# GEOENVIRONMENTAL GROUND INVESTIGATION

## Phase 2 Capitol Park
## Junction 37 – M1
## Barnsley

| | |
|---|---|
| Reference | JP/GI/2450-5.v1 |
| Date | June 2017 |
| Version | 1 |

5 John Charles Way
LEEDS
LS12 6QA

Tel: 0113 263 1155
Fax: 0113 263 0405
admin@jpg.group
www.jpg.group



# CONTENTS

Confidentiality Statement

Document History

Executive Summary

1.0 Introduction 1

1.1 Introduction 1
1.2 Objectives 1
1.3 Scope of Works 1
1.4 Location 2
1.5 Site Description and Topography 2
1.6 Development Proposals 2
1.7 Limitations 3

2.0 Summary of Relevant JPG Desk Study Information 4

2.1 Site History 4
2.2 Geology 4
2.3 Mining 4
2.4 Hydrology and Hydrogeology 5
2.5 Landfills 5
2.6 Radon 5

3.0 Fieldwork 6

3.1 Fieldwork 6
3.2 Surveying 6

4.0 Laboratory Testing 7

4.1 Chemical Analysis 7
4.2 Geotechnical Testing 8

5.0 Ground and Groundwater Conditions 9

5.1 Introduction 9
5.2 Ground Conditions 9
5.3 Laboratory Testing 12
5.4 Hydrocarbon Odours 13
5.5 Groundwater 13
5.6 Ground Gas 14

6.0 Geotechnical and Engineering Assessment 15

6.1 Development Proposals 15
6.2 Foundations 15
6.3 Ground Floor Construction 17
6.4 Earthworks 17
6.5 Roads, Pavements and Hardstanding Surfaces 17
6.6 Excavations 18
6.7 Obstructions 18
6.8 Chemical Attack on Buried Concrete 18

7.0 Environmental Risk Assessment 19

7.1 Introduction 19
7.2 Assessment Approach 20
7.3 Evaluation of Soils Analysis 20
7.4 Evaluation of Controlled Waters Analysis 22
7.5 Summary of Potential Sources, Pathways and Receptors 22
7.6 Source – Pathway – Receptor Linkages 23
7.7 Mitigation Measures 25
7.8 Classification of Materials for Disposal Off-Site 26

8.0 Hazardous Gas Monitoring 27

8.1 Potential Gas Sources 27
8.2 Ground Gas Monitoring 27
8.3 Summary of Results 27
8.4 Requirements for Gas Protection Measures 28
8.5 Radon Risks 29

## APPENDICES

### Appendix A Figures/Drawings

Figure 1 - Site Location Plan
Figure 2 - SPT N Value vs Depth
Figure 3 - Conceptual Site Model

The Harris Partnership. Proposed Development Masterplan, Capitol Park, Junction 37 - M1, Higham Lane, Barnsley. Proposed Site Plan. Job Dwg No 14120-043, dated 12.04.2017.Building

### Appendix B Exploratory Hole Logs and Plan

Subsurface Section A - A'
Subsurface Section B - B'
Subsurface Section C - C'
Subsurface Section D - D'
Subsurface Section E - E'

### Appendix C Chemical Analysis Certificates and HazWasteOnline Waste Classification

### Appendix D Geotechnical Testing Results

### Appendix E Gas and Groundwater Monitoring Results

### Appendix F Notes on Limitations

## CONFIDENTIALITY STATEMENT

This report is addressed to and may be relied upon by the following:

Commercial Development Projects Limited
Marshall House
Huddersfield Road
ELLAND
West Yorkshire
HX5 9BW

This report has been prepared for the sole use and reliance of the above-named party. This report shall not be relied upon or transferred to any other parties without the express written authorisation of JPG (Leeds) Limited. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

## DOCUMENT HISTORY

| VERSION | PURPOSE/DESCRIPTION | DATE |
|---|---|---|
| 1 | Final – For Issue to Client | June 2017 |

# EXECUTIVE SUMMARY

| | |
|---|---|
| Site Address | Capitol Park, Capitol Close, Junction 37 – M1, Barnsley |
| NGR | Approximate NGR 431672, 405990. |
| Current Site Use | The site comprises an engineered level plateau and is currently undeveloped. |
| Proposals | Commercial development. |
| Previous Report | A desk study report for the site has been prepared by JPG which should be read with this report. |
| Fieldwork | The fieldwork comprised trial pits and drilling of cable percussive boreholes with in situ testing. A rotary borehole investigation was also undertaken. Two gas and groundwater monitoring wells were installed. Soil samples were obtained and submitted for chemical and geotechnical analysis. The installations have been monitored for gas and groundwater on four occasions. |
| Ground and Groundwater Conditions | Made ground to a maximum of 5.6m (BH05), overlying natural clay over mudstone. No made ground encountered sporadically across the north. A single stockpile of clay made ground present on the site. No shallow groundwater was encountered during the investigation or during the post investigation monitoring visits. |
| Geotechnical and Engineering Assessment | Foundations – The made ground is unsuitable for the support of structural loads. It is therefore recommended that foundation loads are transferred to deeper natural strata of suitable bearing capacity, by the use of pad foundations (Unit C and D) and piled foundations (Unit B).<br>Ground Floor Construction - For a ground bearing floor slab for the proposed units, the made ground will need to be subjected to some form of ground improvement techniques in order to provide a uniform formation and ensure an adequate bearing capacity. This may include proof rolling, the excavation of soft materials, and the selection and controlled compaction of suitable materials.<br>Earthworks, Roads, Pavements and Hardstanding Surfaces - Locally earthworks will be required for distribution of the stockpile and also roadways, parking areas and for backfilling of excavations. It is recommended that a CBR value of 2% is adopted for the site. However, where made ground is reworked, it will be potentially possible to achieve a CBR of 4%.<br>Excavations - Excavations through the made ground and shallow natural ground should remain dry and stable in the short term. However, if excavations are left open for long periods of time, it is envisaged instability may eventually occur. Perched groundwater may be encountered.<br>Obstructions – No significant obstructions were encountered during the site investigation within the superficial deposits. Shallow rock, which was found to be hard to dig locally, was encountered across the north of the site.<br>Chemical Attack on Buried Concrete - It is recommended that concrete should be designed to ACEC Design Sulphate Class DS-1 and ACEC Class AC-2z. |
| Environmental Risk Assessment | Based on the identified potential sources of contamination and available pathways and receptors, the following linkage assessments have been considered. This assessment is based on current site conditions and does not consider exposure pathways following any remediation of the site.<br>Sources - The following potential sources of contamination are considered to be present on the site:<br>• Hazardous ground gases.<br>Mitigation Measures - In order to mitigate the risks posed by the potential contaminants which are present on the site, consideration should be given to the following mitigation measures.<br>Development and Maintenance Workers - In order to mitigate the risks posed by the potential contamination present on the site, consideration should be given to the following mitigation measures:<br>• Site workers involved in groundworks should take the necessary measures to ensure that all works in excavations and confined spaces are carried out in accordance with best practice in order to prevent exposure to potentially hazardous gases.<br>• Site workers involved in groundworks should use appropriate PPE, i.e. overalls and gloves and where appropriate masks. Appropriate health and safety measures, e.g. washing hands prior to eating or drinking, should also be enforced.<br>During development of the site, all workers should remain vigilant to the possible risk of encountering areas of potentially contaminated material. Should potentially contaminated material be encountered, site management should be informed. Further testing may then be required to assess the risk to health and safety of the site workers and the environment.<br>All employers involved in works at the site should produce an appropriate method statement and risk assessment, to which all employees should comply.<br>Reference should also be made to appropriate HSE and other guidance for working on contaminated and potentially contaminated sites.<br>Future Site Users - Gas protection measures are provided in Section 8.0 of this report.<br>Buildings and Services - Based on the potential sources of contamination which have been identified on the site, there may be a risk to buildings and services, such as buried concrete and supply pipes. Confirmation should be sought from the utilities provider as to the potential requirement for upgrading any proposed new water service pipes. |
| Hazardous Gas | The site is characterised as Characteristic Situation 2 and measures to protect the development against a gas protection score of 1.5 will be required for Type D and 2.5 for Type C buildings. |
| This sheet is intended as a summary only of the assessment of the site in relation to ground condition. It does not provide a definitive engineering analysis. | |

# 1.0 INTRODUCTION

## 1.1 Introduction

JPG (Leeds) Limited has been instructed by Commercial Development Projects Limited, to carry out a geoenvironmental ground investigation for a proposed commercial development at Capitol Park, Capitol Close, Junction 37 – M1, Barnsley. This report relates to Phase 2 of the development which occupies the western part of a larger site

In May 2016, JPG (Leeds) Ltd issued a geoenvironmental desk study report (Reference JP/DS/2450.v1), covering a larger site than the current subject site referred to in this report. This involved an inspection and description of the site and a review of the geological and coal mining aspects. The study included a review of previous reports by FWS Consultants and Sirius Geotechnical and Environmental Ltd and a description of Ordnance Survey maps, radon gas risk, indicative flood risk, hydrogeology, landfill, and other environmental issues. In addition to comments and conclusions on a wide range of environmental and geotechnical issues, the report also provided recommendations for a ground investigation and assessment. The findings and contents of the desk study are not reproduced here in their entirety, but a brief summary of the pertinent information is presented in Section 2.0 of this report.

During the preparation of this geoenvironmental ground investigation report, the physical ground investigation and assessment works, as recommended in the desk study referenced above, covered the larger site in its entirety, but only the aspects of the works directly relating to the western area of the proposed development site are included here.

## 1.2 Objectives

The main objective of the geoenvironmental ground investigation was to identify potential geotechnical and environmental issues that may represent constraints to the proposed redevelopment of the site.

## 1.3 Scope of Works

The scope of the investigation included the following works:

- A description of the ground investigation works carried out, i.e. factual reporting.

Interpretative reporting, including:

- Assessment of potential contaminants.
- A quantitative (Tier 1) screening assessment using source-pathway-receptor linkages.
- An assessment of the classification of materials for disposal offsite, not including Waste Acceptance Criteria (WAC) testing.

- Engineering assessment to include recommendations with respect to foundations, ground floor and pavement design.
- Comments on the likely requirements for remedial measures on the site, to address potential contamination or ground gas issues.
- Recommendations for further work where appropriate; and
- Presentation of the findings in a tabular non-technical summary.

## 1.4 Location

The site is located on Capitol Park, adjacent to Junction 37 of the M1 motorway, to the north of Dodworth near Barnsley. The approximate centre of the site is located at NGR 431672, 405990. A site location plan is given as Figure 1 in Appendix A.

## 1.5 Site Description and Topography

The site is a roughly trapezium shaped piece of land extending to an area of approximately 3.7ha.

The site is currently undeveloped and comprises a level engineered plateau, which was completed during site regrade works sometime between 2005 and 2007. During these works a large box culvert was constructed which generally trends north to south, parallel to the eastern boundary of the site. The surrounding area slopes to the south east.

The site generally has a surface covering of short rough grass and a single large stockpile is present to the south of the site.

