Eastwood & Partners
CONSULTING ENGINEERS

E P

GEOTECHNICAL AND GEO-ENVIRONMENTAL SITE INVESTIGATION

PONTEFRACT ROAD, LUNDWOOD

FOR

GLEESON DEVELOPMENTS LTD

ISSUE 2



36487-001 (I2)

MARCH 2014

Eastwood & Partners, St Andrew's House, 23 Kingfield Road, Sheffield, S11 9AS
Tel: 0114 255 4554 Fax: 0114 255 4330 mail@eastwoodandpartners.com www.eastwoodandpartners.com

GEOTECHNICAL AND GEO-ENVIRONMENTAL SITE INVESTIGATION

PONTEFRACT ROAD, LUNDWOOD

FOR

GLEESON DEVELOPMENTS LTD

ISSUE 2

Job No.	:	36487
Report Status	:	Issue 2
Document Date	:	March 2014
Approved	:	

J M Wood

Also at: Principle House, 121 - 123 Fleet Road, Fleet, GU51 3PD

Directors: **G M Seaman** BSc, CEng, FICE, FIStructE **S D Preston** BEng, CEng, FICE, FIStructE **N J Baines** BSc, CEng, MICE, MCIWEM
P Richardson BSc, CEng, MICE, MIStructE **J M Wood** BSc, CEng, MICE, FIStructE **M J Yates** BSc(Eng), ACGI, CEng, MICE, FIStructE
S R Ellis, BEng, CEng, MIStructE, AMICE **K R Pursall** BEng, CEng MIStructE
Senior Associates: **K Newsome** BSc, CEng, MICE, MIStructE **S J Mitchell** BSc, MSc, CEng, MEI, MCIBSE, MASHRAE
Associates: **A Jones** BEng, CEng, MICE, MIStructE **M Young** MA, CEng, MICE, MIStructE **A Allison** B.Eng
C A WOOD BSC, CENG, MISTRUCTE, AMICE **C A TOPLISS** BSC, CENV, CSCI, CGEOL, AMICE, FGS
S J ENGLISH **BENG, CENG MISTRUCTE** A R PRIEST **B.ENG**

Eastwood & Partners (Consulting Engineers) Limited Registered No 1835021

1.0 EXECUTIVE SUMMARY 6

2.0 INTRODUCTION 9

2.1 Terms of Reference 9
2.2 Context 9
2.3 Aims and Objectives 9
2.4 Scope of Investigation 9
2.4.1 Phase 1 9
2.4.2 Phase 2 10

3.0 THE SITE 11

3.1 Description 11
3.2 History 11
3.2.1 The Site 11
3.2.2 The Surrounding Area 11
3.3 Geology 12
3.4 Hydrogeology 12
3.4.1 Groundwater Vulnerability 12
3.4.2 Groundwater Abstractions 12
3.5 Hydrology 12
3.6 Mining 12
3.7 Ground Gas 13
3.8 Pollution Incidents to Controlled Waters 14
3.9 Discharge Consents 14
3.10 Flooding 14

4.0 OUTLINE CONCEPTUAL MODEL 15

4.1 Potential Pollutant Linkages 15

5.0 GROUND INVESTIGATION 16

5.1 Site Works 16
5.2 Laboratory Testing 16

6.0 GROUND CONDITIONS 17

6.1 Surface Covering 17
6.2 Made Ground 17
6.3 Natural Ground 17
6.4 Obstructions 17
6.5 Groundwater 17
6.6 Evidence of Contamination 18

7.0 GEOTECHNICAL APPRAISAL 19

7.1 General 19
7.2 Foundations 19
7.3 Ground Floors 19
7.4 Superstructure Precautions 20
7.5 Excavation Problems 20
7.6 Obstructions 20
7.7 Surface Water Drainage 20
7.8 Roads 20

8.0 REFINEMENT OF OUTLINE CONCEPTUAL MODEL 21

8.1 Source Characterisation 21
8.2 Ground Conditions 21
8.3 Gas Precautions 21
8.4 Unexpected Contamination 21
8.5 Chemical Testing 21
8.6 Assessment Criteria 22
8.7 Chemical Test Results 22
8.8 Significant Pollutant Linkages 25

9.0 RISK ASSESSMENT 27

9.1 Human Health & Plants 27
9.2 Construction Materials 28
9.3 Controlled Waters 29
9.4 Ground Gas 29

10.0 CONTAMINATION - RECOMMENDATIONS AND APPROVALS 30

APPENDICES

Appendix 1 Exploratory Hole Location Plan 36487/001B

Appendix 2 Envirocheck Report

Coal Authority Report

Appendix 3 Trial Pit Logs

Monitoring Well Logs

WS Log

Appendix 4 Chemtest Reports 242811 &245490

Table of Assessment Values

Modified Mean Calculations

CLEA Arsenic Calculation

Appendix 5 Plasticity Results

Appendix 6 Gas Monitoring Results

Table of Atmospheric Conditions

1.0 EXECUTIVE SUMMARY

1. The site, around 3.4 hectares in area, is located to the north west of Pontefract Road in Lundwood, Barnsley, centre on grid reference SE 375 079 (437490, 407940).

2. The site is a field, accessed via a track off Wilson Grove to the south. It has not been developed previously. An escarpment-type feature runs along the south eastern site boundary. Ground levels then generally fall to the north and east and rise again towards the north western site boundary. A large pipeline is visible at the surface in the northern site corner, extending into site. Overhead electric cables cross the north eastern site corner. A drainage ditch lies along the north western site boundary. The site features heavily overgrown areas, with dense trees adjacent to the north west and north east.

3. Generally, topsoil was encountered to 0.3 m depth, occasionally logged as slightly ashy and containing bricks and rare glass fragments. Beneath natural stiff clay was found over mudstone from around 1.8 m depth. Mudstone was found at shallower depths of around 1 m in the raised escarpment near the south eastern boundary. Made ground was found in 4 of the 17 trial pits excavated. This material generally comprised reworked clay, not exceeding 0.8 m depth. One trial pit recorded a fine coaly sand, but this was only found between 0.3 and 0.8 m depth in TP6. Damp ground was occasionally noted at around 2.0 m depth.

4. Precautions against the effects of shallow coal mining will not be required.

5. The site does not lie within a flood zone but due to the size of the site, a flood risk assessment will be required.

6. Radon precautions are not required. Amber 1 gas precautions will be required for plots within 30 m of the landfill to the north west of the site, with no gas precautions required for the remainder of the site.

7. Based on the ground conditions encountered, unreinforced strip or trench fill foundations will be appropriate, taken through any made ground and founded in the natural clay at minimum depth of 900 mm.

8. The northern site corner and north eastern boundary could not be investigated due to overhead electric cables and dense vegetation. A landfill boundary overlaps onto these areas. Deep made ground may be present here. Based on the sketch layout, only 3 plots lie within the landfill boundary. We would allow for these plots to be piled.

9. Trees are present on and adjacent to the site and footings will need to be deepened in accordance to NHBC Standards. Heave precautions will be required for footings deepened over 1500 mm due to the effects of trees. We estimate that around 30% of the site will require footings over 1500 mm and heave precautions.

