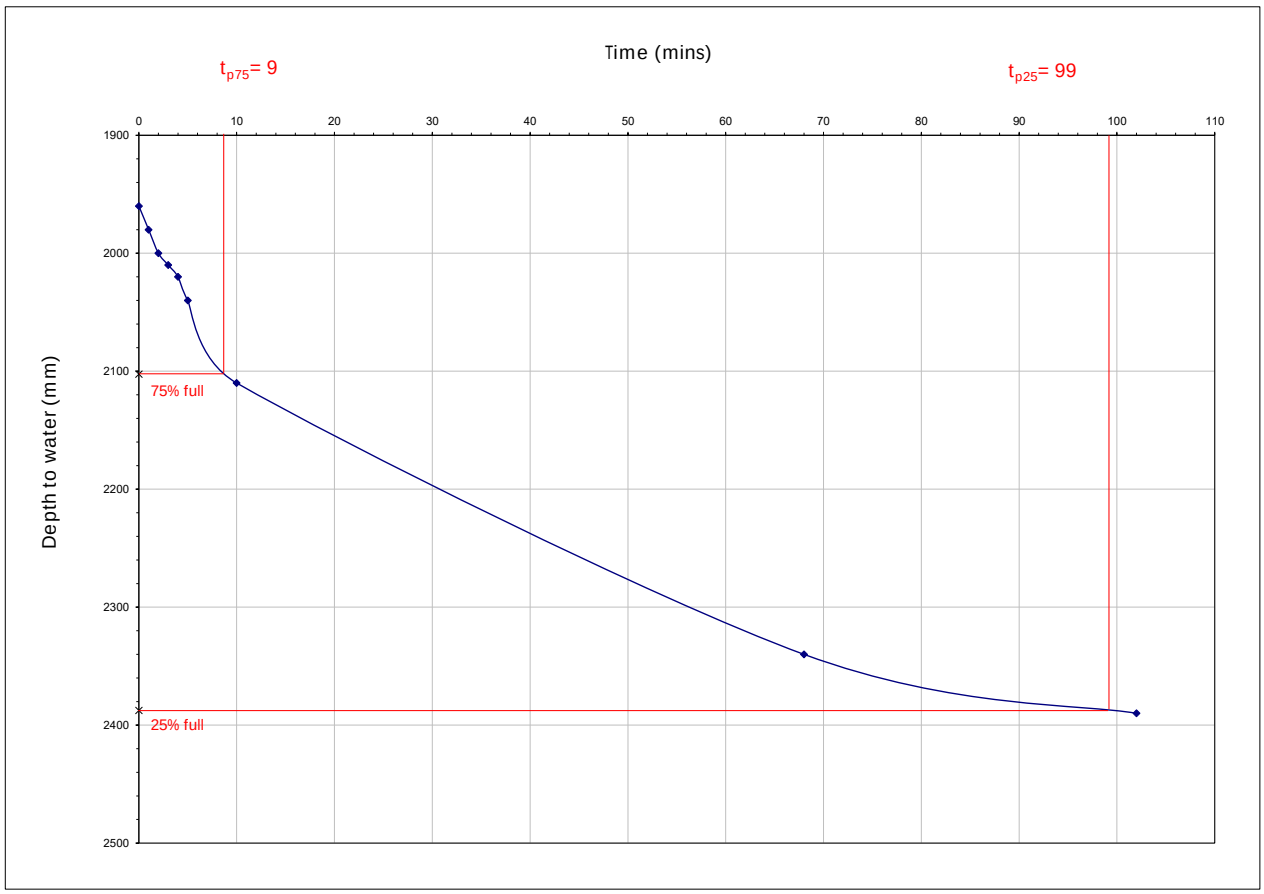
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:15	0	1.96	1960
10:16	1	1.98	1980
10:17	2	2.00	2000
10:18	3	2.01	2010
10:19	4	2.02	2020
10:20	5	2.04	2040
10:25	10	2.11	2110
11:23	68	2.34	2340
11:57	102	2.39	2390

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	2.53	2530

Effective Depth (% full)		(mm)	(m)
0.25	=	2387.5	2.39
0.50	=	2245	2.25
0.75	=	2102.5	2.10

Depth at start of test (mm)	=	1960
Depth at end of test (mm)	=	2390
Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	3.384
V_{p75-25} - Volume 75 - 25%	=	0.4446

Read from the graph:		
$t_{p\ 75}$ (min)	=	9.00
$t_{p\ 25}$ (min)	=	99.00



Soil infiltration rate, f, (m/s) = 2.43E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP33
Test No.	2

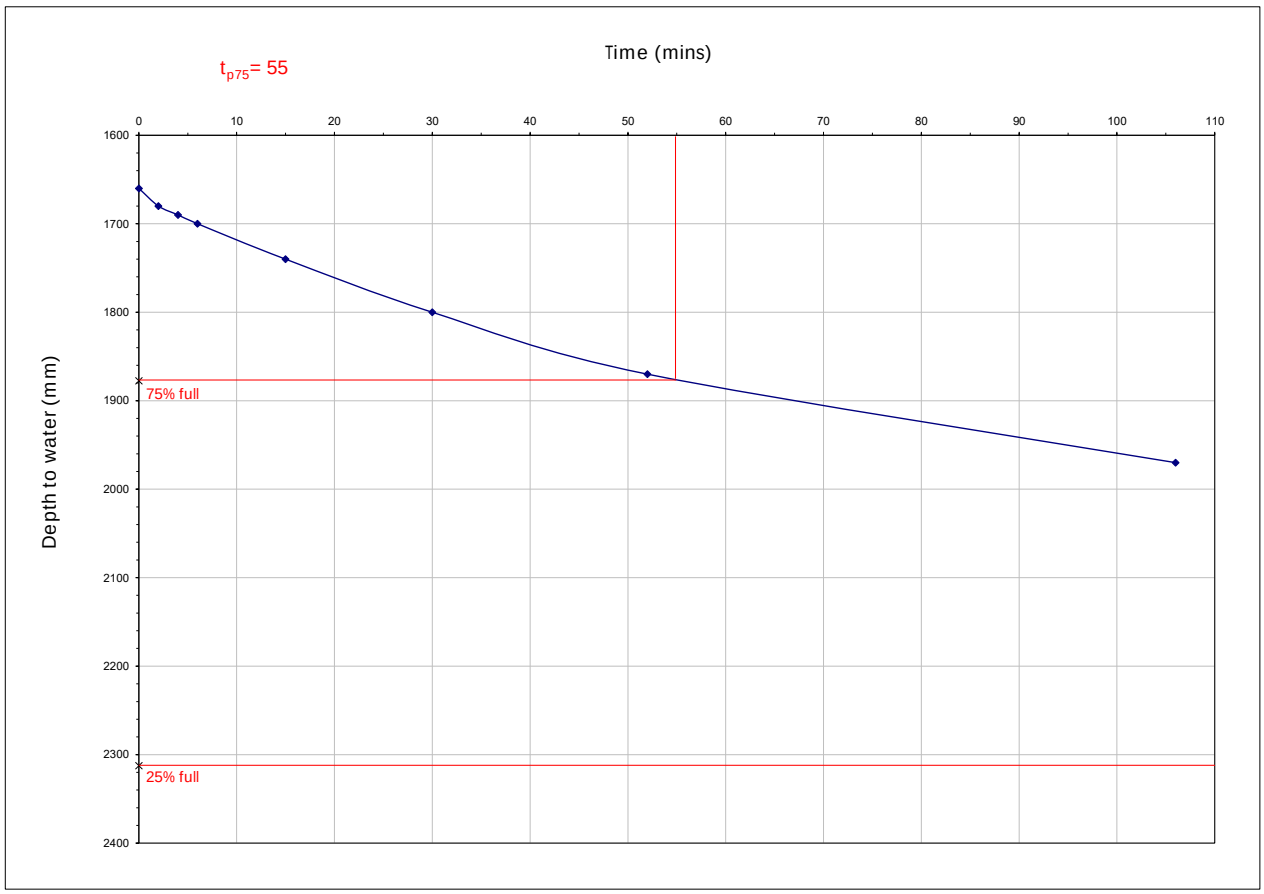
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
13:38	0	1.66	1660
13:40	2	1.68	1680
13:42	4	1.69	1690
13:44	6	1.70	1700
13:54	15	1.74	1740
14:08	30	1.80	1800
14:30	52	1.87	1870
15:24	106	1.97	1970

SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	2.53	2530

Effective Depth (% full)		(mm)	(m)
0.25	=	2312.5	2.31
0.50	=	2095	2.10
0.75	=	1877.5	1.88

Depth at start of test (mm)	=	1660
Depth at end of test (mm)	=	1970
Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	4.344
V_{p75-25} - Volume 75 - 25%	=	0.6786

Read from the graph:		
$t_{p\ 75}$ (min)	=	55.00
$t_{p\ 25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Hallam Land Management and Stockeld Park
Job Name:	Spofforth Hill (Hallam)
Job No.:	2638

Trial Pit No.	TP35
Test No.	1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:42	0	1.49	1490
10:43	1	1.49	1490
10:44	2	1.50	1500
10:45	3	1.50	1500
10:46	4	1.50	1500
11:02	20	1.52	1520
11:59	77	1.58	1580
13:28	166	1.60	1600
14:38	236	1.62	1620
15:08	266	1.63	1630