The site is bounded to the west by by Higham Lane, to the north east by Capitol Close, to the south east by Whinby Road, and to the east by further undeveloped land which is part of the same engineered plateau. There are no substantial physical boundaries between the site and the adjacent land and roads, except for a limited amount of low wooden fence and some overgrown hedging along the western boundary. The site is essentially open over most of the boundaries.

To the north of the site, the slope batters rise up from the plateau to the adjacent Capitol Close, with a maximum difference in level of approximately 8.5m. To the south of the site, a batter slopes down from the site plateau to the adjacent Whinby Road below, with a maximum difference in level of approximately 8m.

Several manholes, assumed to be associated with the box culvert, are present along the length, and parallel to, the eastern site boundary. An assumed gravel drain follows the base of the batter around the perimeter of the site plateau. Further manhole covers were noted periodically along the run of the drain.

The site is located in an area of mixed commercial and industrial use, with commercial development, associated with Capitol Park, to the north, and open fields further afield. The town of Dodworth is located to the south and the M1 motorway to the east, with Barnsley beyond.

## 1.6 Development Proposals

A development masterplan is available for the site. It is proposed to develop the site for a commercial end use comprising two industrial units and one two-storey office block, referenced Unit B, Unit C and Unit D respectively. The plan is referenced below and a copy is contained in Appendix A.

- The Harris Partnership. Proposed Development Masterplan, Capitol Park, Junction 37 - M1, Higham Lane, Barnsley. Proposed Site Plan. Job Dwg No 14120-043, dated 12.04.2017.

## 1.7 Limitations

The general limitations to the nature of the investigation are outlined in Appendix F.

# 2.0 SUMMARY OF RELEVANT JPG DESK STUDY INFORMATION

## 2.1 Site History

The site remained farmland until the site was regraded to its current state, sometime between 2005 and 2007. A railway line has been present 25m to the south of the site since the mid-1800s. Old Silkstone Collieries was present approximately 450m to the south west of the site since the late 1800s, with an associated spoil heap which was extended over time, towards the site. The colliery was demolished in the early 1990s.

## 2.2 Geology

The following BGS maps has been consulted:

- British Geological Survey 1:50,000 Series. Sheet 87 Barnsley. Bedrock and Superficial Geology Edition. Published 2008.

Most of the site is underlain by Pennine Middle Coal Measures Formation, from the Carboniferous Period, comprising both sandstone, and undifferentiated strata (interbedded sequences of sandstone, siltstone, mudstone and coal seams). There is no drift cover indicated on site and no faults are shown to affect the site.

Two coal seams are shown to outcrop on site. Both trend in a north west to south east direction with the more northerly outcrop being the Top Haigh Moor Coal and the southerly outcrop being Low Haigh Moor Coal.

## 2.3 Mining

The coal mining report indicates the site is in an area that could be affected by underground workings in six seams of coal at 70m to 280m depth and last worked in 1967. In addition, the site is in an area where the Coal Authority believe there is coal at or close to the surface, which may have been worked at some time in the past. There are no known coal mine entries within, or within 20m of, the boundary of the property.

Rotary boreholes undertaken during previous site investigation, proved coal measures strata to 30m depth and also the presence of several coal seams. However, no evidence of workings, in the form of voids, broken ground or soft push material were encountered.

To confirm the findings of previous investigations, further rotary boreholes were implemented across the site. These are discussed in Section 5.2 of this report.

## 2.4 Hydrology and Hydrogeology

The bedrock underlying the site is classified as a Secondary A Aquifer. These aquifers generally comprise 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.

There are no surface water features on, or adjacent to the site. The nearest surface water feature is a drain (Tertiary River), beyond Higham Lane to the west of the site.

There are no surface, potable or groundwater abstraction licences within 1km of the site.

The site does not lie within a floodplain.

A flood risk assessment may be required by the Local Authority as part of any planning application for the site.

## 2.5 Landfills

There are no records of any currently licenced or historical landfill sites with 250m of the site. However, spoil heaps associated with the former colliery to the west are present immediately beyond Higham Lane, to the west of the site.

## 2.6 Radon

The property is in a Radon Affected Area, as 1% to 3% of properties are above the Action Level. However, no radon protective measures are necessary.

# 3.0 FIELDWORK

The intrusive investigation was designed to provide information on the general ground, groundwater and hazardous gas conditions at the site.

The boreholes and trial pits were located at the positions of the proposed units and also at locations of potential contamination sources, i.e. targeting the on-site stockpile.

The rationale behind each exploratory location is summarised in Table 3.0 below.

Table 3.0 – Exploratory Hole Rationale

| Potential Issue | Exploratory Holes |
|---|---|
| Trial pits and boreholes across site. | TP01, TP02, TP03, TP05, TP06, TP08, TP09, TP14, TP15, TP19, TP21, BH01, BH03, BH05, RO01, RO02, RO05, RO06 and RO08 |
| Trial pits within existing stockpile. | TP18 and TP20 |

## 3.1 Fieldwork

The fieldwork was carried out between 13 and 16 March 2017. The works undertaken are summarised in Table 3.1 below.

Table 3.1 – Summary of Ground Investigation Works

| Investigation Method | No. of Positions | Maximum Depth (m bgl) | Monitoring Wells | Monitoring |
|---|---|---|---|---|
| Trial pits. | 11 (TP01, TP02, TP03, TP05, TP06, TP08, TP09, TP14, TP15, TP19 and TP21) | 3.1 | - | - |
| Trial Pits in Stockpile | 2 (TP18 and TP20) | 1.5 | - | - |
| Cable percussive boreholes | 3 (BH01, BH03 and BH05) | 7.24 | 2 x 50mm | GG, WL |
| Rotary boreholes | 5 (RO01, RO02, RO05, RO06 & RO08) | 33.8 | 1 x 50mm | GG, WL |

bgl – below ground level
GG – ground gas monitoring (methane, carbon dioxide, oxygen, hydrogen sulphide, gas flow and atmospheric pressure using a portable gas meter)
WL – standing groundwater level using an electric contact dip meter

The ground investigation has been undertaken in general accordance with the techniques outlined in BS5930: 2015 Code of Practice for Site Investigations at the positions shown on the Exploratory Hole Location Plan, which is contained in Appendix B. The Exploratory Hole Records, and trial trench sketches are also contained in Appendix B. The investigation was carried out under the full time supervision of an engineer from JPG.

## 3.2 Surveying

The borehole locations were surveyed by handheld GPS and measurements from site features.

# 4.0 LABORATORY TESTING

## 4.1 Chemical Analysis

The chemical analysis suite was designed to:

- Characterise near surface contamination levels to provide an assessment of the risks associated with direct contact with soils on site in its current state.
- Provide information on the general contamination concentrations in the various strata across the site.
- Characterise in detail visible or odorous contamination using targeted analytical testing techniques.
- Provide information on the solubility of contaminants and therefore the potential for impact on controlled waters; and
- Provide information on the quality of shallow groundwater beneath the site.

Chemical testing was carried out for the following determinands by Derwentside Environmental Testing Services Limited (DETS) in County Durham. Chemical analysis certificates are presented in Appendix C.

Soils – General
Selected samples of soil were tested for the following contaminants on a total concentration basis:

| | | |
|---|---|---|
| Arsenic | Mercury | Copper |
| Cadmium | Lead | Nickel |
| Chromium | Zinc | Selenium |
| Cyanide (free) | Phenol | |
| Speciated Poly Aromatic Hydrocarbons (PAH) | | |
| Soil Organic Matter | | |
| Sulphate (water soluble) and pH | | |
| Asbestos Screen/Quantification | | |

In addition, selected samples were submitted for the following analysis:

- Hexavalent chromium, total chloride, total sulphate, total sulphide and ammoniacal nitrogen.
- Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG).

Selected samples of soil leachate were tested for the following contaminants:

| | | |
|---|---|---|
| Arsenic | Mercury | Copper |
| Cadmium | Lead | Nickel |
| Chromium | Zinc | Selenium |
| Cyanide (free) | Phenol | |
| Speciated Poly Aromatic Hydrocarbons (PAH) | | |
| Sulphate and pH | | |

## 4.2 Geotechnical Testing

In situ standard penetration tests (SPT) were performed within the cable percussive boreholes. The results are presented on the exploratory hole logs provided in Appendix B.

Laboratory geotechnical testing was carried out by Professional Soils Laboratory in Doncaster, in order to determine the physical characteristics of the substrata and comprised the following:

- Moisture content and particle size distribution to confirm the field descriptions of the soils encountered.
- Compaction testing (2.5kg and 4.5kg) and particle density to determine the compaction properties of the soils.
- California Bearing Ratio (CBR) test (2.5kg, unsoaked) to determine the bearing characteristics of the soils.
- pH, 2:1 water extract soluble sulphate, acid soluble sulphate, total sulphur and water soluble chloride.

The geotechnical testing was carried out in accordance with BS 1377:1990, "Methods of Test for Soils for Civil Engineering Purposes". The results of the geotechnical testing are contained in Appendix D.

# 5.0 GROUND AND GROUNDWATER CONDITIONS

## 5.1 Introduction

The ground conditions encountered during the investigation were generally consistent with the anticipated sequence of strata indicated by the desk study information.

The trial pit and borehole logs, the trial trench sketch cross sections, and an investigation location plan, are all included in Appendix B.

Geological cross sections through the site are presented as Subsurface Section A-A', B-B', C-C', D-D' and E-E' in Appendix B.

## 5.2 Ground Conditions

Shallow ground conditions typically comprise made ground underlain by firm and stiff clay (weathered bedrock) and Pennie Middle Coal Measures strata at depth, i.e. mudstone, siltstone and sandstone.

Made ground is absent locally in the northern and western parts of the site (TP02, TP06, TP09 and TP15). Where present, the thickness of the made ground increases to a maximum thickness of 5.6m in the south (BH05).

Further details on ground conditions are provided below.

Trial Pits
All 13 exploratory trial pit locations undertaken across the site and within the stockpile (TP01, TP02, TP03, TP05, TP06, TP08, TP09, TP14, TP15, TP18, TP19, TP20 and TP21) generally had a surface covering of rough grass, but with some areas being less well vegetated and revealing exposed soil at the surface.

Beneath the surface covering, in the majority of the trial pits across the site, made ground was proven to a maximum depth of 3.1m (TP21). However, in TP21, to the south of the site, the trial pit was terminated within the made ground at 3.1m depth, with the full thickness of made ground at this location not being fully determined. The deepest made ground was encountered to the south of the site. No made ground was encountered in TP02, TP06, TP09 and TP15, which were undertaken to the north and west of the site.

The made ground comprised:

- Brown/grey slightly silty, slightly sandy, gravelly clay with occasional cobbles and rare boulders (up to 0.7m diameter). The gravel and cobbles comprise sandstone, mudstone and locally rare brick and coal fragments. The boulders were generally found to comprise sandstone.