10. We expect ground levels will be raised across the majority of the development. Due to this assumption and the number of mature trees observed around the perimeter and occasionally inside the site boundaries, precast concrete floors should be allowed for with an underlying 150 or 250 mm ventilated void, depending on if heave precautions are required.

11. Due to the ground conditions, we do not consider soakaways will be suitable for surface water drainage.

12. Strong sandstone was encountered in TP1 in the west of the site which may cause excavation difficulties.

13. No major obstructions were recorded during trial pitting. There is a sewer crossing the site from north east to south west. This should be avoided during excavations.

14. The topsoil within TP2 is ashy and recorded elevated heavy metal and benzo(a)pyrene concentrations. The topsoil around this trial pit will need to be excavated and removed from site.

15. The remainder of the site won topsoil recorded slightly elevated copper and zinc concentrations. The regulators will need to give their approval to the use of this topsoil and the landscape architect should be advised as it may affect the planting layout. With regards to human health, the remainder of the topsoil is considered to be suitable for re-use.

16. Made ground was encountered in four trial pits down to a maximum depth of 0.8 m. Elevated arsenic, copper, lead, zinc and naphthalene concentrations were recorded. The made ground appears to be localised pockets (TP3, TP6, TP13 and TP14, and near a manhole position) and most likely due to drainage installations. Due to the localised nature of the made ground, the material should be either capped by 600 mm of clean cover in gardens overlying the made ground, or the excavation of the made ground and placement beneath roads or hardstanding and not beneath houses.

17. DS-2 AC-2 sulphate precautions for concrete in contact with the made ground is required. No sulphate precautions will be required for concrete in contact with natural ground.

18. The conclusions made in this report in relation to contamination are subject to agreement by the approving bodies.

2.0 INTRODUCTION

2.1 Terms of Reference

This report presents the findings of a geotechnical and geo-environmental site investigation carried out by Eastwood and Partners (Consulting Engineers) Ltd for, and on the instructions of, Gleeson Developments Ltd. Any other parties using the information in this report do so at their own risk and any duty of care is excluded.

2.2 Context

Gleeson Developments Ltd intends to develop a parcel of land near Pontefract Road, in Lundwood for residential end use. No other site investigations are known to have taken place at this site.

2.3 Aims and Objectives

The aims and objectives of this investigation were as follows.

- Assimilate Phase 1 data to derive an outline conceptual model identifying potential contaminants, pathways and receptors, as well as possible linkages between these;
- Detail the ground conditions and their geotechnical properties enabling outline foundation proposals to be made;
- Carry out tiered risk assessment to establish the likely risks to future receptors, involving the use of generic assessment criteria and where unacceptable risks are identified, site specific assessment criteria within a detailed quantitative risk assessment;
- Identify feasible remediation options if unacceptable risks are highlighted;
- Develop an appropriate remediation strategy where remediation is required.

2.4 Scope of Investigation

This document is split into two sections. These constitute the findings of the Phase 1 and Phase 2 investigations, consecutively.

2.4.1 Phase 1

The Phase 1 investigation involved a review of information extracted from published documentation as well as that obtained from a site reconnaissance. Information regarding the current and former

land uses both on and surrounding the site, as well as the environmental sensitivity of the site location as determined by factors including geology, hydrogeology and hydrology have been examined.

Information analysed in this section of the report has been obtained from a variety of sources and included the following:

- Envirocheck Report;
- Coal Authority Report;
- Geological Maps and Associated Geological Memoirs.

2.4.2 Phase 2

This part of the investigation consisted of intrusive works. The findings were used to test the conceptual model and produce a final risk assessment.

The intrusive works comprised trial pits, which were excavated to enable:

- Examination of the upper few metres of ground;
- Assessment of any contamination identified using visual and olfactory methods.

A window sample rig was also used to install 14 monitoring wells and drill one window sample hole in an area not accessible by the mechanical excavator.

A gas monitoring programme was also carried out.

3.0 THE SITE

3.1 Description

The site, around 3.4 hectares in area, is located to the north west of Pontefract Road in Lundwood, Barnsley, centre on grid reference SE 375 079 (437490, 407940).

The site is a field, accessed via a track off Wilson Grove to the south. . An escarpment-type feature runs along the south eastern site boundary. Ground levels then generally fall to the north and east. The levels rise again towards the north western site boundary. A large pipeline is visible at the surface in the northern site corner, extending into site. Overhead electric cables cross the north eastern site corner. A drainage ditch lies along the north western site boundary.

The site features heavily overgrown areas, with dense trees adjacent to the north west and north east. Housing is adjacent to the south west and north east, and a small coach depot to the south east. Fields lie to the north west.

The site features are shown on the enclosed 'Exploratory Hole Location Plan'.

3.2 History

Historical maps, obtained as part of the Envirocheck Report, have been reviewed to assess the previous use of the site and surrounding area. Copies of the maps are presented in Appendix 2.

3.2.1 The Site

The earliest map dated 1854-1855 shows the site to be open fields. By 1892, the eastern boundary of the site overlaps onto a railway cutting. Between 1955 and 1961 a drain is shown in the northern site corner, running parallel to the site's north western boundary. By the 1990s, the drain appears to be diverted along the boundary of the northern site corner. The site is still an open field today.

3.2.2 The Surrounding Area

In 1855 the surrounding area is predominately agricultural fields, with a canal and a small bleach works around 250 m west of the site. By 1894, Monk Bretton Colliery was built around 275 m north west of the site. Housing was built adjacent to the site's western corner by the 1930s. A build-up of colliery spoil can be seen to the north of the site y the 1940s, extending south towards the site's northern corner by the 1960s. A small rectangular warehouse was built adjacent to the southern site corner by 1974. By this time, the colliery buildings had been removed and the colliery spoil is labelled as a disused tip. The railway line adjacent to the east of the site is also labelled as dismantled. In

the last 10 years, housing had been built to the south west and north east of the site, and warehouse-type units are built over the former colliery.

The area is predominantly residential today, with the warehouse to the south east of the site a small coach storage depot.

3.3 Geology

The geological map sheet SE 30 NE (1:10,560 scale) shows the site to overlie undivided Coal Measures, most likely comprising interbedded mudstone and siltstone. Colliery waste is shown to overlie the north western boundary of the site.

No alluvium is shown to be present on site.

The geological map does not indicate any faults or other lines of weakness to cross the site. However, a fault is present 53 m south west of the southern boundary of the site.

The dip of the strata is indicated to be approximately 5^{o} to the south east.

3.4 Hydrogeology

3.4.1 Groundwater Vulnerability

The Envirocheck Report identifies the site to overlie a Secondary A aquifer comprising 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.

The Envirocheck Report records that the site is not located within a Groundwater Source Protection Zone.

3.4.2 Groundwater Abstractions

The Envirocheck Report does not record any water abstractions within 500 m of the site.

3.5 Hydrology

The Envirocheck Report records the nearest surface water feature to be the drain along the site's north western boundary.