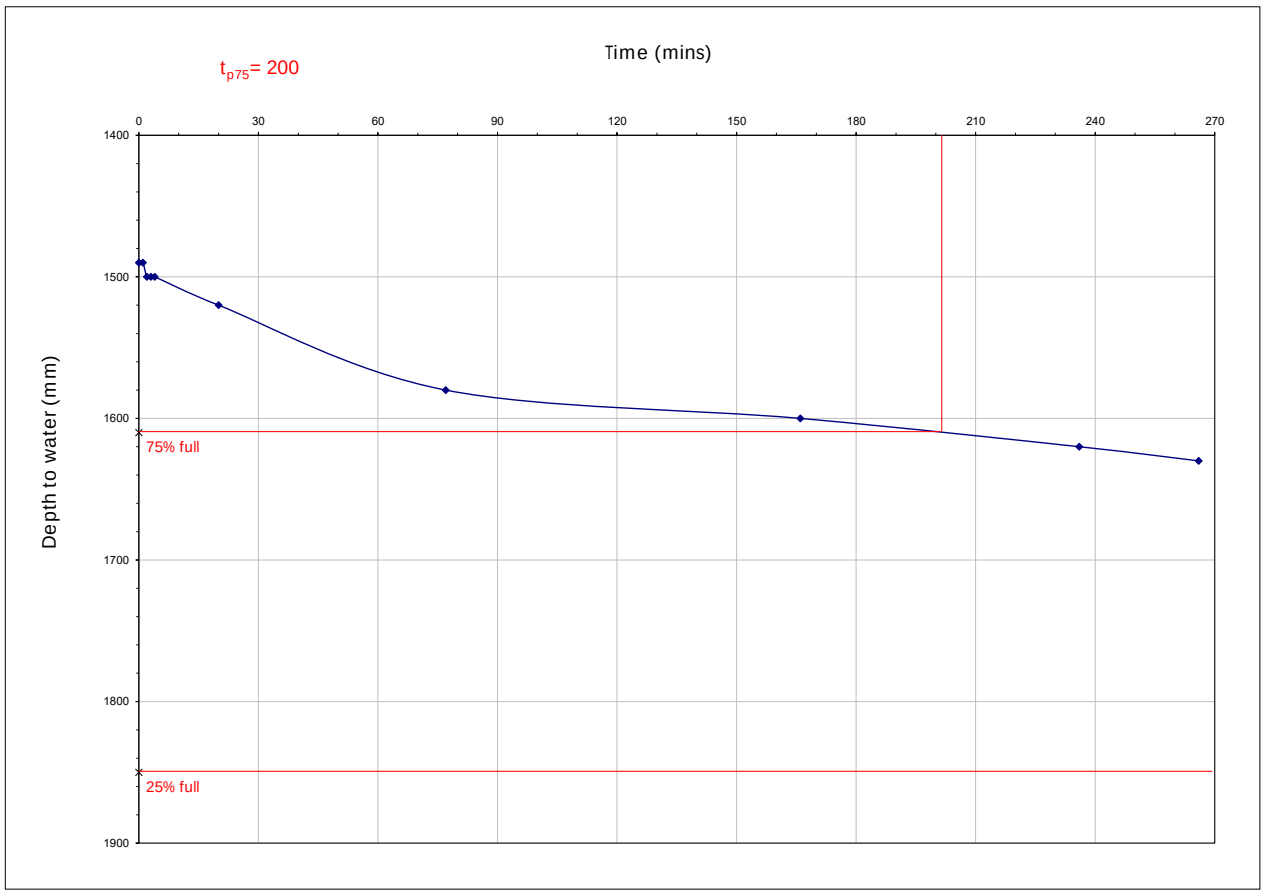
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.70	2700
Width	=	0.60	600
Depth	=	1.97	1970

Effective Depth (% full)		(mm)	(m)
0.25	=	1850	1.85
0.50	=	1730	1.73
0.75	=	1610	1.61

Depth at start of test (mm)	=	1490
Depth at end of test (mm)	=	1630

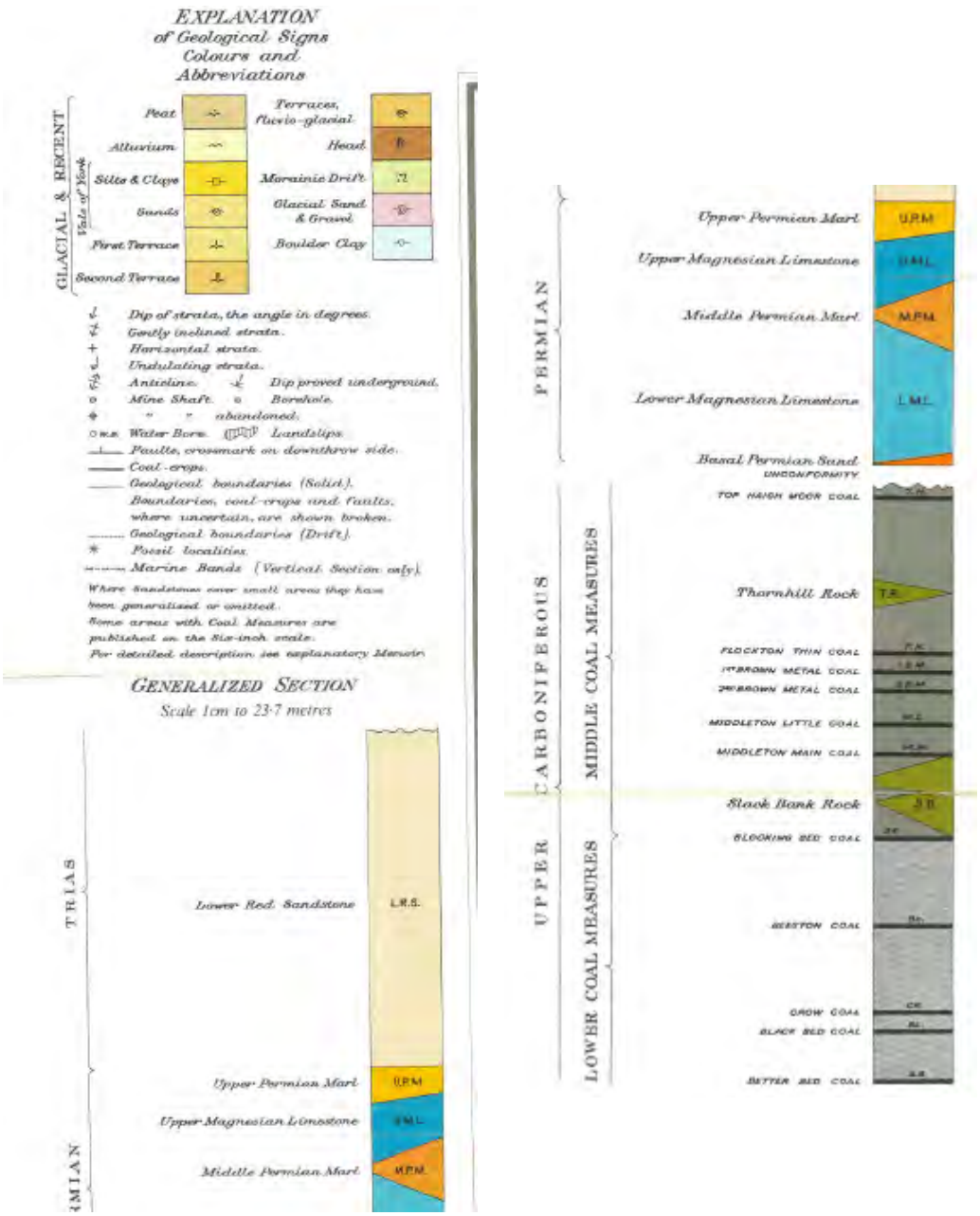
Base area of pit	=	1.62
a_{p50} - 50% internal surface area inc. base	=	3.204
V_{p75-25} - Volume 75 - 25%	=	0.3888