Below the made ground, natural strata were confirmed at every exploratory trial pit location, except for TP21, which was terminated within made ground at 3.1m depth. Natural strata comprising high strength (stiff), locally firm, yellowish brown and grey slightly silty slightly sandy clay, generally with rare mudstone gravel was encountered in approximately half of the trial pit location. The clay was confirmed to a maximum depth of 2.8m in the base of TP19. No clay was encountered in the trial pits excavated mainly across the north of the site, and also in the very south of the site where the made ground was at its thickest. The clay was interpreted as weathered Pennine Middle Coal Measures Formation.

Bedrock was proven at depths as shallow as 0.1m across the north of the site, and was found to deepen towards the south of the site. The depth to bedrock was not proven at all survey locations in the southern part of the site. The rock was found to comprise thinly laminated mudstone, locally with iron staining, or a light grey clay smear on bedding surfaces, or grey siltstone. The bedrock strata were interpreted as Pennine Middle Coal Measures Formation.

On completion the trial pits were backfilled with the arisings.

Stockpile

Two trial pits were excavated through the sides of the stockpile. The trial pits revealed the material contained within the stockpile to be similar to the made ground encountered in the majority of the trial pits across the site, and comprise brown/grey slightly silty, slightly sandy, gravelly clay with occasional cobbles. The gravel and cobbles comprised sandstone, mudstone and rare brick and coal fragments. The stockpile also contained rare sandstone boulders, up to 0.7m diameter, and rare pieces of timber.

Cable Percussive Boreholes

The cable percussive boreholes (BH01, BH03 and BH05) encountered similar made ground over Pennine Middle Coal Measures Formation strata to that found in the trial pits.

Borehole BH05 revealed low to medium strength (soft to firm), clay made ground, as described in the trial pits section above, to a depth of 5.6m. Boreholes BH01 and BH03 revealed a thin layer made ground only, with a maximum thickness of 0.3m. Natural very weak to weak mudstone and siltstone bedrock was encountered beneath the made ground. Limited penetration was achieved into the bedrock.

The results of the in situ penetration testing, carried out in the boreholes, has been plotted against depth (m bgl). The results have been corrected in accordance with the energy ratio of the testing equipment. The plot is presented as Figure 2 in Appendix A and the SPT data (uncorrected) is included on the borehole logs contained in Appendix B.

The SPTs show little correlation with increasing strength/density with depth.

On completion of the boreholes, gas and water monitoring standpipes were installed into each hole.

Rotary Boreholes and Coal Mining Risk Assessment

The Coal Authority have indicated that there is coal at or close to the surface, which may have been worked at some time in the past. There are no known coal mine entries within, or within 20m of, the boundary of the site.

Assessment of the geological records indicates the site is underlain by Pennine Middle Coal Measures Formation, with no drift cover and no faults shown. Two coal seams are shown to outcrop on site, both of which trend in a north west to south east direction. The more northerly outcrop is the Top Haigh Moor Coal and the southerly outcrop is the Low Haigh Moor Coal.

Previous rotary borehole investigations proved coal measures strata to 30m depth and also the presence of several coal seams. No evidence of workings, in the form of voids, broken ground or soft push material were encountered.

The five rotary boreholes (RO01, RO02, RO05, RO06 and RO08) undertaken as part of this investigation revealed made ground and presumed natural clay, assumed to be weathered Pennine Middle Coal Measures Formation, to depths of between 0.3m (RO01) and 5.3m (RO08), over Pennine Middle Coal Measures Formation bedrock. The underlying bedrock comprised successive bands of mainly mudstone, siltstone, and sandstone locally.

Various intact, 0.1m to 0.5m thick coal seams were encountered in each borehole. The coal seams are detailed in table 5.2.1 below:

Table 5.2.1 – Summary of Coal Seams

| RO01 | | RO02 | | RO05 | | RO06 | | RO08 | |
|---|---|---|---|---|---|---|---|---|---|
| Depth to seam (m bgl) | Seam thickness (m) | Depth to seam (m bgl) | Seam thickness (m) | Depth to seam (m bgl) | Seam thickness (m) | Depth to seam (m bgl) | Seam thickness (m) | Depth to seam (m bgl) | Seam thickness (m) |
| 3.2 | 0.1 | 3.4 | 0.3 | 10.3 | 0.2 | 5.3 | 0.3 | 15.5 | 0.3 |
| 13.1 | 0.5 | 12.7 | 0.3 | 22.7 | 0.3 | 7.1 | 0.15 | 23.5 | 0.4 |
| 14.6 | 0.2 | - | - | - | - | 19.0 | 0.3 | - | - |

bgl – below ground level

No evidence of workings, in the form of voids, broken ground or soft push material were encountered.

Based on the results of the investigation, the risk to the site from ground movement due to shallow mine workings is low.

Water Seepages and Stability

Slight water seepages were recorded in trial pit TP14 and TP19 at 1.1m and 2.5m respectively. The remaining trial pits and cable percussive boreholes remained dry during the site works. The water encountered was perched and from the made ground.

Water strikes were encountered in all the rotary boreholes, except RO06, at depths of between 20.5m and 26.5m. Borehole RO06 remained dry.

The trial pits across the majority of the site generally remained stable during excavation. However, trial pits excavated into the stockpiled made ground were found to be slightly unstable.

## 5.3 Laboratory Testing

A total of eight samples, comprising seven samples natural clay and bedrock, and one sample of made ground, were submitted for geotechnical testing.

All eight samples were submitted for moisture content testing, with three of the natural clay samples tested further for Atterberg limits. The results are summarised in Table 5.3.1 below.

| Material | Moisture Content (%) | | Atterberg Limits Modified Plasticity Index (%) | |
|---|---|---|---|---|
| | No of samples | Range | No of samples | Range |
| Natural clay | 4 | 18 and 25 | 3 | 23 and 30 |
| Natural mudstone | 3 | 6.2 to 7.9 | - | - |
| Made ground | 1 | 13 | - | - |

The Plasticity Indices reported have been modified based on the percentage of particles smaller than 425µm. The laboratory results indicate that the natural clay can be classified as high plasticity, which indicates, once modified, a medium potential for volume change.

Particle size distribution testing was carried out on two samples in order to confirm the field descriptions of the materials.

One sample of natural gravelly clay with cobbles (BH01), and one sample of the made ground from the stockpile (TP20), were submitted for maximum dry density/optimum moisture content (MDD/OMC) relationship testing.

The compaction tests were carried out using both a 2.5kg and 4.5kg hammer. The results are summarised in Table 5.3.2 below.

Table 5.3.2 - Summary of Compaction Test Results

| Exp. Hole | Depth (m bgl) | Material | Weight of Rammer | Natural Moisture Content (NMC) | Max. Dry Density (Mg/m3) | Optimum Moisture Content (OMC) | Suitability for Compaction and Range of Acceptable Moisture Contents* |
|---|---|---|---|---|---|---|---|
| BH01 | 0 -1 | Natural gravelly clay with occasional cobbles. | 2.5kg | 21 | 1.68 | 18 | OK, 16.9% - 22.7% |
| BH01 | 0 -1 | Natural gravelly clay with occasional cobbles. | 4.5kg | 21 | 1.84 | 13 | OK, 12% - 17.8% |
| TP20 | 1.0 – 1.5 | MADE GROUND: gravelly clay with occasional cobbles. | 2.5kg | 13 | 1.89 | 13 | OK, 12.4% - 17.7% |
| TP20 | 1.0 – 1.5 | MADE GROUND: gravelly clay with occasional cobbles. | 4.5kg | 13 | 2.02 | 10 | OK, 9.5% - 14.5% |

* To achieve >95% of Maximum Dry Density and <5% Air Voids.

Based on the results of both the 2.5kg and 4.5kg rammer compaction testing, the made ground across the site and contained in the stockpile is likely to be suitable for compaction to achieve >95% of the maximum dry density and <5% air voids.

The optimum moisture content of the compaction tests utilising the 4.5kg rammer were found to be 3% to 5% lower, than the 2.5kg tests, but still within acceptable limits.

Remoulded California Bearing Ratio (CBR) tests were carried out on the two samples of made ground comprising clay, at their as received moisture contents. The results are summarised in Table 5.3.3 below.

Table 5.3.3 – Summary of CBR Value Tests

| Sample | Material | As Received Moisture Content (%) | CBR Value (%) | |
|---|---|---|---|---|
| | | | Sample Top | Sample Bottom |
| BH01, 0 - 1 | Natural gravelly clay with occasional cobbles. | 21 | 2.4 | 2.6 |
| TP20, 1.0 – 1.5 | MADE GROUND: gravelly clay with occasional cobbles. | 13 | 13.7 | 19.6 |

The CBR values for the samples tested have been achieved with the materials at near equilibrium moisture content values.

If the materials become too wet, or indeed too dry, to achieve suitable compaction, then consideration could be given to the improvement of the materials by the addition of lime and or cement.

Measures would have to be implemented during the earthworks in order to control and check the moisture content of the material during placement and compaction.

## 5.4 Hydrocarbon Odours

No hydrocarbon odours were encountered at any of the exploratory locations.

## 5.5 Groundwater

Water strikes were recorded in the rotary boreholes RO01, RO02, RO05 and RO08 at depths of between 20.5m and 26.5m, and slight seepages of perched water from the made ground were encountered in TP14 at 1.1m and TP19 at 2.5m. No water seepages or strikes were recorded in the remaining majority of the trial holes, or rotary borehole RO06, or in any of the cable percussive boreholes.

Monitoring wells were installed in a single rotary borehole and two cable percussive boreholes. A summary of the monitored groundwater levels is presented in Table 5.5 below.

Table 5.5 – Summary of Monitored Groundwater Levels

| Location | Water level during monitoring (m bgl) | | | | | |
|---|---|---|---|---|---|---|
| | 20/03/2017 | 28/03/2017 | 05/04/2017 | 12/04/2017 | 20/04/2017 | 25/04/2017 |
| RO01 | 13.54 | 13.67 | 15.63 | 15.62 | 16.38 | 16.49 |
| BH03 | NR | 1.94 | Dry | DRY | Dry | Dry |
| BH05 | Dry | Dry | Dry | Dry | Dry | Dry |

NR – Not recorded

The monitoring wells in RO01 and BH03 were installed within the natural strata, with the well in BH05 installed in the made ground.

Groundwater monitoring has been carried out on six occasions. Boreholes BH03 and BH05 remained dry throughout the monitoring period. Water levels from between 13.54m depth, and dropping gradually over the monitoring period to 16.49m depth, were recorded in RO01.

It should be noted that the groundwater conditions recorded are based on observations made at the time that site work was carried out. Groundwater levels will vary owing to seasonal and weather related effects.

## 5.6 Ground Gas

Ground gas monitoring has been undertaken on six occasions. The works were carried out using a portable gas meter in accordance with the standard JPG methodology and included measurements of methane, carbon dioxide, oxygen, hydrogen sulphide, gas flows and atmospheric pressure. The results of the gas monitoring are presented in Appendix E and discussed in Section 8.0 of this report.