3.6 Mining

The shallowest named coal seam expected beneath the site is the Swinton Pottery coal seam. This seam was logged as being around 0.4 m thick in Monk Bretton Colliery, located around 300 m to the

north west of the site. Stratigraphically, the seam is expected to lie around 55 m below the Mansfield Marine Band, which outcrops along the site's western corner. In the Colliery, the shaft sinking has a topographic level of around 53 m AOD, and the Swinton Pottery coal seam was found at around 34 m depth. The site level ranges between 57 and 44 m AOD. At its lowest point beneath the site, the coal seam is therefore expected at around 25 m depth.

The geological memoir considers the seam to be poor quality and is not expected to have been worked. Precautions against the effects of shallow coal mining will not be required.

The Coal Authority report indicates that the site is in the likely zone of influence from workings in 10 seams of coal at 130m to 580m depth, and last worked in 1991. Reserves of coal are present in the area which could be worked at some time in the future, but this is considered unlikely due to the site's built up surrounding area.

There are no known mine entries on or within 20 m of the boundary of the site, although Coal Authority records may be incomplete.

Four claims for coal mining subsidence lie to the south east of the site. We do not know if these were discharged for repair. They may relate to more recent mining, since the report states that deeper coal seams were last worked just 20 years ago.

The site lies within an area for which notices of entitlement to withdraw support were published in the 1980s. These have not been revoked, however, future coal mining beneath the site is considered to be unlikely.

3.7 Ground Gas

The Envirocheck Report states that no radon precautions are required.

Information obtained from the Envirocheck Report indicates that a landfill is adjacent to the north western boundary of the site. It is managed by Barnsley Metropolitan Borough Council and includes household waste. The date of the last input was recorded as December 1996. The boundary for this landfill overlaps onto the site's northern corner and along eastern site boundary where the railway cutting was located. No other landfills have been identified within 250 m of the site.

The geological map shows the colliery waste stockpile to overlap onto the north western section of the site.

A gas monitoring programme has been carried out to determine the gassing regime of the site.

3.8 Pollution Incidents to Controlled Waters

The Envirocheck Report does not record any pollution incident to controlled waters within 250 m of the site.

3.9 Discharge Consents

The Envirocheck Report does not record any discharge consents within 250 m of the site.

3.10 Flooding

The Envirocheck Report indicates the site is not within a flood plain. However, due to the size of the site, a flood risk assessment will be required.

4.0 OUTLINE CONCEPTUAL MODEL

The following table details the possible sources and associated contaminants of concern, pathways and receptors, highlighted by the Phase 1 investigation as potentially present.

4.1 Potential Pollutant Linkages

Source	Pathway	Receptor
Heavy metals or PAHs contained in any made ground/colliery spoil which may be present, particularly if ashy materials are present	Ingestion, inhalation, direct contact	Future residents and visitors Site construction workers Secondary A aquifer
Localised hydrocarbon hotspots from adjacent coach depot	Ingestion, inhalation, direct contact	Future residents and visitors Site construction workers Secondary A aquifer
Naturally elevated concentrations of heavy metals or PAHs within natural ground	Ingestion, inhalation, direct contact	Future residents and visitors Site construction workers Secondary A aquifer
	Direct Contact	Water supply pipes
Sulphates in made ground	Direct contact	Sub-surface concrete structures
Ground gas from adjacent landfill	Inhalation	Future residents and visitors

5.0 GROUND INVESTIGATION

5.1 Site Works

We visited site on 23 October 2013 and excavated 17 trial pits, TP1 to TP17, in order to determine the underlying ground conditions. These reached a maximum depth of 2.8 m below ground level. The northern site corner and north eastern boundary could not be investigated due to overhead electric cables and dense vegetation.

During a second site visit on 5 November 2013 fourteen monitoring wells, MW1 to MW14, were installed using a window sampling rig. A window sample hole, WS1, was also carried out in the north east of the site where the excavator could not access due to the overhead electric lines. During this site visit, trenches were also excavated to find two buried manhole covers, associated with a large combined sewer that runs beneath the centre of the site.

Six rounds of gas monitoring have now been carried out over four months, between November 2013 and February 2014. The results and the atmospheric conditions are presented in Appendix 6.

Copies of all logs are presented in Appendix 2, and their locations are plotted on the Exploratory

Hole Location Plan, Drawing number 36487/001 Revision B in Appendix 1.

5.2 Laboratory Testing

Twelve samples of topsoil, three samples of made ground and five samples of natural ground were initially sent for chemical testing.

During the second site visits, a further twelve samples of topsoil and eight samples of natural ground were collected around possible contamination hotspots and sent for testing.

Soil samples were taken in 1 kg plastic tubs and analysed at Chemtest Laboratories, Newmarket using MCERTs accredited methodologies where available. Laboratory testing results are presented in Appendix 4 and discussed further in Section 8.0.

Seven samples of natural clay were sent for plasticity testing to Professional Soils Laboratory in Doncaster. Laboratory testing results are presented in Appendix 5 and discussed further in Section 7.0.

6.0 GROUND CONDITIONS

6.1 Surface Covering

The surface is covered by topsoil, generally found up to 0.3 m depth. The topsoil from trial pits TP2 and TP3, which are located at the eastern corner of the site, was logged as being ashy. Brick and glass fragments were noted in the topsoil in a variety of locations.

6.2 Made Ground

Made ground was found in 4 (TP3, TP6, TP13 and TP14) of the 17 trial pits excavated. Trial pit TP3 and TP6 are located near the north western boundary of the site and trial pits TP13 and TP14 are located near the south eastern boundary of the site. The made ground generally comprised reworked clay not exceeding 0.8 m depth. TP6 encountered a coaly sand between 0.3 and 0.8 m depth.

Made ground was also noted to at least 1.2 m depth in the expected position of a manhole cover. This made ground comprised brick rubble and reworked clay.

Monitoring well MW6 recorded a 200 mm band of ash beneath the topsoil between 0.1 and 0.3 m depth. However, TP7 was excavated adjacent to this found a 50 mm coal band at 0.3 m depth. It is likely that the ash band noted in MW6 is a crushed coal layer. These two exploratory holes lie adjacent to the landfill, which will require further investigation when the vegetation has been cleared.

6.3 Natural Ground

The natural ground generally comprised stiff brown occasionally gravelly clay over mudstone from around 1.8 m depth. Mudstone was found at shallower depths of around 1 m in the raised escarpment near the south eastern boundary.

In addition, in TP1, strong grey medium grained sandstone was encountered 1.9 m below ground level.

6.4 Obstructions

No obstructions were recorded during the excavations.

6.5 Groundwater

The following table displays the groundwater observations from this investigation:

TP	Observation	Depth (m)
TP1	Damp ground	2.0
TP10	Damp ground	2.3

Groundwater has also been noted from around 1 to 2 m depth in a number of the gas monitoring wells.

6.6 Evidence of Contamination

No visual or olfactory evidence of possible contamination was recorded in the trial pits.

7.0 GEOTECHNICAL APPRAISAL

7.1 General

Generally the ground conditions near the surface comprise topsoil over natural ground with made ground locally encountered. The natural ground comprises generally stiff brown occasionally gravelly clay overlying mudstone. In one trial pit, sandstone was encountered at 1.9 m depth.