Read from the graph:		
$t_{p\ 75}$ (min)	=	200.00
$t_{p\ 25}$ (min)	=	N/A



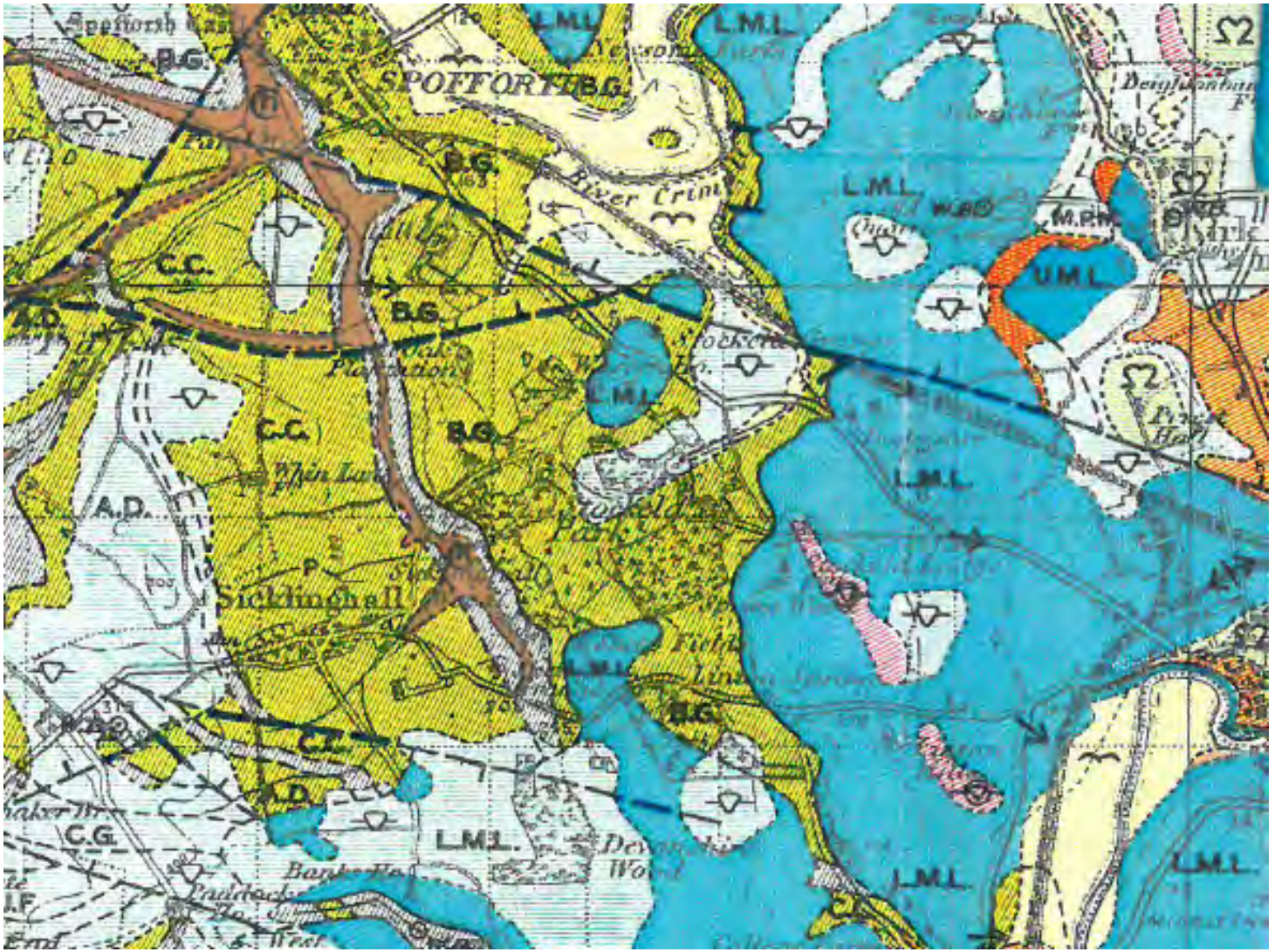
Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

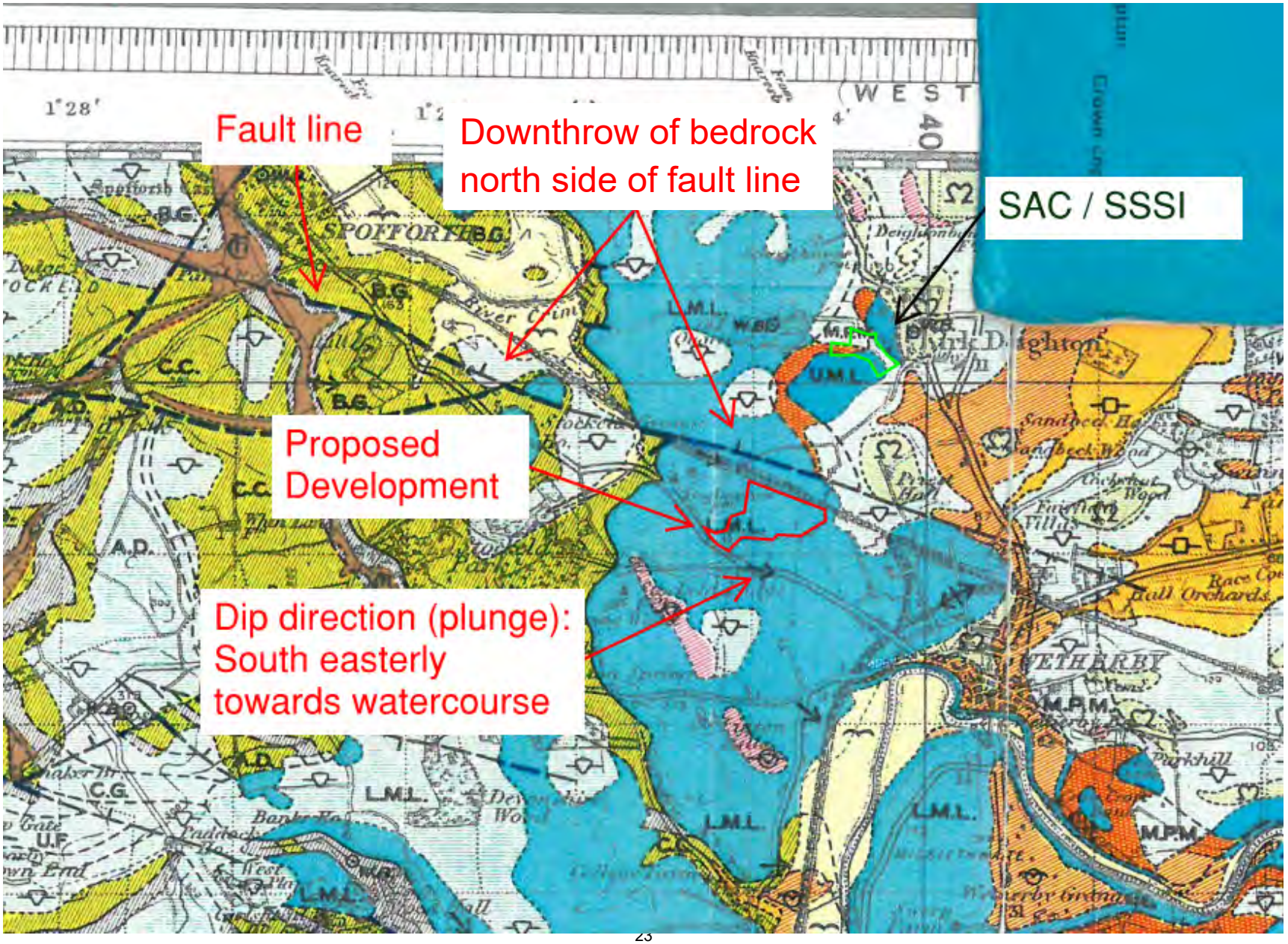
APPENDIX 3



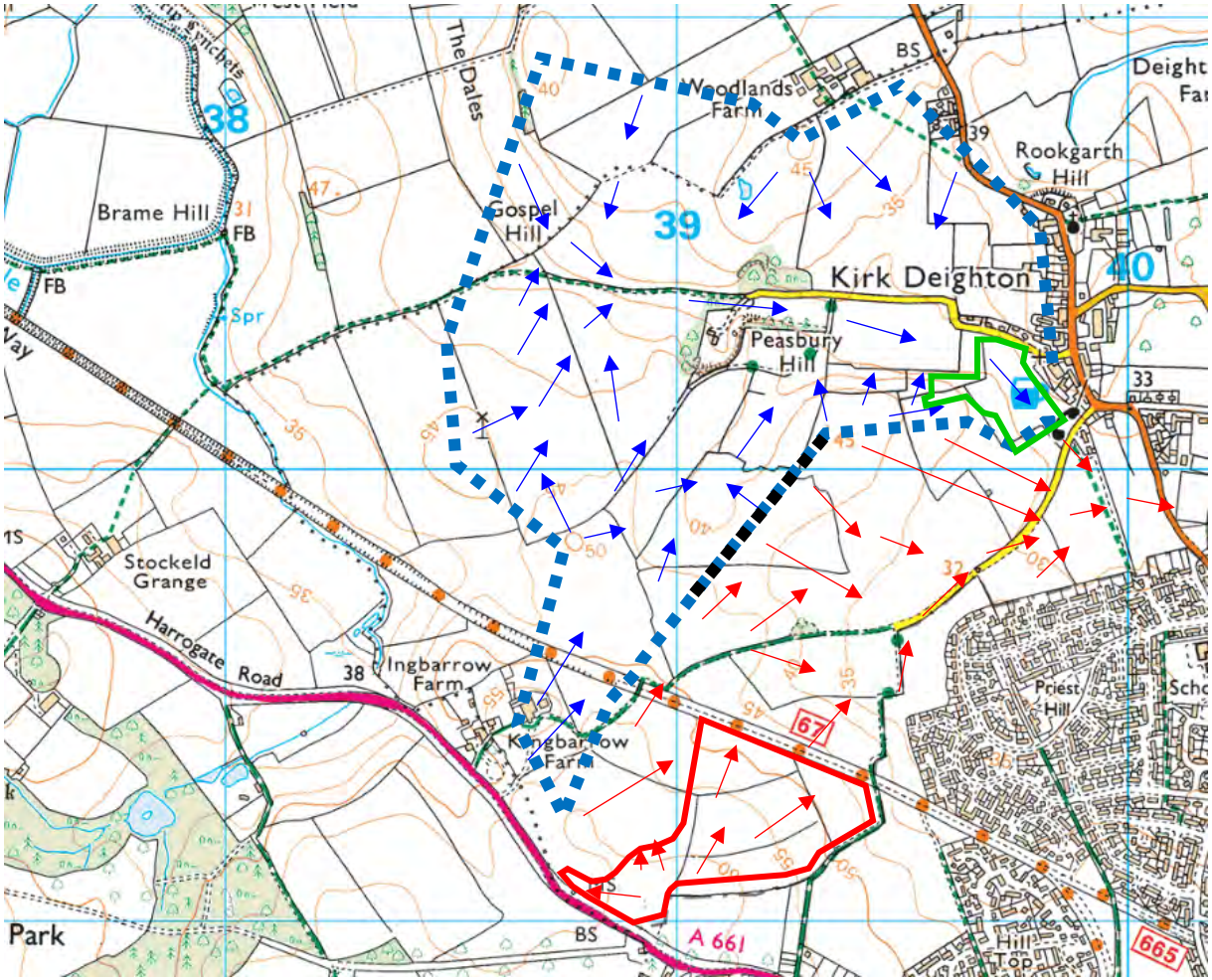
Geological map key

.