# 6.0 GEOTECHNICAL AND ENGINEERING ASSESSMENT

## 6.1 Development Proposals

It is proposed to develop the site for a commercial end use comprising two industrial units and one two storey office building, referenced Unit B, Unit C and Unit D respectively. The development masterplan is referenced below, and contained in Appendix A.

- The Harris Partnership. Proposed Development Masterplan, Capitol Park, Junction 37 - M1, Higham Lane, Barnsley. Proposed Site Plan. Job Dwg No 14120-043, dated 12.04.2017.

Should development proposals change, then additional site investigation works may be recommended.

## 6.2 Foundations

The selection of foundation type will be largely governed by the thickness of the made ground and the nature of the underlying natural strata. Made ground is unsuitable for the support of structural loads due to variations in material properties. If shallow spread foundations were to be used within the made ground, the materials would become overstressed, leading to significant settlements. It is therefore recommended that foundation loads are transferred to natural strata of suitable bearing capacity.

Recommendations for each of the proposed units are provided below.

Unit B
Made ground was encountered in all the exploratory holes undertaken beneath the proposed Unit B building footprint, to depths of between 2.5m (TP19) and 5.6m (BH05). The made ground was shallowest to the north of the plot and deepened towards the south.

The underlying natural strata comprised high strength (stiff) clay and mudstone bedrock.

To transfer the foundation loads to the natural strata, piled foundations may provide a practical solution. The piles should penetrate any made ground and, found within the mudstone bedrock. The presence of groundwater in the natural materials at depth, may be of significance to the selection of a suitable piling method. The advice of a specialist contractor will be required to confirm that ground conditions are suitable for these techniques, and that adequate bearing values and tolerable settlements can be achieved.

Unit C
Made ground was encountered in the majority of the exploratory holes undertaken in the vicinity of the proposed Unit C building footprint, to depths of between 1.1m (TP14) and 3m (RO06). No made ground was encountered in TP15 to the north of the plot. Where made ground was encountered it was generally at its shallowest to the north of the plot, and deepened towards the south.

The underlying natural strata comprised high strength (stiff) clay, locally overlying mudstone bedrock. In RO06, in the centre of the proposed building plot, mudstone bedrock was encountered immediately beneath the made ground at a depth of 3m.

Based on the thickness of the made ground and the strength of the underlying natural clay strata, it is considered likely that pad foundations could be utilised. Mass concrete will be necessary to extend the pad bases to the level of suitable natural strata.

The underlying natural strata comprises natural clay, an allowable bearing capacity of 150kN/m² for total settlements of less than 25mm will be available.

The allowable bearing capacity is a function of the foundation configuration, depth and the ability of the structure to tolerate such movements and should therefore be validated during detailed design.

Unit D
Made ground was encountered sporadically across the proposed plot of Unit D, generally with a thickness of between 0m and 0.4m (RO02). In the south east corner of the plot only, made ground to 2.2m in thickness was encountered.

The underlying natural strata comprised high strength (stiff) clay, locally overlying mudstone bedrock. In RO06, in the centre of the proposed building plot, mudstone bedrock was encountered immediately beneath the made ground at a depth of 3m.

Based on the thickness of the made ground and the strength of the underlying natural clay strata, it is considered likely that pad foundations could be utilised. Mass concrete will be necessary to extend the pad bases to the level of suitable natural strata.

The underlying natural strata comprises natural clay, an allowable bearing capacity of 150kN/m² for total settlements of less than 25mm will be available.

The allowable bearing capacity is a function of the foundation configuration, depth and the ability of the structure to tolerate such movements and should therefore be validated during detailed design.

## 6.3 Ground Floor Construction

The made ground beneath the proposed units was found to be variable in strength, ranging between low and medium strength (soft to firm). For ground bearing floor slabs for the units, the made ground will need to be subjected to ground improvement techniques in order to provide a uniform formation and ensure an adequate bearing capacity. This may include the excavation of materials with suitable selection and controlled compaction to provide a competent formation.

## 6.4 Earthworks

Locally earthworks will be required to incorporate the stockpiled material, and for roadways, parking areas and for backfilling of excavations.

Based on the results of the geotechnical testing, the natural strata and stockpiled materials are likely to be suitable to achieve adequate compaction.

Proper selection and control will be required as part of the works to use this material. The material should not be allowed to deteriorate during excavation and compaction and must be sufficiently protected from traffic and adverse weather conditions after placement.

If the material does deteriorate then consideration should be given to the addition of lime and/or cement to improve the material for use as general fill.

It is recommended that a detailed Earthworks Specification is produced prior to commencement of works on the site.

## 6.5 Roads, Pavements and Hardstanding Surfaces

In accordance with the current proposed layout, the formation for road pavements and parking areas is unlikely to be natural clay strata.

Laboratory CBR values of 2.4% to 19.6% were obtained for samples of the natural strata and stockpiled made ground respectively. Due to the variability in material properties, it is recommended that a CBR value of 2% is adopted for the site. Where made ground is reworked, the proper selection and control of materials will be necessary, and it will be potentially possible to achieve a CBR of 4%.

Prior to roads and hardstanding being formed, the formation should be proof rolled and any soft spots removed and replaced with well compacted suitable granular fill. Any substructure remains should be “grubbed out” to a minimum depth of 500mm below the underside of formation to prevent hard spots from forming.

Any earthworks carried out as part of the redevelopment works may result in changes to the sub-grade materials. The works should therefore be designed to achieve a suitable CBR value for the proposed development.

## 6.6 Excavations

Excavations through the made ground and shallow natural ground should remain dry and stable in the short term. However, if excavations are left open for long periods of time, it is envisaged instability may eventually occur.

Small volumes of perched water may be encountered in deeper excavations which may be dealt with by pumping from sumps.

Good working practice with respect to drainage of excavations and formations will be required to protect materials. Any excavation for structural foundations must be covered without delay with blinding concrete to prevent softening by water.

The requirement for temporary support of excavations should be assessed on an individual basis and, in any case, excavations of greater than 1.2m depth requiring man entry will require temporary support in accordance with HSE guidance. Alternatively, the sides of the excavation will need to be battered back for the safety of operatives. Guidance on safe batter slopes can be obtained from CIRIA Report 97 Trenching Practice.

## 6.7 Obstructions

No significant obstructions were encountered during the site investigation within the superficial deposits. However, shallow rock, which was found to be hard to dig locally, and was also substantial enough to halt the progress of the boreholes, was encountered across the north of the site.

## 6.8 Chemical Attack on Buried Concrete

Laboratory testing has been undertaken on samples of the made ground and natural ground to determine the sulphate content and acidity and hence the concrete class required for buried concrete.

Laboratory testing in the made ground recorded water soluble sulphate contents ranging between <10mg/l and 97mg/l and pH values between 6.4 and 8.2.

In the natural ground, water soluble sulphate contents of 10mg/l and 82mg/l and pH values of 5.5 and 7.6 were recorded.

A water sample obtained from RO01 recorded sulphate contents of 79mg/l and pH values of 6.4.

Foundations are likely to come into contact with made ground and natural ground.

On this basis it is recommended that concrete should be designed to Aggressive Chemical Environment for Concrete (ACEC) Design Sulphate Class DS-1 and ACEC Class AC-2z.

This assessment has been made in accordance with BRE Special Digest 1: 2005, entitled ‘Concrete in Aggressive Ground’.

# 7.0 ENVIRONMENTAL RISK ASSESSMENT

## 7.1 Introduction

Legislation and guidance on the assessment of contaminated sites acknowledges the need for a tiered risk based approach comprising:

| | |
|---|---|
| Tier 1 Assessment | Comparison of site contaminant concentrations against generic assessment criteria (GAC), i.e. a generic quantitative risk assessment (GQRA). Including an assessment of risk using the source-pathway-receptor model. |
| Tier 2 Assessment | Derivation of site specific risk assessment criteria and calculation of site specific clean up goals, i.e. a detailed quantitative risk assessment (DQRA). |

A Tier 1 Assessment has been completed; however, a Tier 2 Assessment has not been undertaken as part of this report.

The statutory definition of contaminated land is given in the Environmental Protection Act, Part IIA, Section 78, 1990, which was introduced by the Environment Act, Section 57, Department of Environment, 1995 and is defined as:

Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land that:

- Significant harm is being caused or there is a significant possibility of such harm being caused (where harm is defined as harm to health of living organisms or other interference with the ecological systems of which they form a part and, in the case of man, includes harm to his property); and/or
- Significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused (by the land).

The presence of contaminated materials on a site is generally only of concern if an actual or potentially unacceptable risk exists. The potential for harm to occur requires three conditions to be satisfied:

- Sources – The presence of substances (potential contaminants/pollutants), in or under the ground, that may cause harm or pollution.
- Receptors - The presence of a receptor which may be harmed, e.g. the water environment or humans, buildings, fauna and flora; and
- Pathway - The existence of a linkage between the Source and the Receptor.

In order to assess the contamination risk at the site, the above rationale has been applied and is discussed in the context of Contamination Sources and Potential Pollutant Linkages.

In summary, the presence of measurable concentrations of contaminants within the ground and subsurface environment does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and an unacceptable risk of harm to available receptors.

The nature and importance of both pathways and receptors, which are relevant to a particular site, will vary according to the sensitivity of the intended end use of the site and the sites characteristics and environmental setting.

## 7.2 Assessment Approach

The results of the chemical analysis for each determinand will be assessed against their respective GAC.

These include the LQM/CIEH Suitable 4 Use Levels (S4UL) and Category 4 Screening Levels (C4SL) which were developed using the UK Contaminated Land Exposure Assessment (CLEA) Framework Documents and Software.

The CLEA model uses generic assumptions about the fate and transport of chemicals in the environment and a generic conceptual model (referred to as generic land use scenarios) for site conditions and human behaviour, to estimate child and adult exposures to soil contaminants for those living, working and/or playing on contaminated sites over long time periods.

The S4UL and C4SL screening levels have been derived for a variety of land uses including residential, allotments, commercial and public open space.

In the absence of S4UL and C4SL for potential contaminants, appropriate alternative GAC will be used.

### Controlled Waters

No standards currently exist in the UK which provides threshold values for potential contamination in groundwater. Alternative guidance is therefore used, against which the significance of potential contaminants can be assessed.

The results of the leachate analyses will be compared to the same standards as for groundwater.

## 7.3 Evaluation of Soils Analysis

Initially, the results of the chemical analysis for each potential contaminant will be compared directly with their respective GAC. Based on the current development proposals for the site, i.e. commercial, the results of the chemical analysis for the soil samples have been assessed against GAC for a commercial end use.

If any significant exceedances of the GAC are noted, then the results will be subject to statistical analysis if appropriate. An outline of the methodology of the statistical analysis is presented in Appendix C.

In total, ten samples of made ground were submitted for chemical analysis and an asbestos screen, with selected samples submitted further for TPHCWG analysis. A summary of the results of the chemical analysis is provided below.

Human Health
The results have been compared directly with their respective GAC and are summarised in Table 7.3.1 below.