Plasticity tests were carried out on 7 samples of the natural clay. The modified plasticity index ranged between 19 and 62%, with 5 of the 7 results recording indices of between 23 and 31%. Based on these results, medium shrinkability can be considered a suitable classification for the natural clay.

An allowable bearing pressure of 125 kN/m² can be assumed for the foundations within the natural clay.

7.2 Foundations

The most suitable foundations are considered to be traditional unreinforced strip or trench fill footings. These should be taken through any made ground and into the natural ground at a minimum depth of 900 mm.

The natural clay will be influenced by surrounding trees. Footings should be deepened in accordance with NHBC Standards when under the influence of trees or hedgerows. Heave precautions will also be required if footings are to be deepened over 1500 mm due to trees, or where desiccated ground is encountered. We estimate that around 30% of the site will require footings over 1500 mm and heave precautions.

A landfill boundary overlaps onto the site's northern corner and north eastern boundary. Deep made ground may be present here. Based on the sketch layout, only 3 plots lie within the landfill boundary. Piling will probably be necessary on these plots.

7.3 Ground Floors

We expect ground levels will be raised across the majority of the development, and a proportion of the site will require Amber 1 gas precautions. Due to this assumption and the number of mature trees observed around the perimeter and occasionally inside the site boundaries, precast concrete floors should be allowed for with an underlying 150 or 250 mm ventilated void, depending on if heave precautions are required.

7.4 Superstructure Precautions

No additional superstructure precautions will be required due to the ground conditions encountered.

7.5 Excavation Problems

Strong sandstone was encountered in TP1 in the west of the site which may cause excavation difficulties.

The sides of trenches and excavations may be slightly unstable and temporary support may possibly be required in some areas.

Where excavations which workers are required to enter are over 1.2 m deep, or less where there is a risk of harm from collapse of the sides of the excavation, the sides should be supported or battered back to make them safe.

7.6 Obstructions

No major obstructions were recorded during trial pitting. There is a sewer crossing the site from north east to south west. This should be avoided during excavations.

7.7 Surface Water Drainage

The clayey ground conditions are not expected to be suitable for soakaway drainage. Surface water should be taken a piped drainage system subject to the approval of the regulators.

7.8 Roads

The ground encountered in the upper 600 mm generally comprised natural clay. This is likely to have a CBR value of at least 2%. It is recommended that this value is used as a guide only and that full scale CBR tests are undertaken along roadways prior to construction so that accurate values can be obtained to satisfy the Local Authority. We also recommend that a contingency for removing and infilling local soft spots is allowed.

8.0 REFINEMENT OF OUTLINE CONCEPTUAL MODEL

8.1 Source Characterisation

An outline conceptual model, detailing the possible sources and associated contaminants of concern, potential pathways and receptors identified in the Phase 1 report was detailed in Section 4.0.

This section of the report documents the works undertaken to obtain information to test and refine this model enabling a risk assessment to be produced and, where significant risks are expected, remediation recommendations.

8.2 Ground Conditions

Generally the ground conditions near the surface comprise topsoil over natural clay, which occasionally a band of reworked clay or coaly sand. Mudstone was found from around 1.8 m generally, or at less than 1 m depth beneath the south eastern escarpment. In one trial pit, sandstone was encountered at 1.9 m depth.

8.3 Gas Precautions

The site is in an area where radon protections are not required. Less than 2.5 m of made ground is present on the site. A landfill adjoins the site's north western and eastern boundaries. Fourteen monitoring wells were subsequently installed for a gas monitoring programme.

Six rounds of gas monitoring have now been completed. The results recorded no methane, and generally low levels of carbon dioxide of 2% or less. However, two carbon dioxide concentrations elevated above 5% were recorded; 6.4% in MW2 on the first round, and 9.3% in MW3 on the fourth round. These two wells are both located along the site's north western site boundary. No or negative flow was recorded with normal oxygen levels.

The results obtained are enclosed in Appendix 6 and discussed further in Section 9.4.

8.4 Unexpected Contamination

No visual or olfactory observations of unexpected contamination were noted in the trial pits.

8.5 Chemical Testing

The initial samples of topsoil, made ground and natural ground were tested for the contaminants listed below. The topsoil samples were also tested for the same contaminants, excluding the sulphate suite.

Contaminant Type	Actual Contaminants
Metals/Metalloids	Arsenic, cadmium, chromium, lead, mercury, nickel, copper and zinc
pH	pH
PAHs	Speciated PAH
Sulphates	Water soluble sulphate, total sulphur, acid soluble sulphate

Further samples were obtained during a second visit to test for localised contamination hotspots. This is detailed further in Section 8.7.

Testing was undertaken by Chemtest, using MCERTs accredited methodologies, where available.

8.6 Assessment Criteria

The proposed development of the site is to be residential. Tables detailing the relevant assessment concentrations used are included in Appendix 4.

8.7 Chemical Test Results

Topsoil

Twelve samples of topsoil were tested and recorded the following elevated results:

Contaminant	Assessment Value	Elevated concentrations (mg/kg)
Arsenic	32	50, 73, 69, 72, 55, 65, 59, 62, 51, 43, 60, 64
Copper	80-200 (pH dependent)	1300, 230, 140, 110, 96, 130, 88, 90, 120,
Lead	450	4300, 770
Zinc	200-300 (pH dependent)	8600, 890, 390, 340, 340, 320, 1000, 310,
Benzo(a)pyrene	1.0	1.1, 13

During the second site visit, samples of topsoil were collected from around TP2, TP3 and TP11 and tested for copper and zinc, with the samples from around TP2 and TP3 also tested for lead. The results are displayed below:

TP2	Assessment Value	Elevated concentrations (mg/kg)
Copper	80-200 (pH dependent)	670, 2200
Lead	450	1600, 8900
Zinc	200-300 (pH dependent)	3200, 540, 11000

None of the tested contaminants from the further samples obtained from around TP3 and TP11 were found to be elevated above the generic assessment value.

Topsoil - Modified Means

The results from samples taken during the second visit have been averaged with the original elevated results and included in the modified mean calculation. The following modified means have been calculated:

Contaminant	Assessment Value	Modified Mean (mg/kg)
Arsenic	32	65
Lead	450	357
Benzo(a)pyrene	1	3.3

If the results from TP2 are considered as outliers and excluded from the modified mean calculations, the modified means for arsenic, lead and benzo(a)pyrene are reduced further to 63.9, 216 and 0.5 mg/kg respectively.

Topsoil - Physiologically Based Extraction Test (PBET)

Three PBETs were carried out on three samples of topsoil which contained elevated arsenic results. A maximum bioaccessibility of 6.7% was recorded. Using the CLEA model and the bioaccessibility results, a site specific assessment value (SSAV) of 85 mg/kg can be calculated. The modified mean for all arsenic concentrations recorded in the topsoil is 65 mg/kg which is lower than this calculated SSAV. We therefore do not consider the elevated arsenic concentrations to pose a significant risk to human health.