SPOFFORTH B.G.
B.G.
C.C.
A.D.
Sicklinghall
L.M.L.
U.M.L.
River Crimple
C.G.


Fault line
Downthrow of bedrock
north side of fault line
SAC / SSSI
Proposed
Development
Dip direction (plunge):
South easterly
towards watercourse

APPENDIX 4



Extract OS plan showing indicative Kirk Deighton SSSI catchment

- Indicative SAC/SSSI catchment
- Watershed (ridgeline)
- Overland runoff flow path
- Proposed development
- SAC/SSSI

APPENDIX 5

Climate variable

Rainfall

Year

2015

Period

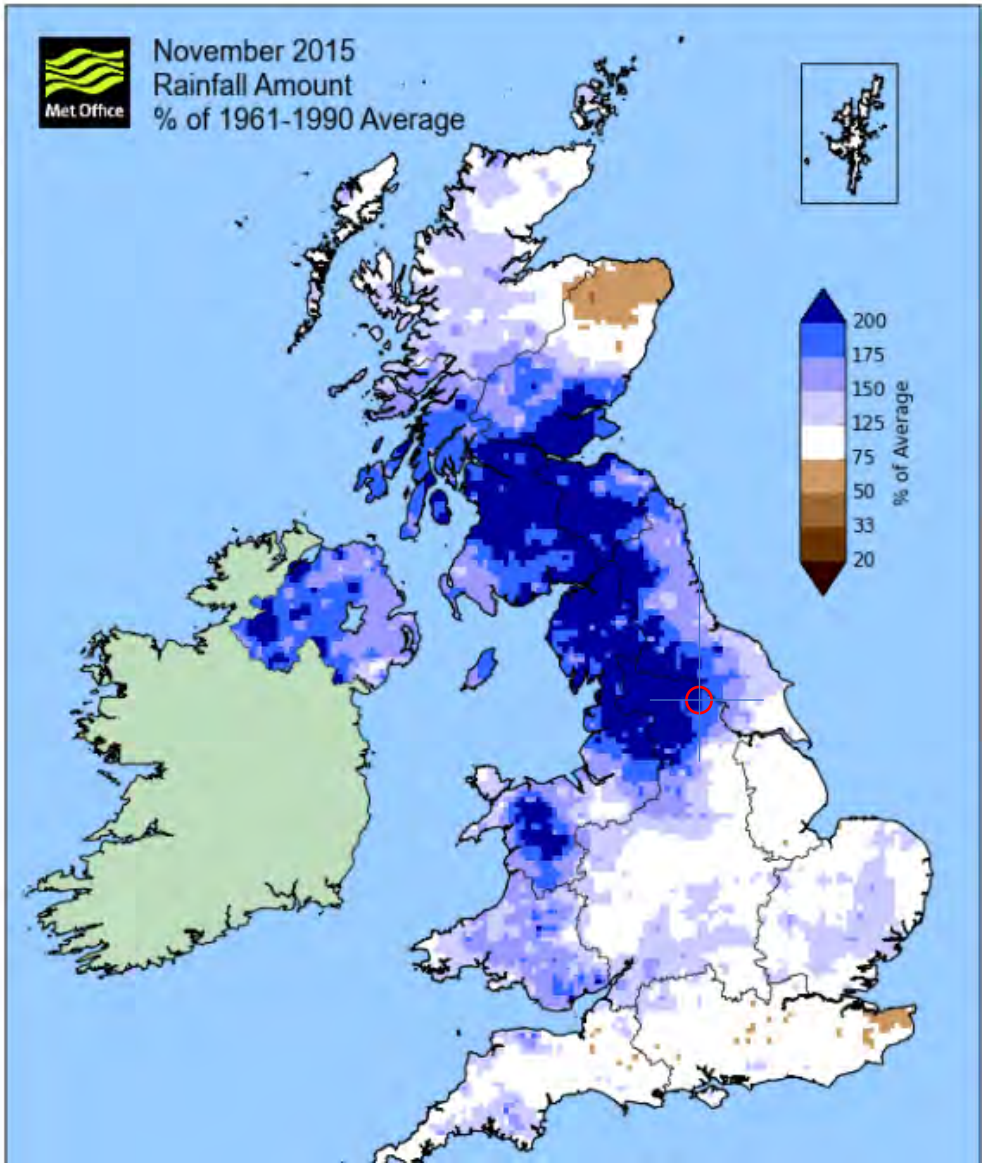
November