Table 7.3.1 – Summary of Chemical Analysis for Samples of Made Ground

| Determinand | GAC for Commercial End Use (mg/kg) | Sample Mean (mg/kg) | Range of Results (mg/kg) | Do any samples exceed the GAC? |
|---|---|---|---|---|
| Arsenic | 640(1) | 8.8 | 4.1 – 16 | No |
| Cadmium | 190(1) | 0.1 | < 0.1-0.2 | No |
| Chromium | 8600(1) | 19.1 | 17 – 24 | No |
| Hexavalent Chromium | 33 (1) | 1.0 | All < 1.0 | No |
| Copper | 68000(1) | 31.3 | 25 – 35 | No |
| Lead | 2330(2) | 18.8 | 13 – 29 | No |
| Mercury (Inorganic) | 1,100 (1) | 0.1 | All < 0.05 | No |
| Nickel | 980(1) | 33.2 | 15 – 47 | No |
| Selenium | 12000(1) | 0.5 | < 0.5 – 0.8 | No |
| Zinc | 730000(1) | 79.6 | 72 – 89 | No |
| Cyanide (free) | 20(3) | < 0.1 | All < 0.1 | No |
| Total Phenols | 440*(1) | 0.3 | < 0.3 – 0.4 | No |
| Naphthalene | 190*(1) | < 0.1 | All < 0.1 | No |
| Acenaphthylene | 83,000*(1) | < 0.1 | All < 0.1 | No |
| Acenaphthene | 84,000*(1) | < 0.1 | All < 0.1 | No |
| Fluorene | 63,000*(1) | 0.1 | < 0.1 – 0.3 | No |
| Phenanthrene | 22000*(1) | 0.1 | < 0.1 – 0.2 | No |
| Anthracene | 520,000*(1) | < 0.1 | All < 0.1 | No |
| Fluoranthene | 23000*(1) | 0.2 | < 0.1 – 0.4 | No |
| Pyrene | 54000*(1) | 0.2 | < 0.1 – 0.9 | No |
| Benz(a)anthracene | 170*(1) | < 0.1 | All < 0.1 | No |
| Chrysene | 350*(1) | < 0.1 | All < 0.1 | No |
| Benzo(b)fluoranthene | 44*(1) | < 0.1 | All < 0.1 | No |
| Benzo(k)fluoranthene | 1200*(1) | < 0.1 | All < 0.1 | No |
| Benzo(a)pyrene | 35*(1) | < 0.1 | All < 0.1 | No |
| Indeno(123-cd)pyrene | 500*(1) | < 0.1 | All < 0.1 | No |
| Dibenzo(ah)anthracene | 3.5*(1) | < 0.1 | All < 0.1 | No |
| Benzo(ghi)perylene | 3,900*(1) | < 0.1 | All < 0.1 | No |

(1) S4UL * BASED ON 1% SOM, (2) C4SL, (3) DUTCH

None of the above determinands were detected at concentrations in excess of their respective GAC.

One sample (TP20 at 10m to 1.5m) was submitted for TPHCWG analysis. No hydrocarbon fractions were detected at concentrations above their respective S4UL GAC.

All ten samples were submitted for an asbestos screen. No asbestos was detected in any of the samples.

## 7.4 Evaluation of Controlled Waters Analysis

Six samples of made ground were submitted for leachability analysis. The result for each determinand was compared directly with their respective GAC, the results are summarised in Table 7.4.1 below.

Table 7.4.1 – Summary of Leachability Results

| Determinand | GAC (µg/l) | TP01, 0 - 0.20 | TP05, 0 - 0.30 | TP14, 0 - 0.5 | TP18, 1.0-1.4 | TP20, 1.0-1.5 | TP21, 0 -0.5 |
|---|---|---|---|---|---|---|---|
| Arsenic | 50(1) | 0.29 | < 0.16 | 1.5 | 0.38 | 0.94 | 0.57 |
| Cadmium | 5(1) | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| Chromium | 50(1) | < 0.25 | < 0.25 | 0.54 | < 0.25 | 0.32 | 0.34 |
| Copper | 2000(1) | 0.7 | 0.4 | 2.6 | 0.7 | 1.4 | 1.1 |
| Lead | 10(1) | 0.14 | < 0.09 | 0.96 | 0.3 | 0.47 | 0.47 |
| Mercury | 1(1) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Nickel | 20(1) | 2.6 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Selenium | 10(1) | < 0.25 | < 0.25 | 0.4 | 0.81 | 0.81 | 0.49 |
| Zinc | 5000(1) * | 190 | < 1.3 | 1.4 | < 1.3 | < 1.3 | 1.3 |
| pH | 6.5-9.5(1) | 7.2 | 6.5 | 7.1 | 6.5 | 7.6 | 6.8 |
| Cyanide free | 50(1) | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 |
| Sulphate as SO4 | 250000(1) | 2500 | 700 | 3000 | 1800 | 1400 | 2300 |
| Naphthalene | 4.24 (2) | < 0.01 | < 0.01 | 0.03 | < 0.01 | 0.02 | < 0.01 |
| Acenaphthylene | NA | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Acenaphthene | NA | < 0.01 | < 0.01 | 0.06 | < 0.01 | 0.03 | < 0.01 |
| Fluorene | NA | < 0.01 | < 0.01 | 0.06 | < 0.01 | 0.03 | < 0.01 |
| Phenanthrene | NA | < 0.01 | < 0.01 | 0.24 | < 0.01 | 0.14 | < 0.01 |
| Anthracene | 0.193(2) | < 0.01 | < 0.01 | 0.04 | < 0.01 | 0.02 | < 0.01 |
| Fluoranthene | 0.0122(2) | < 0.01 | < 0.01 | 0.14 | < 0.01 | 0.08 | < 0.01 |
| Pyrene | NA | < 0.01 | < 0.01 | 0.09 | < 0.01 | 0.07 | < 0.01 |
| Benzo(a)anthracene | NA | < 0.01 | < 0.01 | 0.03 | < 0.01 | 0.03 | < 0.01 |
| Chrysene | NA | < 0.01 | < 0.01 | 0.04 | < 0.01 | 0.05 | < 0.01 |
| Sum of: benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene benzo(g,h,i)perylene | 0.1(1) | 0.04 | 0.04 | 0.12 | 0.04 | 0.22 | 0.04 |
| Benzo(a)pyrene | 0.01(1) | < 0.01 | < 0.01 | 0.03 | < 0.01 | 0.06 | < 0.01 |
| Dibenzo (a, h) anthracene | NA | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Phenol | 14.9 (2) | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |

(1) Water Supply (Water Quality) Regulations 2000.
*Historical 1989 Threshold Value.
(2) Water Framework Directive 2015, Surface Water, Maximum Threshold Value.

Slightly elevated concentrations of several potentially leachable PAH species were detected in two samples from shallow depth (TP14 at 0-0.5m and TP20 at 1m to 1.5m). The slightly elevated determinands are highlighted in the table above.

The results are not considered significant when viewed in relation to the Water Supply (Water Quality) Regulations.

## 7.5 Summary of Potential Sources, Pathways and Receptors

Potential Sources
Based on the results of the analysis carried out, the following potential sources of contamination are considered to be present on the site:

- Slightly elevated concentrations of several potentially leachable PAH species in samples of made ground from shallow depth in the vicinity of TP14 and TP20.
- Hazardous ground gases.

Potential Pathways
Based on the available information and the proposed redevelopment of the site for a commercial end use, the following potential exposure pathways will require consideration, both during the redevelopment works and on completion of the construction:

- Inhalation of hazardous gases.
- Leaching/migration of contaminants into groundwater and surface water via groundwater and surface water flow.
- Permeation of water supply pipes and other services by organic and aggressive contaminants; and
- Uptake of contaminants by amenity planting.

Potential Receptors
The potential receptors are considered to be:

- Development workers and future maintenance workers involved in excavations, e.g. foundations or where services are being installed or repaired following development.
- Future end users of the site (e.g. employees and customers).
- Groundwater in the underlying Secondary A Aquifer.
- Surface Watercourse – a drain at 120m to the west of the site.
- Buildings and services; and
- Amenity planting.

## 7.6 Source – Pathway – Receptor Linkages

Based on the above potential sources, pathways and receptors, the following linkage assessments have been considered. A conceptual site model illustrating the pollutant linkages at the site is presented as Figure 3 in Appendix A and discussed below.

This assessment is based on current site conditions (unless stated) and does not consider exposure pathways following any further works on the site.

Development and Maintenance Workers
Based on the sources of potential contamination which have been identified on the site, there is a risk to development and maintenance workers involved in groundworks at the site.

There is the potential for exposure to the following:

- Hazardous ground gases. (Discussed in Section 8.0).

Future Site End Users
It is unlikely that future site end users will come into contact with the site in its current condition. However, there is the potential for exposure to the following:

- Hazardous ground gases (Discussed in Section 8.0).

The Underlying Aquifers and Surface Watercourse
The risk to controlled water receptors is assessed as follows:

Slightly elevated concentrations of several potentially leachable PAH species in samples of made ground from shallow depth have been detected in the vicinity of TP14 and TP20.

The Water Supply (Water Quality) Regulations, from which the GAC for PAH species has been derived, is considered to be conservative when applied to an assessment of risks to groundwater.

In addition, consideration has been given to the environmental setting of the site, which is summarised as follows.

- Where made ground was encountered, it was generally underlain by natural strata comprising impermeable clay. The underlying clay will form a barrier and reduce the potential for downward migration.
- No significant shallow groundwater was encountered on or in the vicinity of the site. (i.e. no significant shallow groundwater was encountered in on the adjacent site).
- There are no groundwater or surface water abstractions within 1km of the site.
- There are no surface watercourses on or adjacent to the site.

Based on the slightly elevated concentrations of potentially leachable contaminants which have been detected and the environmental setting of the site, there are no plausible linkages to surface or groundwater receptors. The risk to controlled waters is therefore considered to be low.

Buildings and Services
Based on the potential sources of contamination which have been identified on the site, there may be a risk to buildings and services, such as water supply pipes and buried concrete.

Amenity Planting
Based on the potential source of contamination and nature of the made ground, there is not considered to be a significant risk to plants on the site. However, for areas of proposed soft landscaping, provision of a suitable thickness of clean growing medium, i.e. subsoil/topsoil, will be required in order to promote plant growth.

## 7.7 Mitigation Measures

In order to mitigate the risks posed by the potential contaminants which are present on the site, consideration should be given to the following mitigation measures.

Development and Maintenance Workers
In order to mitigate the risks posed by the potential slightly elevated PAH species present on the site, consideration should be given to the following mitigation measures:

- Site workers involved in groundworks should take the necessary measures to ensure that all works in excavations and confined spaces are carried out in accordance with best practice in order to prevent exposure to potentially hazardous gases.
- Site workers involved in groundworks should use appropriate PPE, i.e. overalls and gloves and where appropriate, masks. Appropriate health and safety measures, e.g. washing hands prior to eating or drinking, should also be enforced.

During development of the site, all workers should remain vigilant to the possible risk of encountering areas of potentially contaminated material. Should potentially contaminated material be encountered, site management should be informed. Further testing may then be required to assess the risk to health and safety of the site workers and the environment.