Made Ground

Three samples of made ground were sent for chemical testing. The following contaminants were found to be elevated:

Contaminant	Assessment Value	Elevated concentrations (mg/kg)
Arsenic	32	52, 57, 52
Copper	80-200 (pH dependent)	120, 140
Lead	450	520
Zinc	200-300 (pH dependent)	350, 400
Naphthalene	1.5	3.8

Natural Ground

Five samples of natural ground were tested. The results are observed below.

Contaminant	Assessment Value	Elevated concentrations (mg/kg)
Arsenic	32	77, 37, 38
Copper	80-200 (pH dependent)	150
Nickel	130	190
Zinc	200-300 (pH dependent)	220, 310, 350

During the second site visit, samples of natural clay were collected from around TP4, TP9, TP12 and TP16 and tested for arsenic, copper and zinc, with the samples from around TP16 also tested for nickel. Only sample TP4A 0.9 m recorded a slightly elevated concentration of 88 mg/kg for copper, compared to an assessment value of 80 mg/kg.

Natural Ground – Modified Means

The results from samples taken during the second visit have been averaged with the original elevated results and included in the modified mean calculation. The following modified means have been calculated:

Contaminant	Assessment Value	Modified Mean (mg/kg)
Arsenic	32	35.3
Nickel	130	112

Natural Ground - Physiologically Based Extraction Test (PBET)

Three PBETs were carried out on three samples of natural clay which contained elevated arsenic results. A maximum bioaccessibility of 6.7% was recorded. Using the CLEA model, a site specific assessment value (SSAV) of 85 mg/kg can be calculated. The modified mean for the arsenic concentrations recorded in the natural clay is 35.3 mg/kg which is lower than this calculated SSAV. We therefore do not consider the elevated arsenic concentrations to pose a significant risk to human health.

Sulphates

The following table displays the sulphate results for the materials encountered:

Made Ground	Concentration
Total Sulphur %	0.65, 0.03, 0.03
Total Potential Sulphate %	1.95, 0.09, 0.09
Water Soluble Sulphate g/l	0.01, 0.01, 0.01
Acid Soluble Sulphate %	0.09, 0.02, 0.01
pH	5.8, 6.0, 5.9

Natural Ground	Concentration
Total Sulphur %	0.01, 0.08, 0.01, 0.01, 0.01
Total Potential Sulphate %	0.03, 0.24, 0.03, 0.03, 0.03
Water Soluble Sulphate g/l	0.02, 0.04, 0.01, 0.01, 0.09
Acid Soluble Sulphate %	0.01, 0.16, 0.01, 0.01, 0.01
pH	7.5, 5.1, 6.3, 7.0 6.9

8.8 Significant Pollutant Linkages

The significant pollutant linkages consequently identified are documented in the table below:

Source	Pathway	Receptor
Copper, lead, zinc, benzo(a)pyrene in topsoil	Ingestion, inhalation, direct contact	Future residents and visitors Site construction workers Secondary A aquifer Plants
Arsenic, copper, lead, zinc, naphthalene in made ground	Ingestion, inhalation, direct contact	Future residents and visitors Site construction workers Secondary A aquifer Plants

Copper, nickel, zinc in natural ground	Ingestion, inhalation, direct contact	Future residents and visitors Site construction workers Secondary A aquifer Plants
Sulphates in the made ground and natural ground	Direct contact	Below ground concrete
Ground gas	Migration through ground, inhalation	Future residents and visitors Site construction workers

9.0 RISK ASSESSMENT

9.1 Human Health & Plants

Topsoil

The initial rounds of testing recorded elevated concentrations of arsenic, copper, lead, zinc and benzo(a)pyrene.

The PBETs showed the arsenic concentrations recorded are not expected to pose a significant risk to human health.

The elevated lead concentrations were located within the topsoil samples from TP2 and TP3, which were both described as being slightly ashy. Further testing was carried out around both of these trial pits and the results reduced the corrected mean for lead to 357 mg/kg, which is below the assessment value of 450 mg/kg. However, the concentrations in the original TP2 sample and in 2 of the further tests (TP2A and TP2C) were very high. A benzo(a)pyrene concentration of 13 mg/kg was also recorded within TP2 and is considered to be an outlier. The results show that the topsoil around TP2 would pose a risk to human health. The material is visibly ashy and should be separated from the remainder of the topsoil. Supervision of this excavation of the hotspot may be required, and the excavated material removed from site. The remainder of the topsoil can be considered to be suitable with regards to human health.

Elevated copper and zinc concentrations were also recorded throughout the topsoil, which could pose a risk of phytoxicity to plants. The majority of the concentrations were elevated because the assessment value is pH dependent, and quite low pH values were recorded. The highest concentrations of copper and zinc were recorded within TP2 where a hotspot has already been identified and will be removed. Elsewhere, the concentrations were generally less than 200 mg/kg for copper and less than 400 mg/kg for zinc. The regulators will need to give their approval to the use of this topsoil due to the slightly elevated copper and zinc levels and the landscape architect should be advised as it may affect the planting layout.

Made Ground

Made ground was encountered in four trial pits down to a maximum depth of 0.8 m. Elevated arsenic, copper, lead, zinc and naphthalene concentrations were recorded. The locations of these trial pits where made ground was encountered (TP3, TP6, TP13 and TP14, and near a manhole position) are adjacent to the site's north western and south eastern boundaries. The made ground appears to be localised pockets and most likely due to drainage installations. Due to the localised nature of the made ground, we recommend that the material is either capped by 600 mm of clean cover in gardens

overlying the made ground, or the excavation of the made ground and placement beneath roads of hardstanding and not beneath housing.

Natural Ground

The initial rounds of testing recorded elevated concentrations of arsenic, copper, nickel and zinc.

The PBETs showed the arsenic concentrations recorded are not expected to pose a significant risk to human health.

The nickel modified mean is below the assessment value. Nickel concentrations are therefore not expected to pose a significant risk to human health.

Slightly elevated copper and zinc concentrations were also recorded. The maximum copper and zinc concentrations recorded were 150 and 350 mg/kg, which are only slightly elevated above the assessment values. The Soil Code states that a number of plant species can survive in environments containing elevated copper and zinc concentrations. We therefore do not consider the copper and zinc concentrations within the natural ground to pose a risk of phytoxicity to plants.

9.2 Construction Materials

PAH

Significantly elevated concentrations of PAH compounds were not recorded in the made or natural ground. Ordinary water pipes should therefore be appropriate, after agreement with Yorkshire Water.

Sulphates

In accordance with BRE Special Digest 1, the site comes under the classification of Greenfield as it has technically not been developed previously.

The maximum total potential sulphate concentrations recorded in the samples of made ground (1.95%) equates to a Design Sulphate Class of DS-4 and Aggressive Chemical Environment for Concrete (ACEC) class of AC-4. This 1.95% was recorded in one sample of coaly sand (TP6 at 0.4 m), which only found in one trial pit in a 500 mm layer from 0.3 to 0.8 m depth. The other samples of made ground recorded total potential sulphate results of less than 0.1%. The water soluble sulphate results were also very low at 0.01 g/l. The highest total potential sulphate results was recorded within made ground, which will have been exposed to the air already and thus the sulphides will have already oxidised to sulphates.