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

November 2015



Climate variable

Rainfall

Year

2015

Period

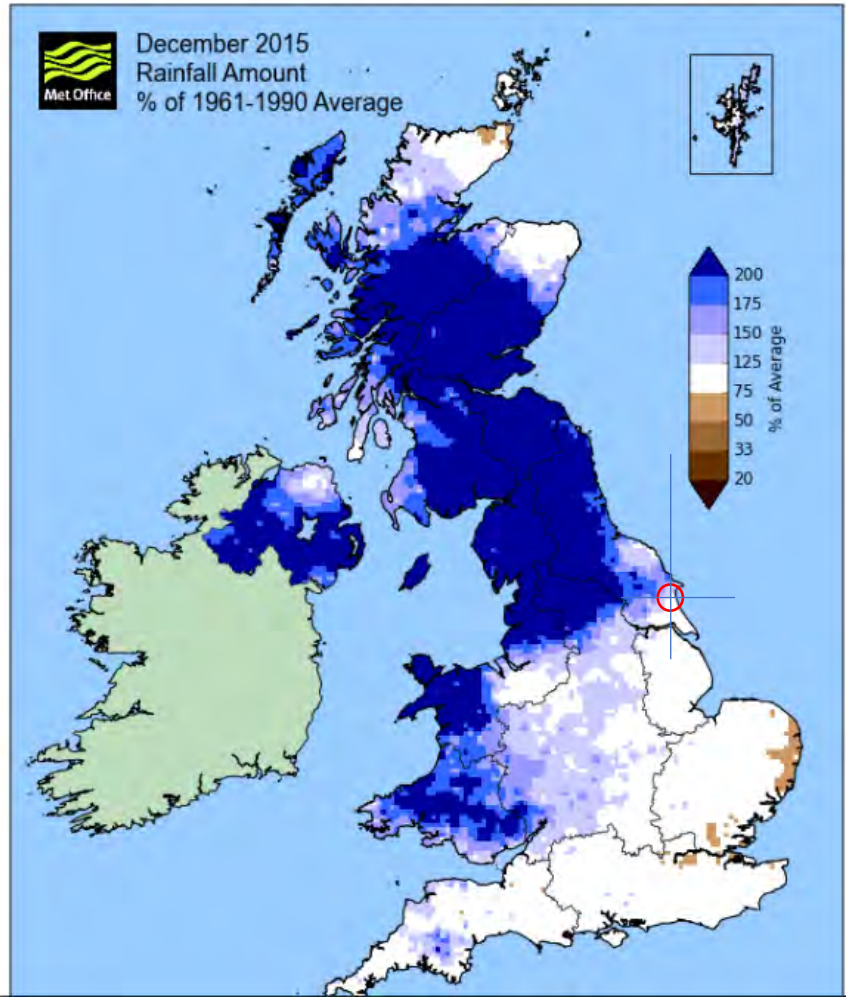
December

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

December 2015



Year

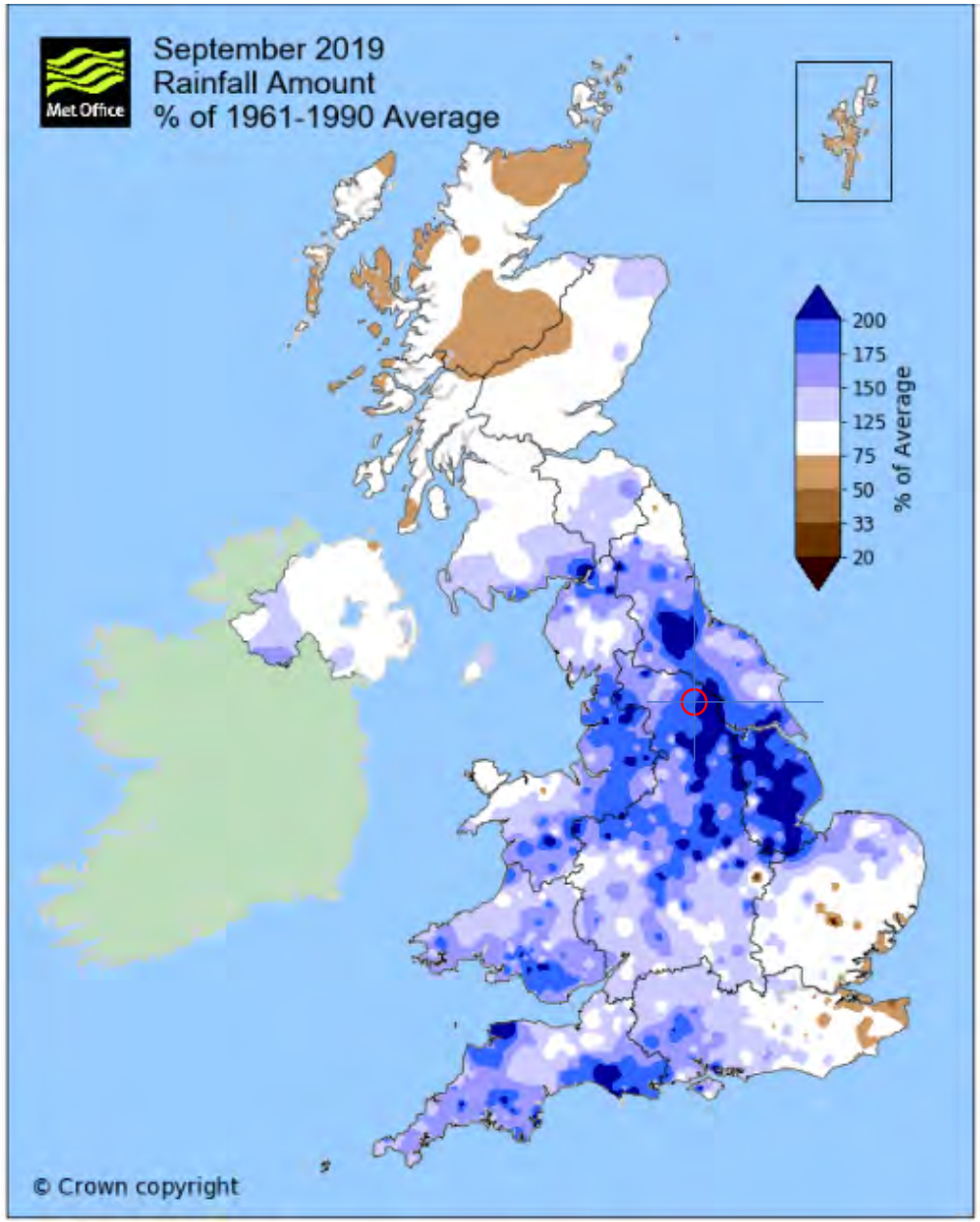
2019

Period

September

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly



Year

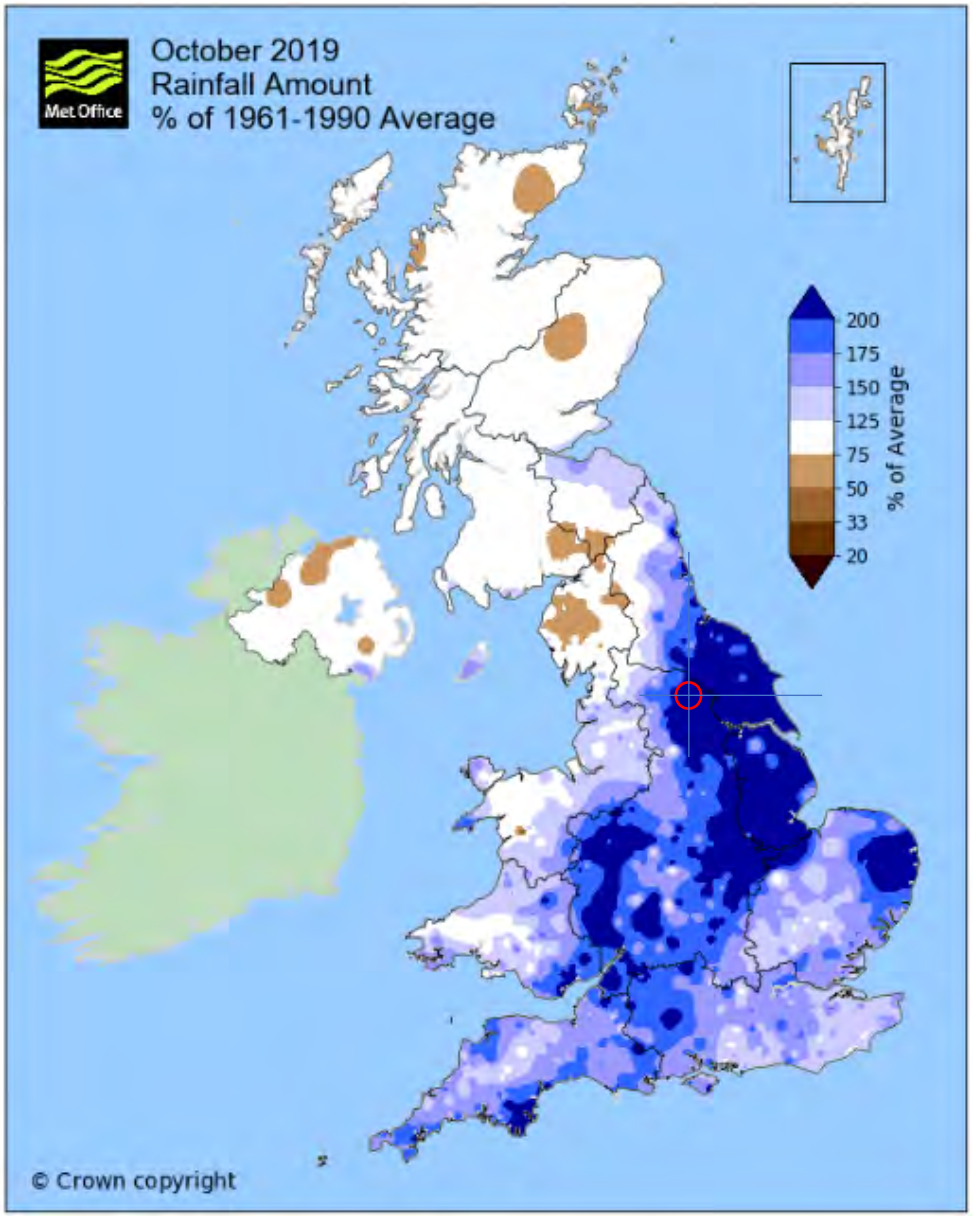
2019

Period

October

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly



Climate variable

Rainfall

Year

2017