All employers involved in works at the site should produce an appropriate method statement and risk assessment, to which all employees should comply.

Reference should also be made to appropriate HSE and other guidance for working on contaminated and potentially contaminated sites.

Future Site Users
Recommendations for gas protection measures are provided in Section 8.0 of this report.

Buildings and Services
Recommendations with respect to the chemical attack on buried concrete are given section 6.8.

Confirmation should be sought from the utilities provider as to the potential requirement for upgrading any proposed new water service pipes.

## 7.8 Classification of Materials for Disposal Off-Site

Ten samples of made ground from across the site, and two samples of the material from the stockpile, were assessed using HazWasteOnline™ in order to determine the classification of the materials for disposal offsite.

Based on the results of the chemical analysis, all the samples can be classified as non-hazardous. Details of the classification generated by HazWasteOnline™, are presented in Appendix C.

The results of the chemical analysis and the waste classification should be forwarded to the landfill operator to confirm this assessment and provide a price for disposal.

# 8.0 HAZARDOUS GAS MONITORING

## 8.1 Potential Gas Sources

Based on the desk study information and ground conditions encountered, it is considered that there is the potential for the presence of hazardous gases on the site.

## 8.2 Ground Gas Monitoring

In order to assess the potential risks posed to the proposed development from hazardous gases, monitoring wells were installed in two cable percussive boreholes and one rotary borehole.

Ground gas monitoring has been undertaken on six occasions. The works were carried out using a portable infra-red gas meter in accordance with the standard JPG methodology and included the measurement of methane, carbon dioxide, oxygen, hydrogen sulphide, gas flows and atmospheric pressure.

## 8.3 Summary of Results

The results of the gas monitoring are presented on the site visit record sheets in Appendix E and are summarised below:

- No methane concentrations were recorded.
- Steady concentrations of carbon dioxide were recorded in all three installations, ranging between 1.0%v/v and 7.9%v/v. Concentrations of greater than 5%v/v were recorded in RO01 and BH05 on several occasions.
- Reduced oxygen concentrations (i.e. <16%v/v) were recorded in all the installations on the majority of monitoring visits.
- Steady positive flows of 6.0 l/hr and 3.8 l/hr were recorded on two occasions in RO01. No other steady flows were recorded.
- Four of the monitoring visits were carried out during periods of falling atmospheric pressure.
- Barometric pressures during the monitoring period ranged between 994mB and 1013mB.
- No shallow water was detected in the boreholes and, therefore, there are no flooded response zones.

## 8.4 Requirements for Gas Protection Measures

The results of the gas monitoring have been assessed in accordance with CIRIA Report C665 'Assessing risks posed by hazardous ground gases to buildings' and BS 8485:2015, 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.

No methane concentrations were recorded. Several concentrations of carbon dioxide in excess of 5.0%v/v were recorded during the monitoring period, up to a maximum concentration of 7.9%v/v in BH05. Two steady flows were recorded in RO01, and reduced oxygen concentrations have also been recorded across the site.

A single steady concentration of carbon dioxide in excess of 5% v/v, and a steady flow have been recorded on the adjacent site.

CIRIA C665
The risk to the site has been assessed in accordance with 'Situation A', i.e. a commercial end use.

Based on the results, the site is characterised as Characteristic Situation 2.

The measures should comprise the following:

- Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200 g DPM2.
- Beam and block or pre-cast concrete slab and minimum 2000 g DPM/reinforced gas membrane.
- Possibly underfloor venting or pressurisation in combination with the above, depending on use.
- All joints and penetrations sealed.

BS 8485:2015
The British Standard takes into account the gas characteristic situation and the nature of the proposed development.

Four building types are prescribed in the standard, ranging from small buildings, e.g. houses (Type A), through to large well ventilated buildings, e.g. warehouses (Type D). A gas protection score is then determined, based on the characteristic situation and building type.

This assessment will be carried out based on the proposed development comprising a commercial unit, with the following assumptions:

- The proposed development will comprise industrial style buildings with large volume well ventilated internal spaces.
- There will be building management controls on alterations to the ground floor and any basement areas.
- Ground gas protective measures will be maintained for the life of the building.

Gas characteristic situation 2 has been determined for the development. Therefore, for building Type D, a gas protection score of 1.5 will be required and for Type C a score of 2.5 will be required.

Based on the gas protection score, an element or combination of elements should be selected from the following:

- Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations. The slab should be well reinforced to control cracking.
- A sufficiently impervious sealed gas resistant membrane lapped through walls and sealed around penetrations.

It is also recommended that further advice be sought from a gas protection specialist to assess whether alternative measures may offer the same level of protection for the proposed development.

## 8.5 Radon Risks

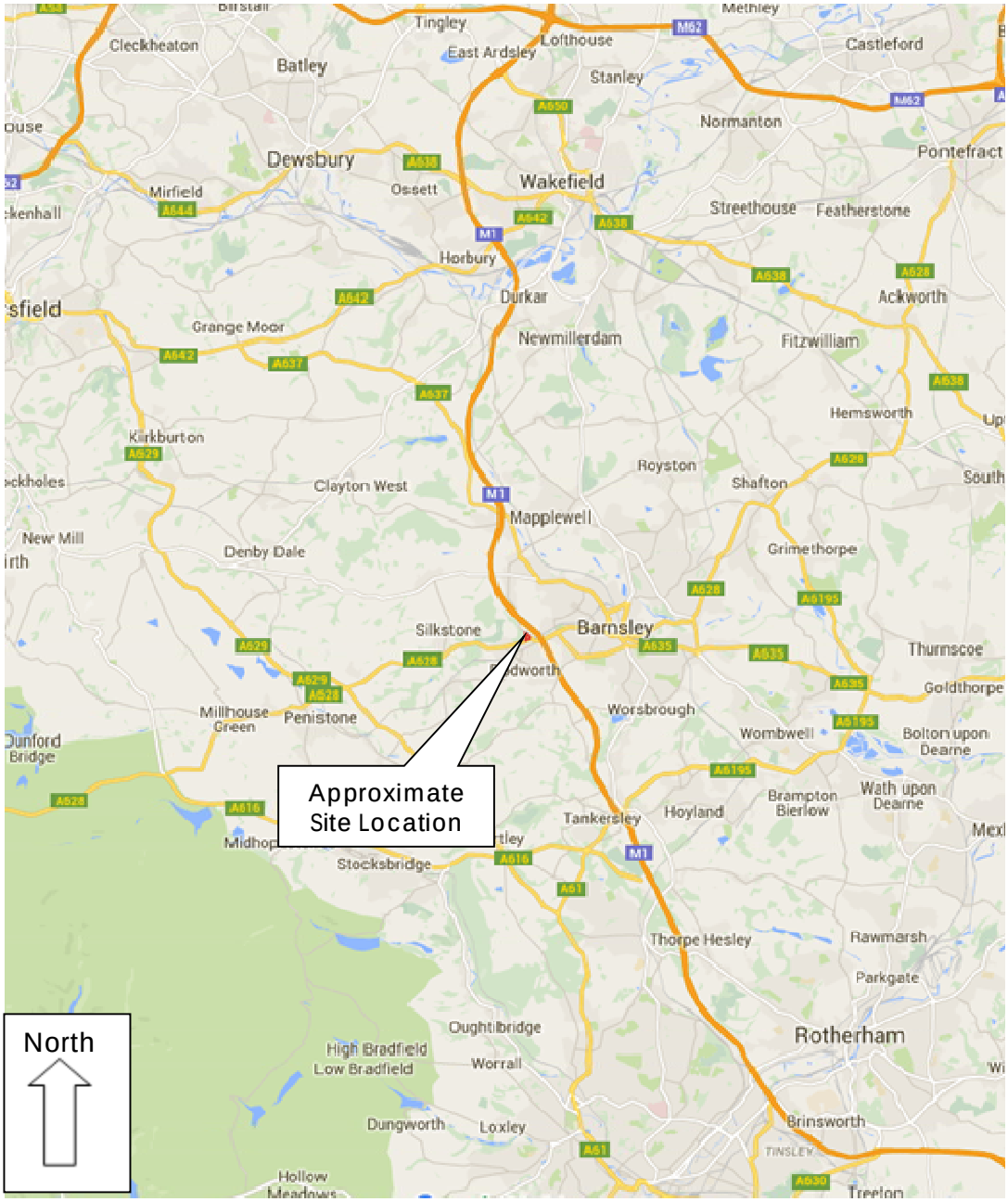
The site is in a radon affected area, as between 1% and 3% of properties are above the action level for radon gas. However, no radon protective measures are required in the construction of new properties.



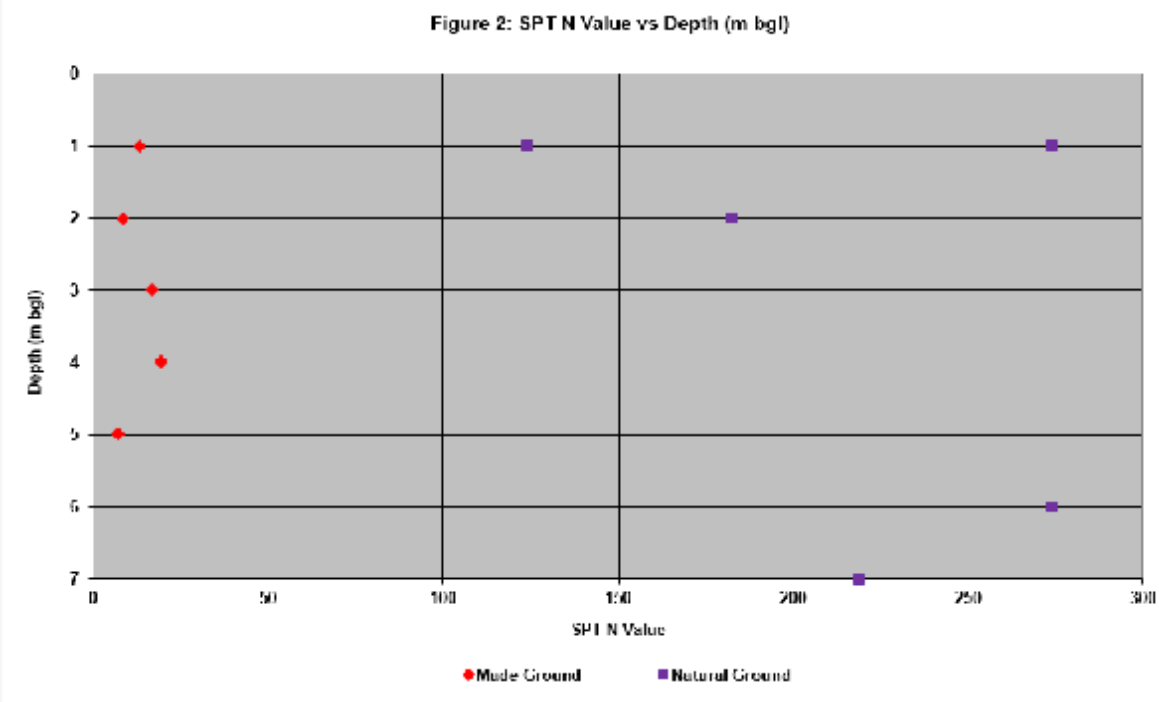
J Parkinson
BSc
For and on behalf of JPG (Leeds) Limited