Based on this assessment, it would be prudent to use DS-2 AC-2 sulphate precautions for concrete in contact with made ground. Concrete in contact with natural ground is not expected to need sulphate precautions.

9.3 Controlled Waters

The nearest surface water receptor is a drain, adjacent to the site's north western boundary. The site does not overlie a Groundwater Source Protection Zone. Although elevated concentrations were recorded within materials on site, the contaminants are not expected to be particularly soluble and therefore should not migrate into the adjacent drains or the underlying aquifer. Materials on site are therefore not considered to pose a significant risk to controlled waters.

9.4 Ground Gas

No radon precautions are required.

A programme of six rounds of gas monitoring has been completed on the 14 monitoring wells across the site.

The results recorded no methane, and generally low levels of carbon dioxide or less than 2%, with two results recording more than 5% at 6.4% in MW2 and 9.3% in MW3. No flow was recorded.

Using a negligible flow rate of 0.1 l/hr, a gas screening value (GSV) of 0.0093 l/hr can be calculated for carbon dioxide, using the highest carbon dioxide concentration of 9.3%. Although this GSV lies below the Amber 1 threshold of 0.78 l/hr, two concentrations exceed the 5% limit for a Green classification.

The results within monitoring wells MW2 and MW3 recorded slightly higher carbon dioxide concentrations than the remainder of the site. These two wells also recorded the two carbon dioxide concentrations over 5%. Wells MW2 and MW3 border the landfill site to the north west. The Local Authority have informed us that the landfill is known for producing landfill gas. We therefore recommend that plots within 30 m of this landfill site should be installed with Amber 1 gas precautions. The remainder of the site will not require gas precautions, as indicated by the low carbon dioxide concentrations recorded in the central and south eastern monitoring wells.

10.0 CONTAMINATION - RECOMMENDATIONS AND APPROVALS

1. The topsoil within TP2 is ashy and recorded elevated heavy metal and benzo(a)pyrene concentrations. The topsoil around this trial pit will need to be excavated and removed from site.

2. The remainder of the site won topsoil recorded slightly elevated copper and zinc concentrations. The regulators will need to give their approval to the use of this topsoil and the landscape architect should be advised as it may affect the planting layout. With regards to human health, the remainder of the topsoil is considered to be suitable for re-use.

3. Made ground was encountered in four trial pits down to a maximum depth of 0.8 m. Elevated arsenic, copper, lead, zinc and naphthalene concentrations were recorded. The made ground appears to be localised pockets (TP3, TP6, TP13 and TP14, and near a manhole position) and most likely due to drainage installations. Due to the localised nature of the made ground, we recommend that the material is either capped by 600 mm of clean cover in gardens overlying the made ground, or the excavation of the made ground and placement beneath roads or hardstanding and not beneath houses.

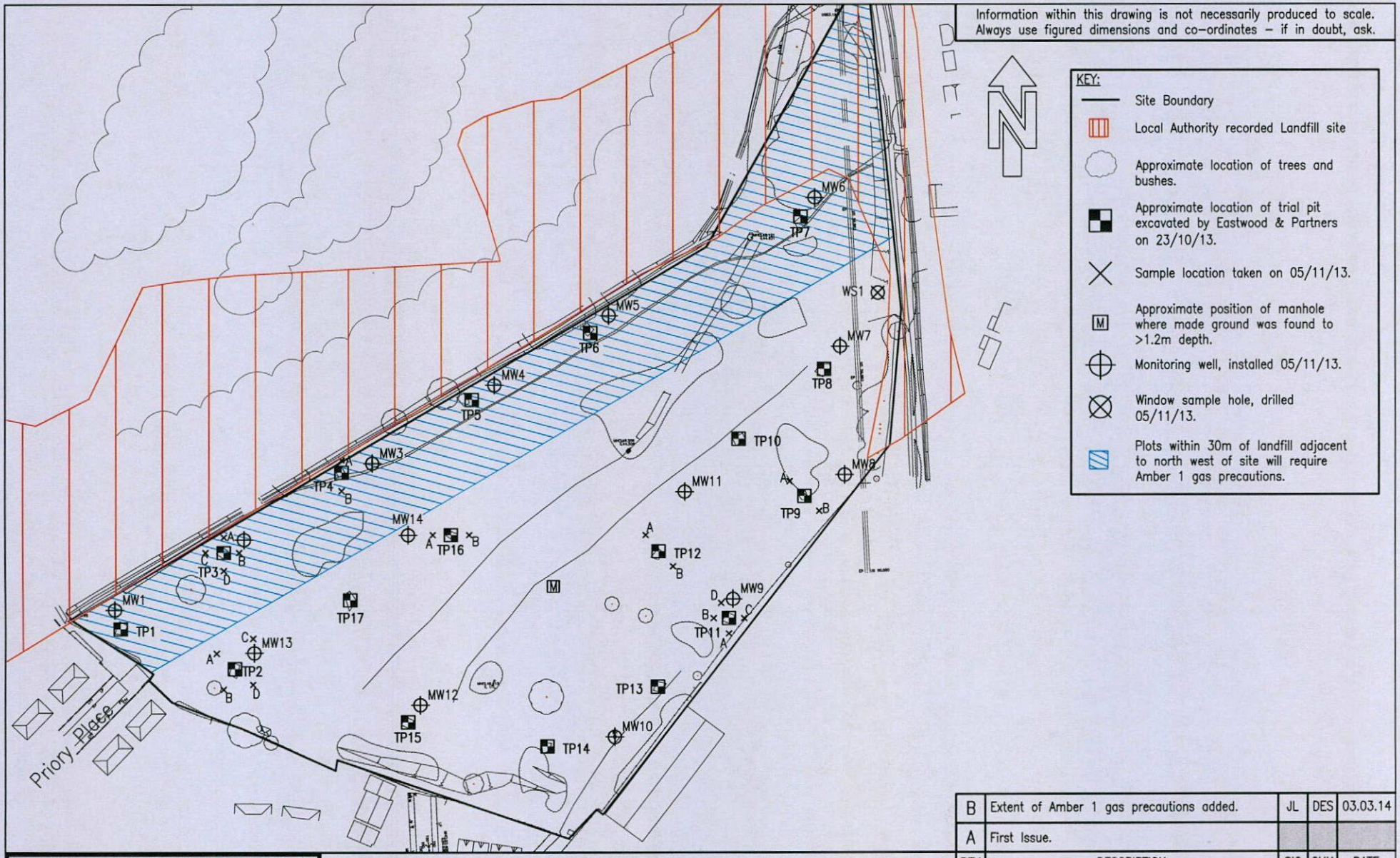
4. DS-2 AC-2 sulphate precautions for concrete in contact with the made ground is required. No sulphate precautions will be required for concrete in contact with natural ground.

5. Radon precautions are not required. Amber 1 gas precautions will be required for plots within 30 m of the landfill to the north west of the site, with no gas precautions required for the remainder of the site.

6. The conclusions made in this report in relation to contamination are subject to agreement by the approving bodies.

Appendix 1

Exploratory Hole Location Plan 36487/001B



Information within this drawing is not necessarily produced to scale. Always use figured dimensions and co-ordinates – if in doubt, ask.