Period

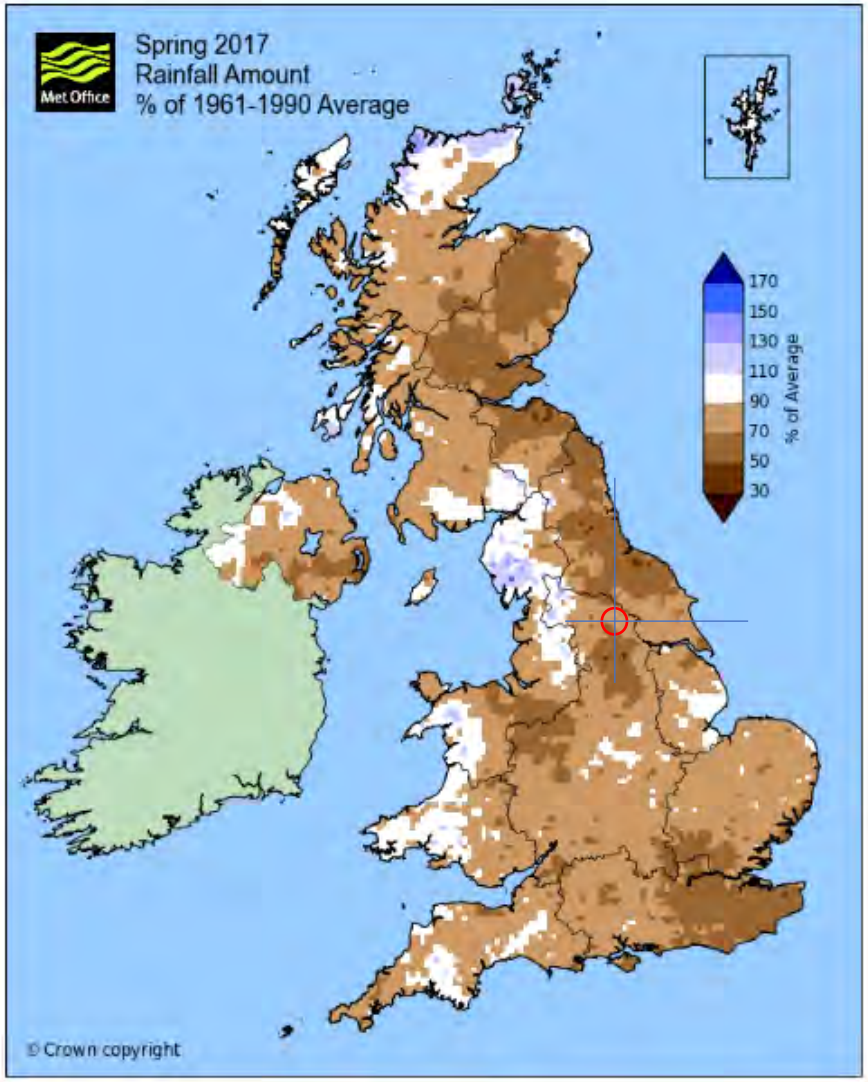
Spring

Map type

- ○ Actual
- ● 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Spring 2017



Climate variable

Rainfall

Year

2018

Period

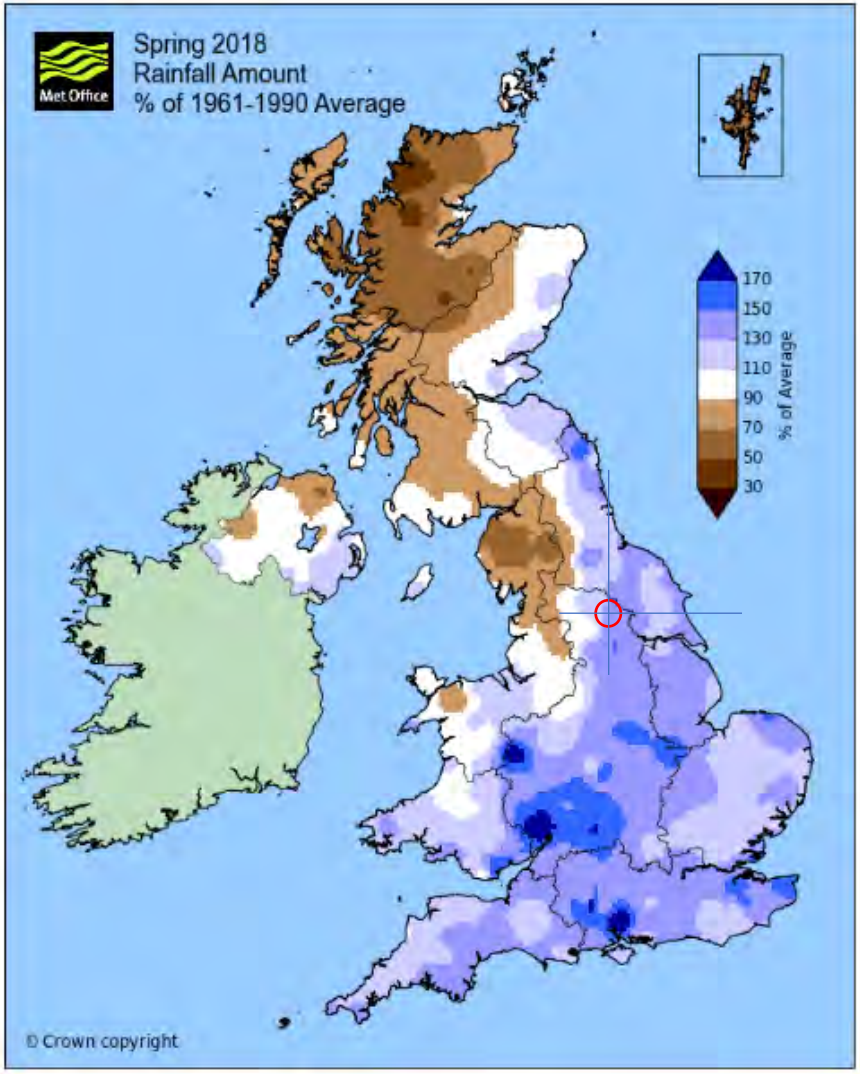
Spring

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Spring 2018



Climate variable

Rainfall

Year

2017

Period

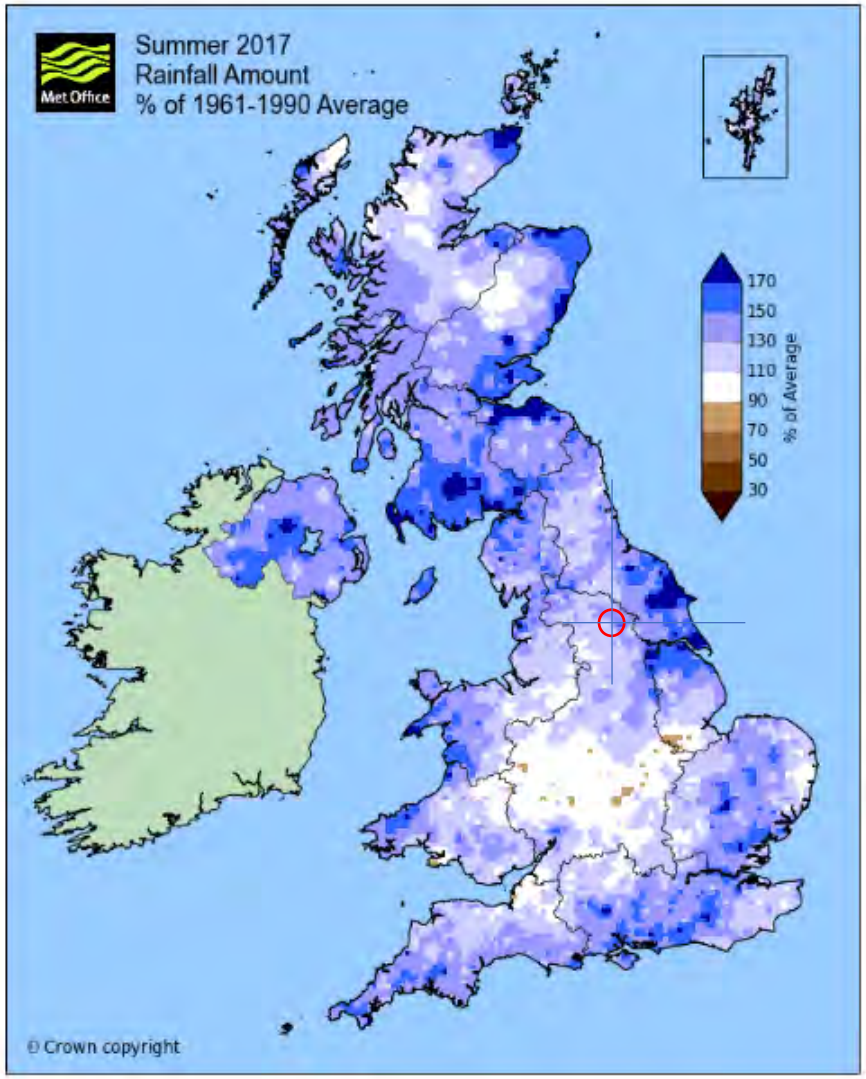
Summer

Map type

- Actual
- 1961 - 1990 anomaly
- 1971 - 2000 anomaly
- 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Summer 2017