June 2017

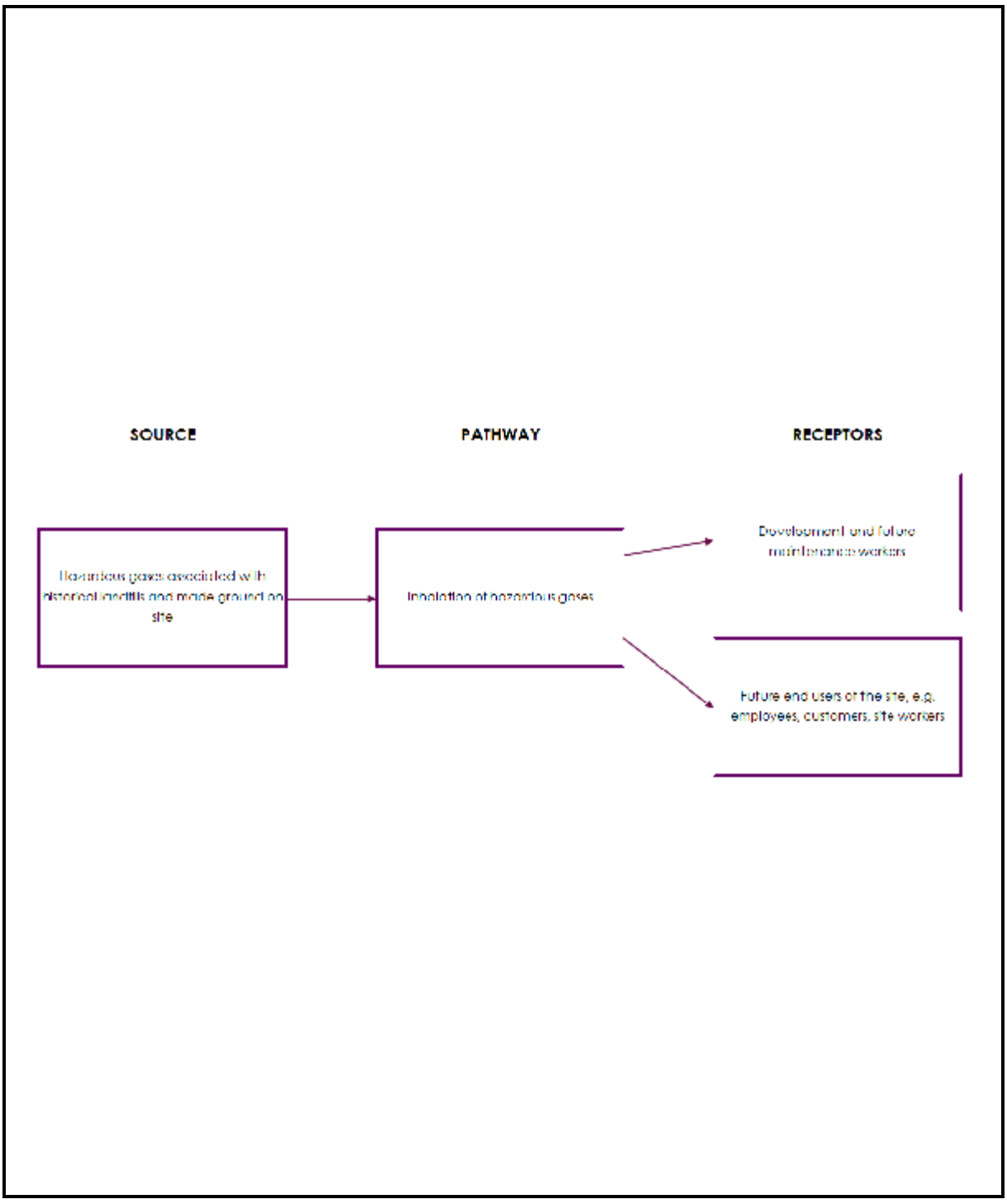
# Appendix A Figures/Drawings




| Figure 1 – Site Location Plan | |
|---|---|
| Site | Capitol Park, Junction 37 – M1, Barnsley |
| Client | Commercial Development Projects Limited |
| Job Number | 2450-5 |
| Scale | NTS |




| Figure 2 – SPT N Value vs Depth | |
|---|---|
| Site | Capitol Park, Junction 37 – M1, Barnsley |
| Client | Commercial Development Projects Limited |
| Job Number | 2450-5 |




| Figure 3 – Conceptual Site Model | |
|---|---|
| Site | Capitol Park, Junction 37 – M1, Barnsley |
| Client | Commercial Development Projects Limited |
| Job Number | 2450-5 |

# PROPOSED DEVELOPMENT

*Capitol Park, Higham Lane, Barnsley*

New Access Road
Subject to L.A. Approval

Possible retaining wall

Refuse 250sqm

Fleet Service Area 350sqm

28m Service spin

Embankment

Serviceyard

Plant

FE stairs

Cycles

PROPOSED
**Site Area**
4.93 Acres

PROPOSED
**NHS Unit D**

***37,674 sqft (3,500sqm) Ground Floor Footprint plus 37,674 sqft (3,500sqm) at First Floor total 75,348 sqft (7,500sqm) (exc lobby & fire escape stairs)***

Proposed parking
6BMV, 30 Van size spaces &
10 rapid response spaces

Entrance

Landscaped Bunking

SITE BOUNDARY LINE

Capitol Close

72 Car parking bays

Existing Development

Boundary from legal plan subject to confirmation

8,000sqft Offices over 2 floors.

UNIT A

Proposed Warehouse Unit
72,000sqft building footprint incl 4.0k of ground floor offices.
+ 4.0k First floor offices Total 76,000sqft.

4 No. Dock Door loading

2 No. Surface Level doors

Service Yard

Proposed car park
239 spaces
(inc 12 disabled, 8 double stack and 19 Fleet cars non blue )

Proposed car park
39 spaces
(inc 4 disabled)

Turning Head

PROPOSED
**Industrial Unit C**
***25,000 sqft (2322.5 sqm) Footprint***
***1250 sqft (116.1 sqm) Office @ 1st***
***26,250 sqft (2438.6 sqm)***

PROPOSED
**Site Area**
2.93 Acres

Proposed car park
19 spaces
(inc 2 disabled)

25m Service spin

Service Yard

PROPOSED
**Industrial Unit B**
***20,000 sqft (1858.1 sqm)Footprint***
***1000sqft (92.9 sqm) Office @ 1st***
***21,000 sqft (1951 sqm)***

Pedestrian Route Thru
(To Engineers Detail)

0 5 10 15 20 25m
SCALE 1:500

**Note:**
Information is based on OS map and received information and is subject to full topographical and building survey.
Assumed site boundary and site constraints subject to confirmation.
All Legal easements and extent of existing underground services locations are subject to confirmation.

**SITE PLAN**

| | | | | | |
|---|---|---|---|---|---|
| Project Title | PROPOSED DEVELOPMENT MASTERPLAN<br>Capitol Park<br>Juntion 37 - M1<br>Higham Lane<br>Barnsley | | | | |
| Client | CDP | | | | |
| Status | INFORMATION | | | | |
| Scale | 1:500 | | Drawing Size | A1 | |
| Drawn By | ASR | Checked By | PSM | Date | 12.04.17 |

| rev | date | notes | rev by | check |
|---|---|---|---|---|

Drawing Title: Proposed Site Plan
Job-Dwg No: 14120-043 Rev: -


THE HARRIS PARTNERSHIP WAKEFIELD
2 St. Johns North, Wakefield, WF1 3QA
t. 01924 291 800 f. 01924 290 072

THE HARRIS PARTNERSHIP MANCHESTER
2nd Floor, Carvers Warehouse,
77 Dale Street, Manchester, M1 2HG
t. 0161 238 8555 f. 0161 244 5809

THE HARRIS PARTNERSHIP MILTON KEYNES
The Old Rectory, 79 High Street
Newport Pagnell, MK16 8AB
t. 01908 211 577 f. 01908 211 722

THE HARRIS PARTNERSHIP READING
101 London Road, Reading, RG1 5BY
t. 0118 950 7700 f. 0118 956 8642

THE HARRIS PARTNERSHIP
ARCHITECTS
www.harrispartnership.com


CAD file reference J:\14001-15000\14120\17.0 Drawings and Issue Sheets

This drawing is copyright and may not be reproduced in whole or part without written authority. Do not scale off this drawing.

# Appendix B Exploratory Hole Logs and Plan

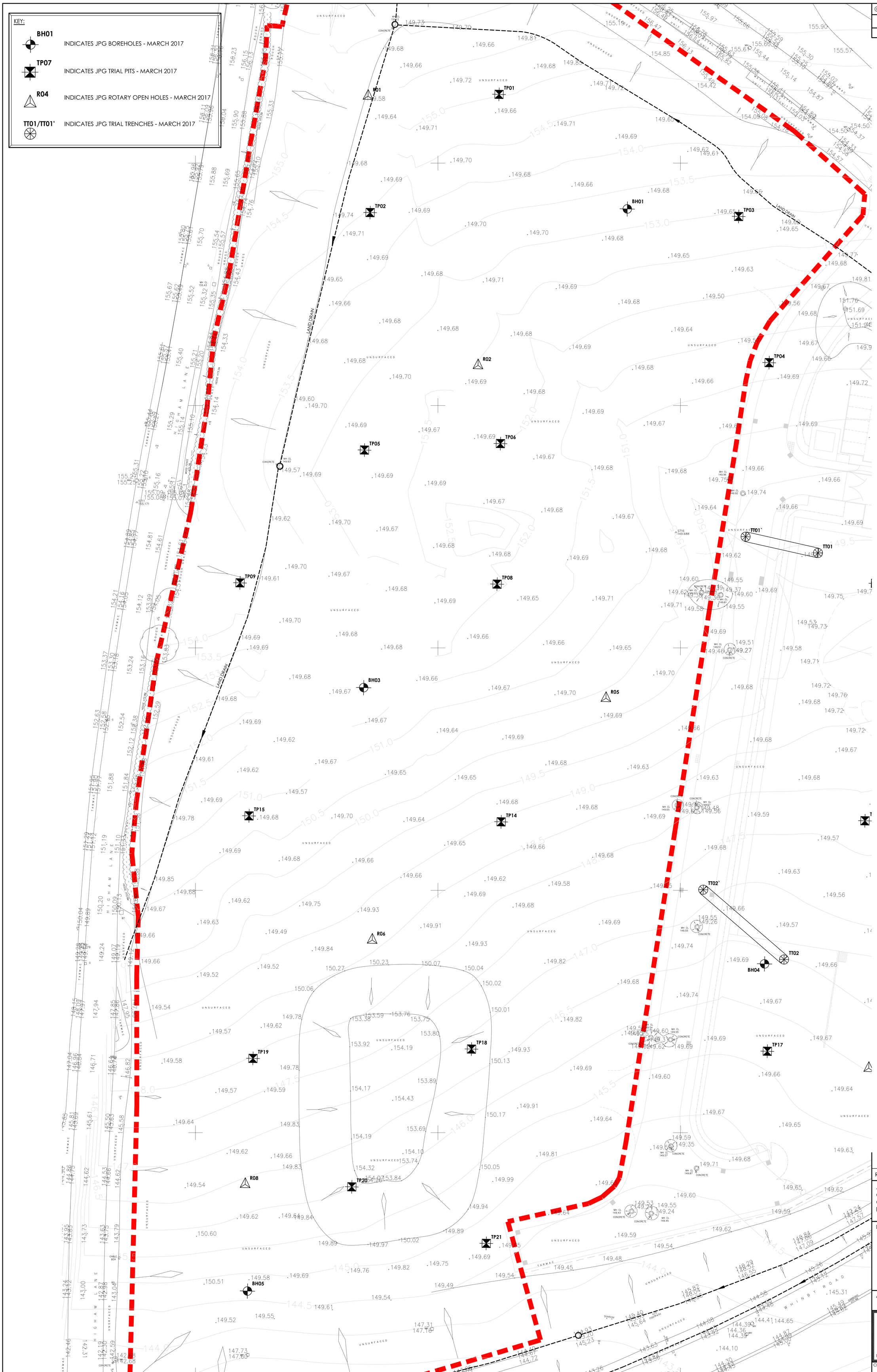
© THIS DRAWING IS THE PROPERTY OF JPG (LEEDS) LIMITED
REGISTERED IN ENGLAND No 4274608. COPYRIGHT RESERVED