KEY:

- Site Boundary
- Local Authority recorded Landfill site
- Approximate location of trees and bushes.
- Approximate location of trial pit excavated by Eastwood & Partners on 23/10/13.
- Sample location taken on 05/11/13.
- Approximate position of manhole where made ground was found to >1.2m depth.
- Monitoring well, installed 05/11/13.
- Window sample hole, drilled 05/11/13.
- Plots within 30m of landfill adjacent to north west of site will require Amber 1 gas precautions.

REV	DESCRIPTION	SIG	CHK	DATE
B	Extent of Amber 1 gas precautions added.	JL	DES	03.03.14
A	First Issue.			

Eastwood & Partners
CONSULTING ENGINEERS
St. Andrew's House
23 Kingfield Road
Sheffield
S11 9AS
Tel 0114 255 4554
Fax 0114 255 4330
mail@eastwoodandpartners.com
www.eastwoodandpartners.com

GLEESON DEVELOPMENTS LTD

PONTEFRACT ROAD, LUNDWOOD

EXPLORATORY HOLE LOCATION PLAN

SCALE WHEN PLOTTED AT A3	DRAWING STATUS
1:1250	INFORMATION

DRAWN	CHECKED	DATE	DRAWING NUMBER	REV
RH	KE	22.10.13	36487/001	B

Appendix 2

Envirocheck Report

Coal Authority Report

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)
R.D. Bdy. Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Sloping Masonry
Electricity Transmission Line
Pole
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

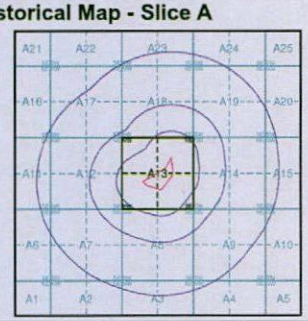
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

Envirocheck®

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Yorkshire	1:10,560	1854 - 1855	2
Yorkshire	1:10,560	1894	3
Yorkshire	1:10,560	1906 - 1907	4
Yorkshire	1:10,560	1932	5
Yorkshire	1:10,560	1938	6
Yorkshire	1:10,560	1938 - 1948	7
Yorkshire	1:10,560	1948	8
Ordnance Survey Plan	1:10,000	1955	9
Ordnance Survey Plan	1:10,000	1966	10
Ordnance Survey Plan	1:10,000	1974	11
Ordnance Survey Plan	1:10,000	1984	12
Ordnance Survey Plan	1:10,000	1993	13
10K Raster Mapping	1:10,000	2006	14
10K Raster Mapping	1:10,000	2013	15

Historical Map - Slice A



Order Details

Order Number: 50157046_1_1
Customer Ref: 36487
National Grid Reference: 437490, 407940
Slice: A
Site Area (Ha): 3.4
Search Buffer (m): 1000

Site Details

Pontefract Road, Lundwood, BARNSLEY, South Yorkshire

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



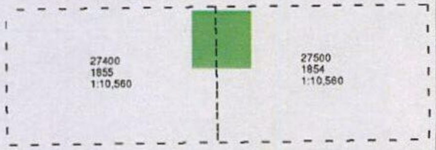
© Crown copyright and Landmark Information Group Limited 2013. All Rights Reserved.

Envirocheck®

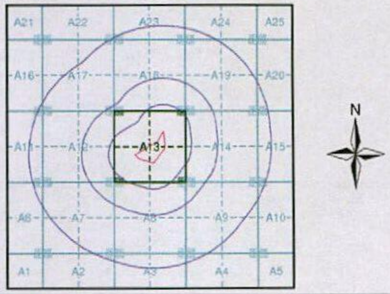
Yorkshire
Published 1854 - 1855
Source map scale - 1:10,560

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

Map Name(s) and Date(s)



Historical Map - Slice A



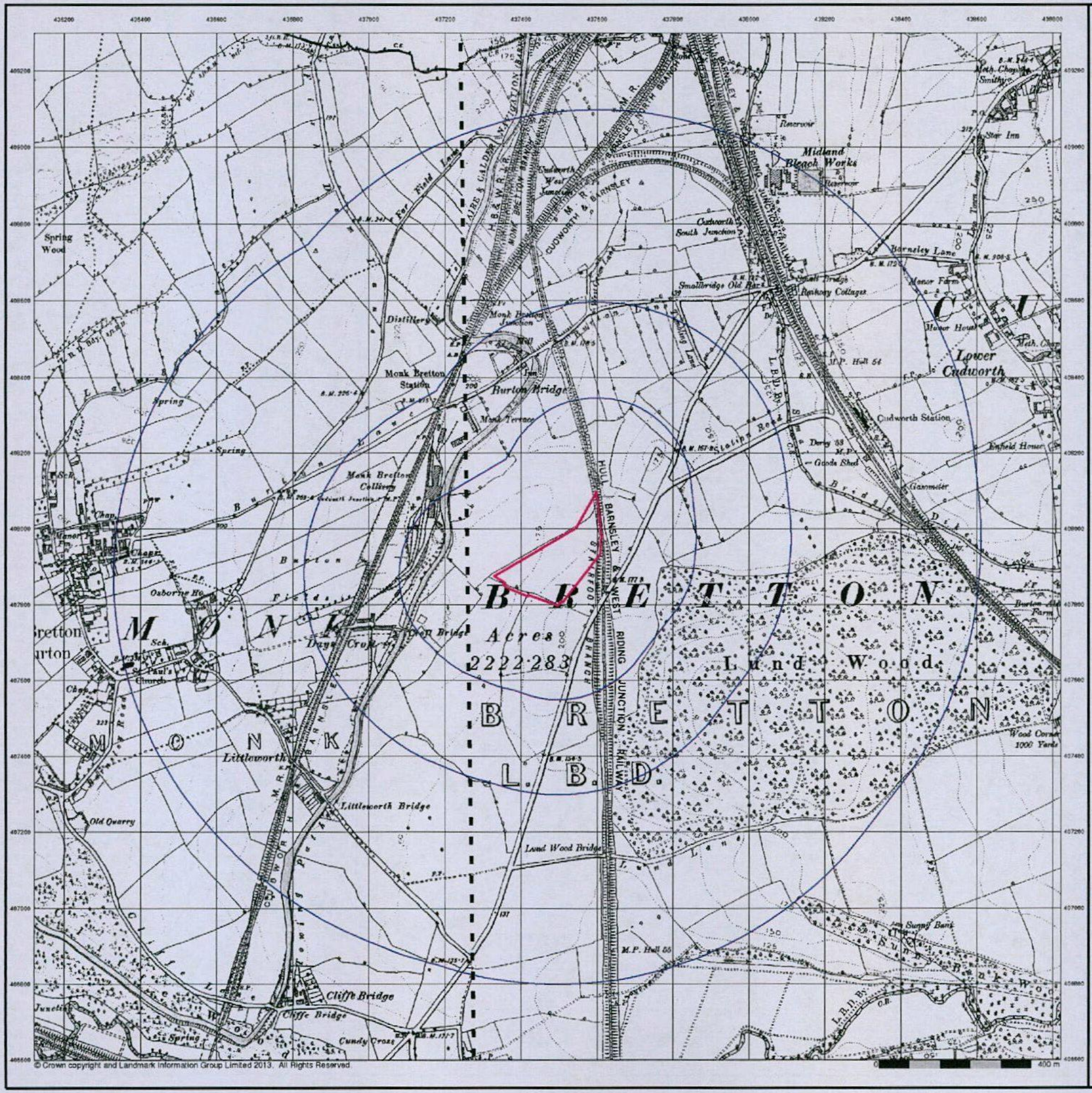
Order Details

Order Number: 50157046_1_1
Customer Ref: 36487
National Grid Reference: 437490, 407940
Slice: A
Site Area (Ha): 3.4
Search Buffer (m): 1000