Climate variable

Rainfall

Year

2018

Period

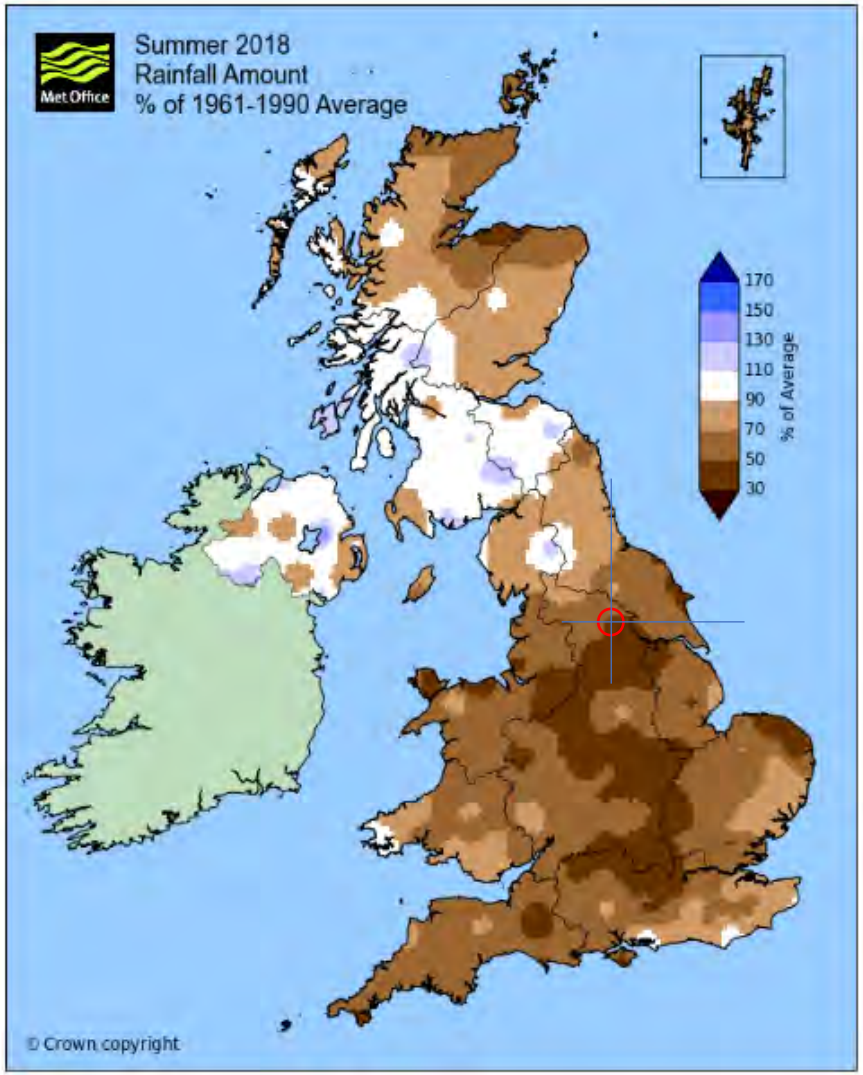
Summer

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Summer 2018



Climate variable

Rainfall

Year

2017

Period

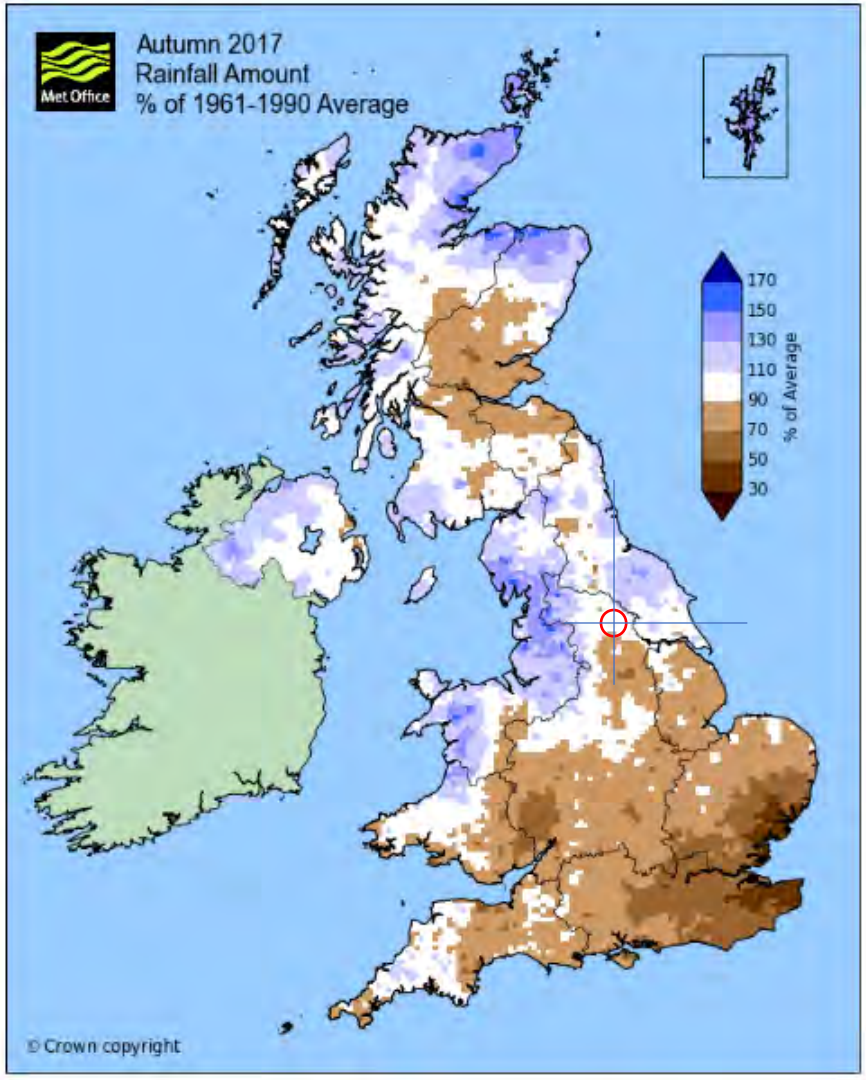
Autumn

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Autumn 2017



Climate variable

Rainfall

Year

2018

Period

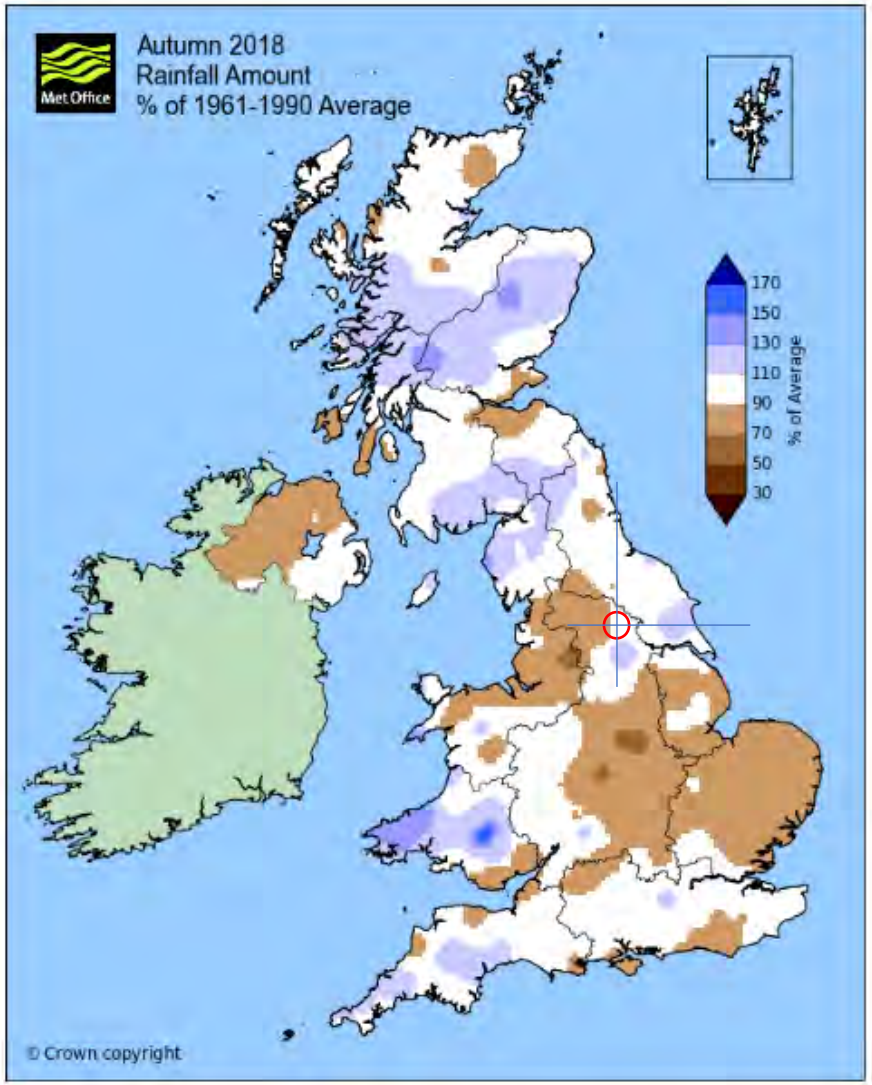
Autumn

Map type

- ○ Actual
- ◉ 1961 - 1990 anomaly
- ○ 1971 - 2000 anomaly
- ○ 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Autumn 2018



Climate variable

Rainfall

Year

2017

Period

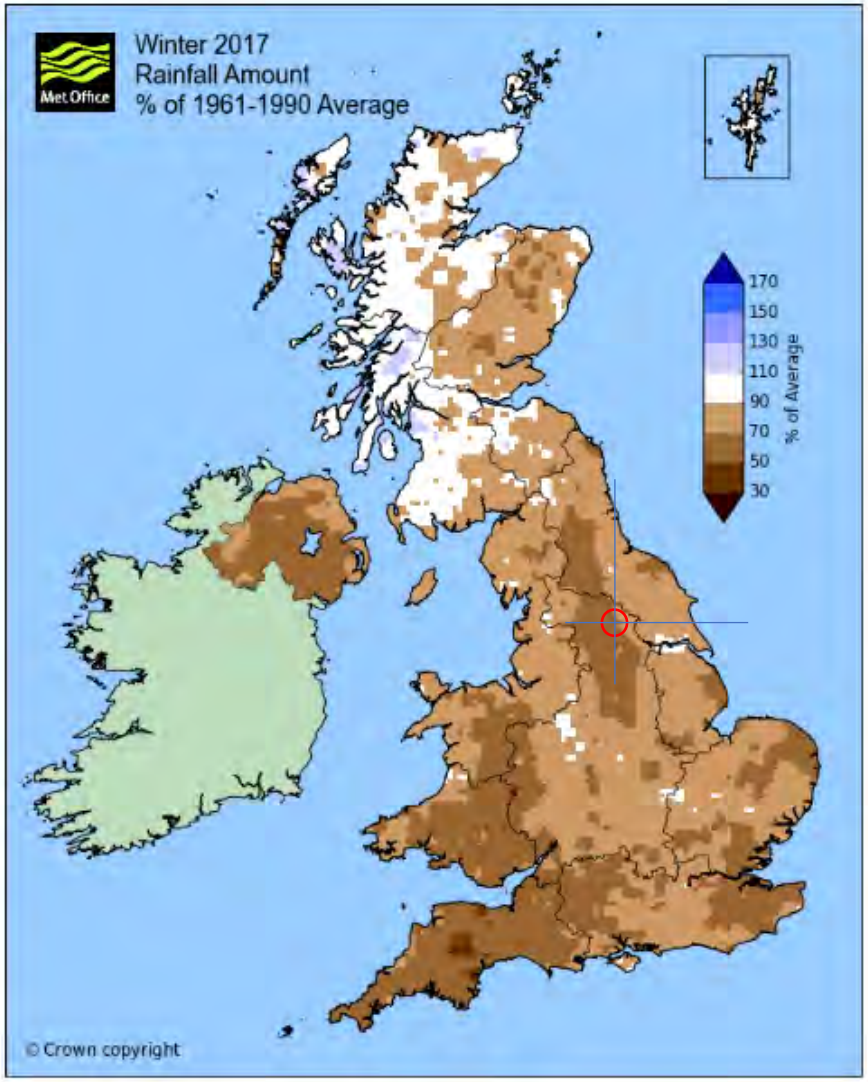
Winter

Map type

- Actual
- 1961 - 1990 anomaly
- 1971 - 2000 anomaly
- 1981 - 2010 anomaly

Rainfall 1961 - 1990 anomaly

Winter 2017



APPENDIX 6

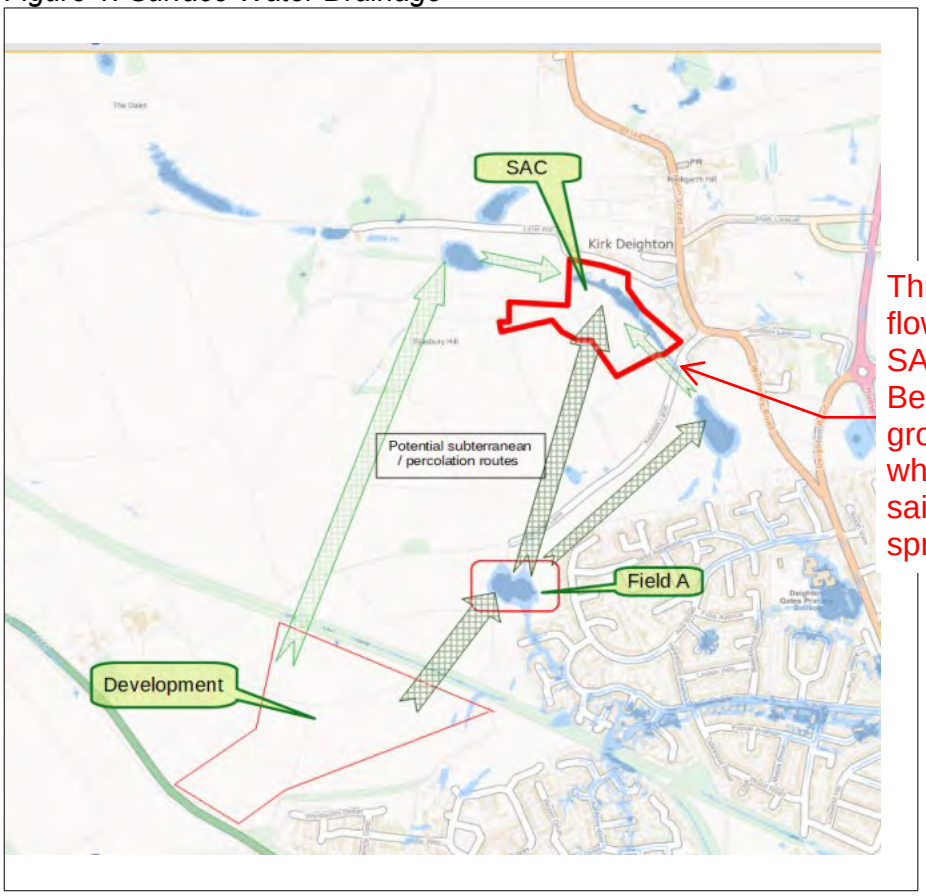
Better Wetherby Partnership Ltd
Wetherby
PO Box 755
LS22 9GA

2 SITE LOCATION / PROPOSED SURFACE WATER DRAINAGE

2.1 The site is located within the National Character Area 30: Southern Magnesian Limestone (http://publications.naturalengland.org.uk/publication/5733629942562816). The underlying bedrock is defined as a principal aquifer - "*..geological strata that exhibit high intergranular and/or fracture permeability and they usually provide a high level of water storage, supplying water and/or river base flow on a Strategic Scale..*"

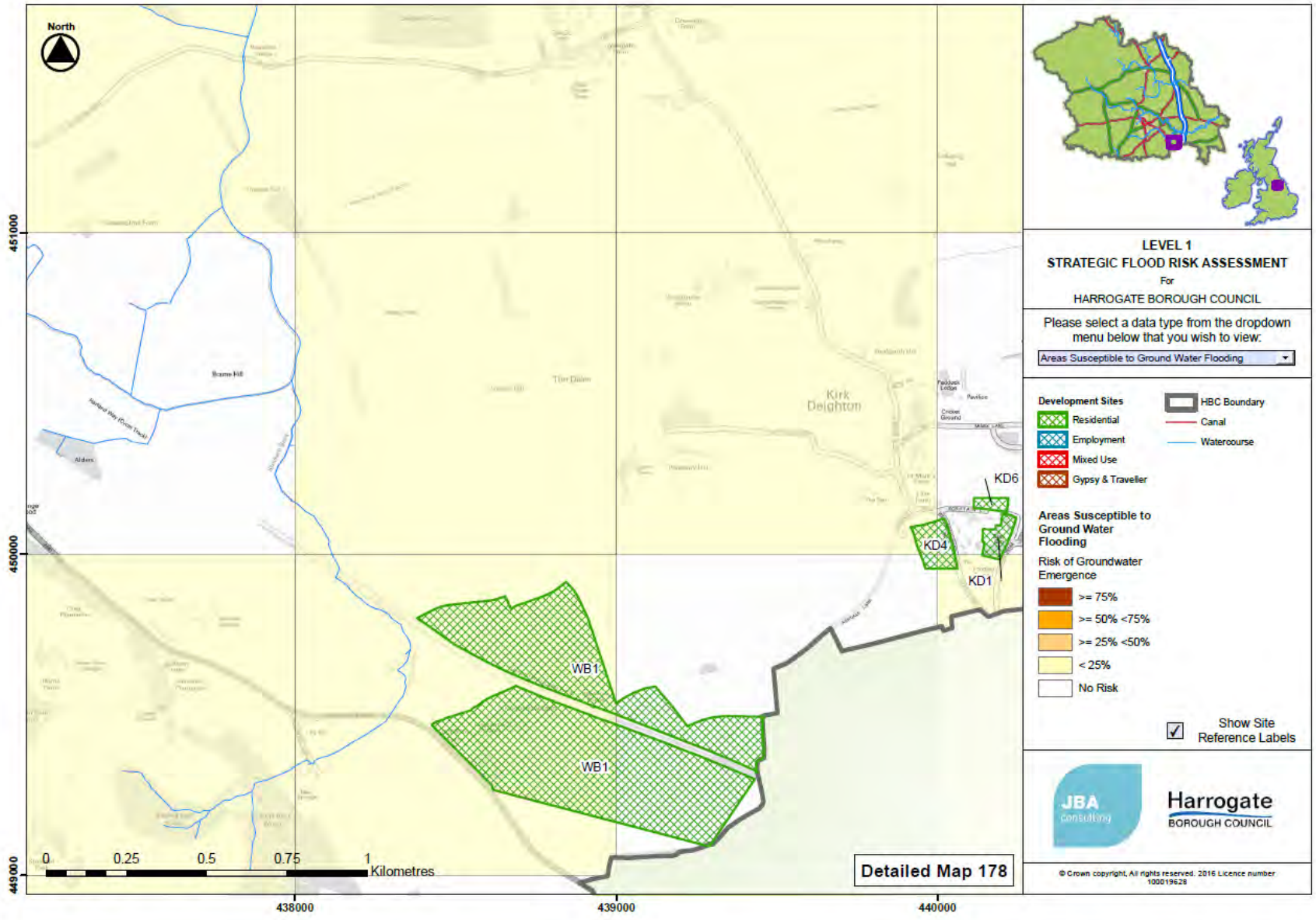
2.2 It is my opinion that the principal drainage from the proposed site follows the underlying dip and strike of the dolomitic limestone / dolostone bedrock (traditionally referred to as Magnesian Limestone) to the North / North-East as depicted below. Note that the map below is based on the UK Flood risk map (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)

Figure 1: Surface Water Drainage



This indicates that water flows uphill towards the SAC/SSSI.
Below ground this implies ground water emergence, which BW Issue 3.6 has said does not occur (i.e. springs)

2.3 Appendix BWHy1 demonstrates that there has been a significant change in the drainage pattern in the area to the north of Harland Way adjacent to the Bellway (and proposed Hallam) developments. This has occurred since groundwork's started for the Bellway development thus indicating a strong causal link and supporting the proposed scheme in Figure 1.


North
451000
450000
449000
438000
439000
440000
0
0.25
0.5
0.75
1
Kilometres
Detailed Map 178
WB1
WB1
KD6
KD4
KD1
Kirk Deighton
LEVEL 1
STRATEGIC FLOOD RISK ASSESSMENT
For
HARROGATE BOROUGH COUNCIL
Please select a data type from the dropdown menu below that you wish to view:
Areas Susceptible to Ground Water Flooding
Development Sites
Residential
Employment
Mixed Use
Gypsy & Traveller
HBC Boundary
Canal
Watercourse
Areas Susceptible to Ground Water Flooding
Risk of Groundwater Emergence
>= 75%
>= 50% <75%
>= 25% <50%
< 25%
No Risk
Show Site Reference Labels
JBA consulting
Harrogate
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