Site Details

Pontefract Road, Lundwood, BARNSLEY, South Yorkshire

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



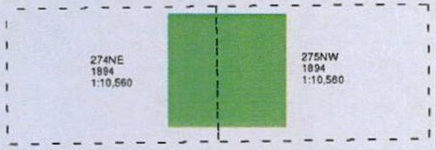
© Crown copyright and Landmark Information Group Limited 2013. All Rights Reserved.

Envirocheck®

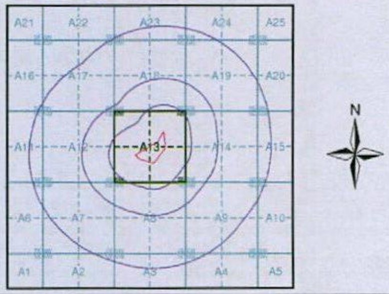
Yorkshire
Published 1894
Source map scale - 1:10,560

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

Map Name(s) and Date(s)



Historical Map - Slice A



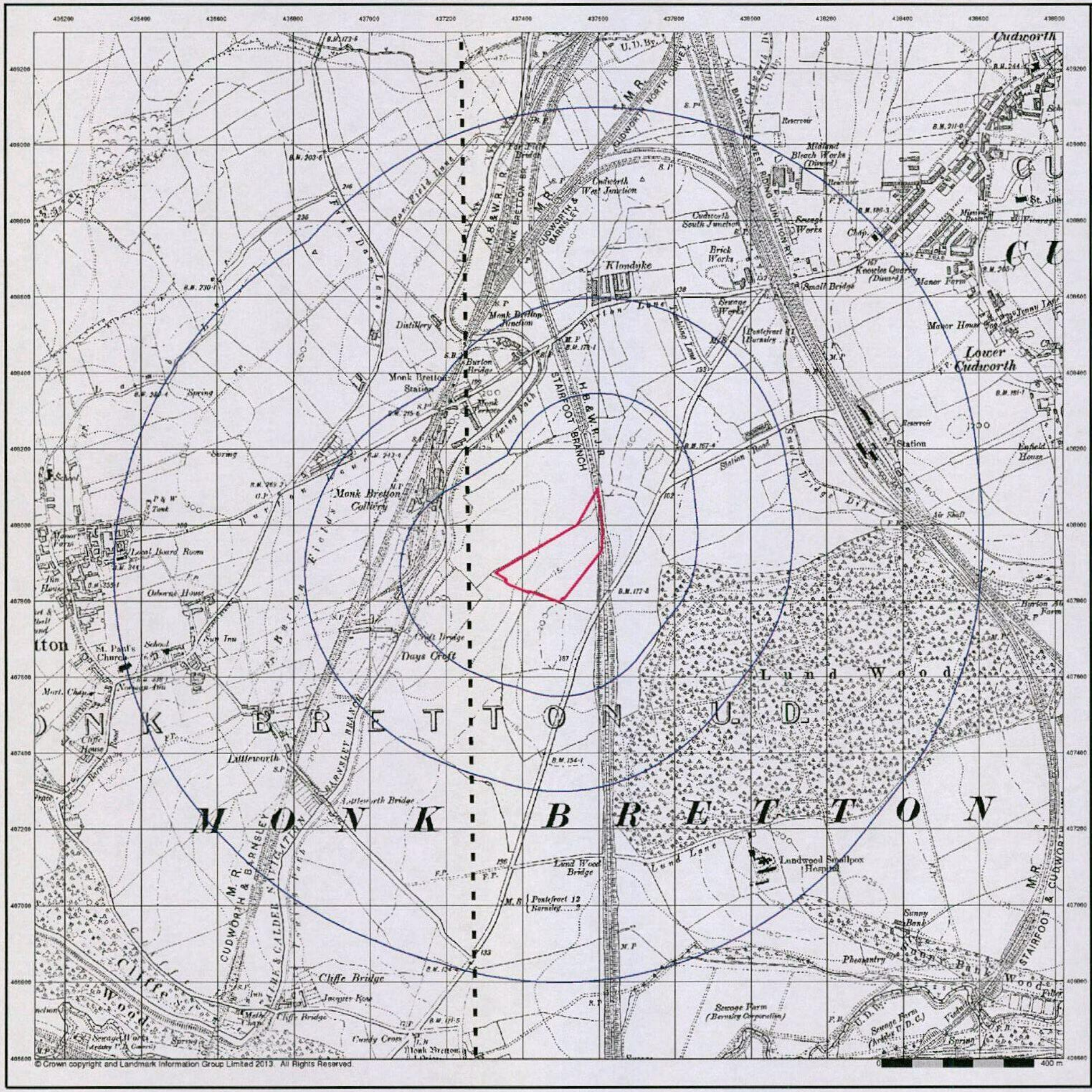
Order Details

Order Number: 50157046_1_1
Customer Ref: 36487
National Grid Reference: 437490, 407940
Slice: A
Site Area (Ha): 3.4
Search Buffer (m): 1000

Site Details

Pontefract Road, Lundwood, BARNSLEY, South Yorkshire

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



© Crown copyright and Landmark Information Group Limited 2013. All Rights Reserved.

Envirocheck®

Yorkshire

Published 1906 - 1907

Source map scale - 1:10,560

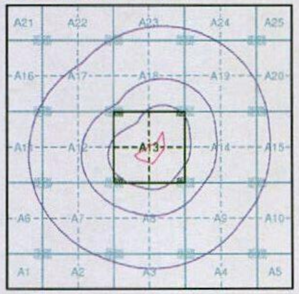
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some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

274NE 1907 1:10,560

275NW 1906 1:10,560

Historical Map - Slice A



Order Details

Order Number: 50157046_1_1
Customer Ref: 36487
National Grid Reference: 437490, 407940
Slice: A
Site Area (Ha): 3.4
Search Buffer (m): 1000

Site Details

Pontefract Road, Lundwood, BARNSLEY, South Yorkshire

Landmark Information Group

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

Customer Care

From: Marcin Bulinski <marcinbuli1980@gmail.com>
Sent: 08 October 2014 15:52
To: Customer Care
Subject: Problem with a gutter at front side of the house.

Marcin Bulinski
94 Kingsley Rd
L8 2XH
Liverpool

Hi. can you please send someone up to check a gutter. Water is overflowing and flows down the wall and through the bedroom window.
Think the gutter is damaged (bent).
Thank you in advance.