DO NOT SCALE

NOTES

KEY:

- **BH01** — INDICATES JPG BOREHOLES - MARCH 2017
- **TP07** — INDICATES JPG TRIAL PITS - MARCH 2017
- **R04** — INDICATES JPG ROTARY OPEN HOLES - MARCH 2017
- **TT01/TT01'** — INDICATES JPG TRIAL TRENCHES - MARCH 2017




| REV | DESCRIPTION | DATE | BY |
|---|---|---|---|

Job Title
CAPITOL PARK
CAPITOL CLOSE
BARNSLEY

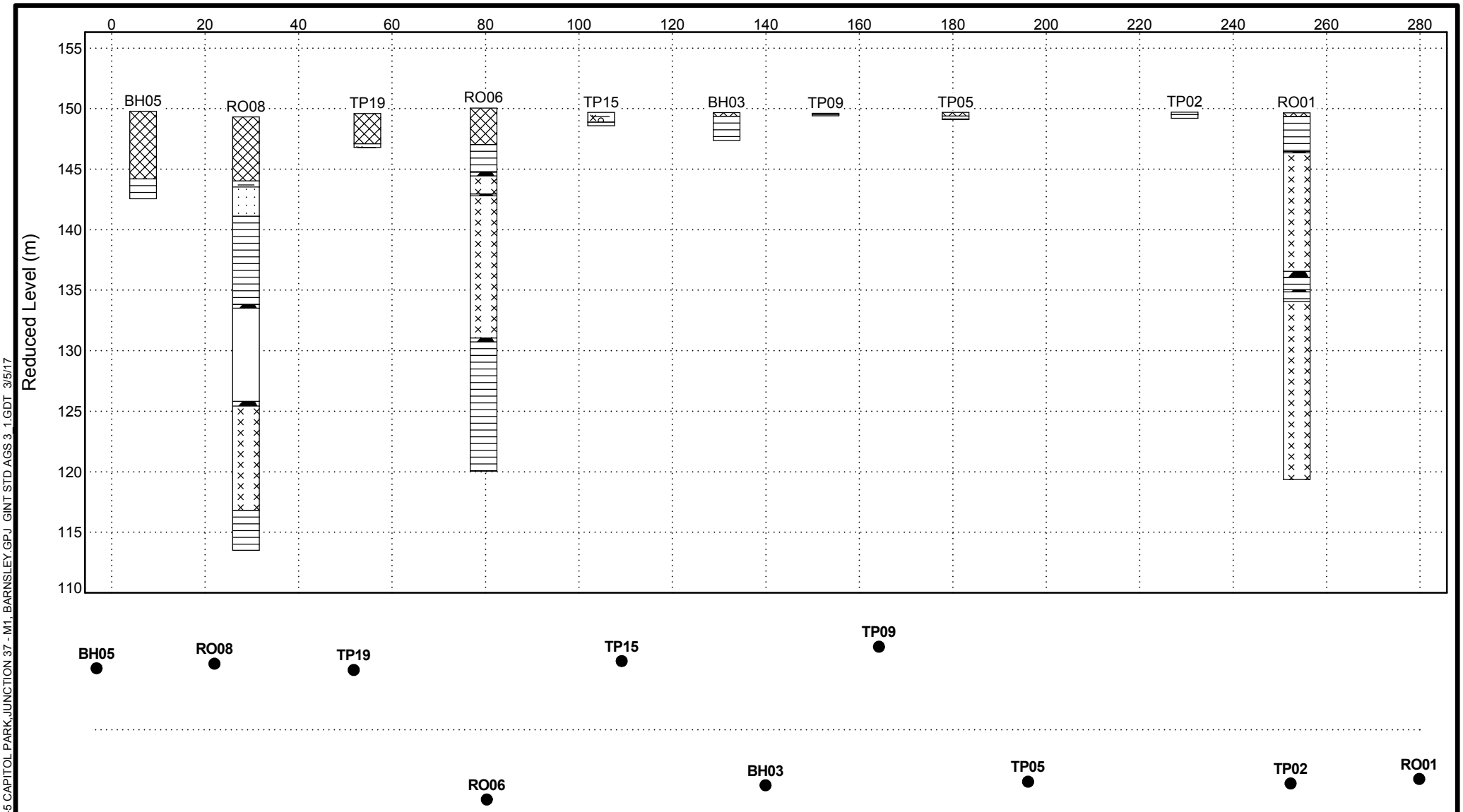
Drawing Title
EXPLORATORY HOLE
LOCATION PLAN

Architect

JPG
www.jpggroup.global
Leeds: +44 (0)113 263 1155 | Also: London & Muscat

| Checked | Date | Scale | | Drawn |
|---|---|---|---|---|
| KB | Feb '17 | 1:250 | A0 | MT |

Drawing No 2450-5-EHLP01




JPG (Leeds) Ltd.

CIVIL & STRUCTURAL ENGINEERING

N

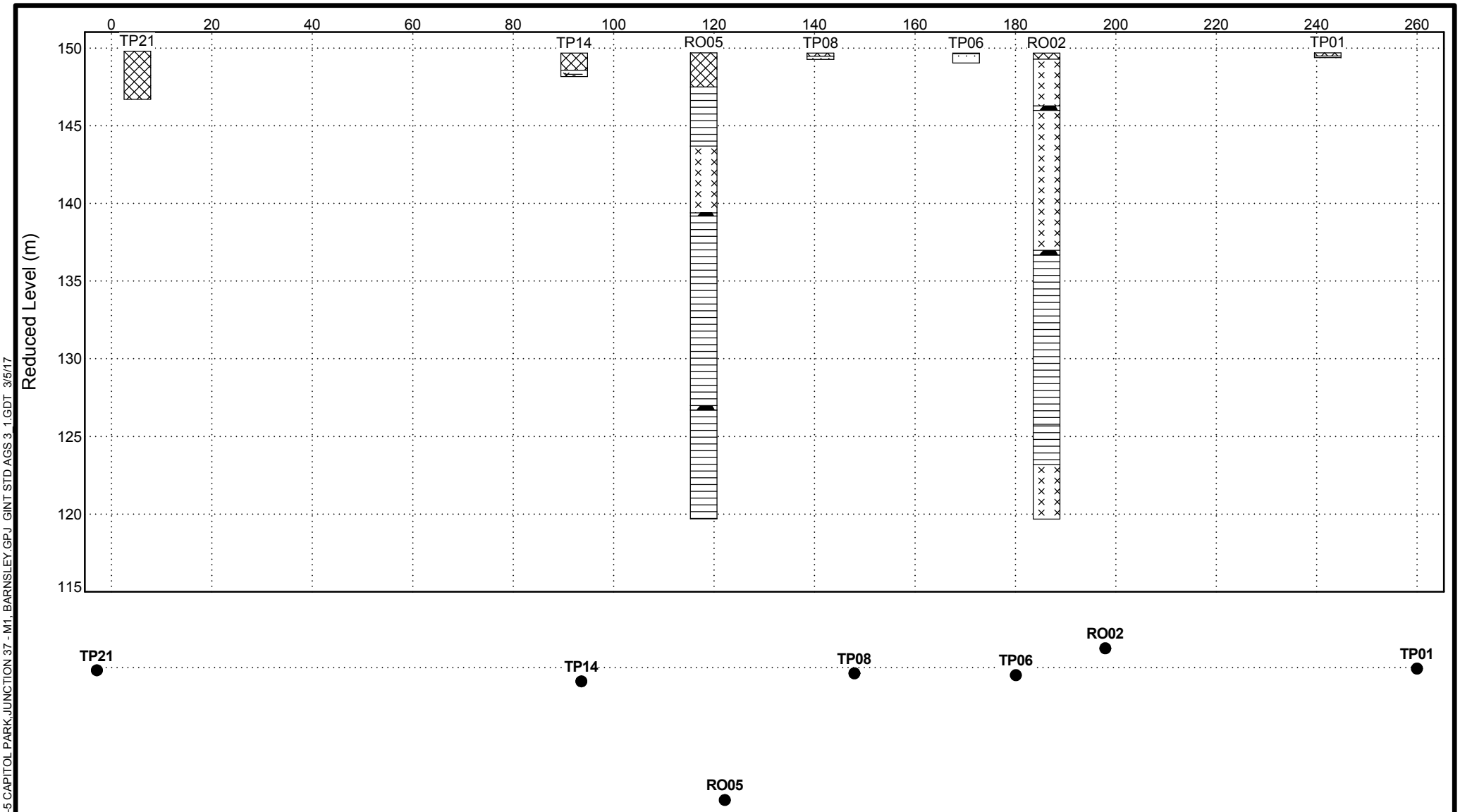
**SUBSURFACE SECTION A - A'**

Client: CDP Ltd.

Project: Capitol Park, Junction 37 - M1, Barnsley

Number: 2450-5

AGS3 LITHOLOGY SITEMAP 2450-5 CAPITOL PARK JUNCTION 37 - M1, BARNSLEY.GPJ GINT STD AGS 3_1.GDT 3/5/17




AGS3 LITHOLOGY SITEMAP 2450-5 CAPITOL PARK,JUNCTION 37 - M1, BARNSLEY.GPJ GINT STD AGS 3_1.GDT 3/5/17

JPG (Leeds) Ltd.
CIVIL & STRUCTURAL ENGINEERING

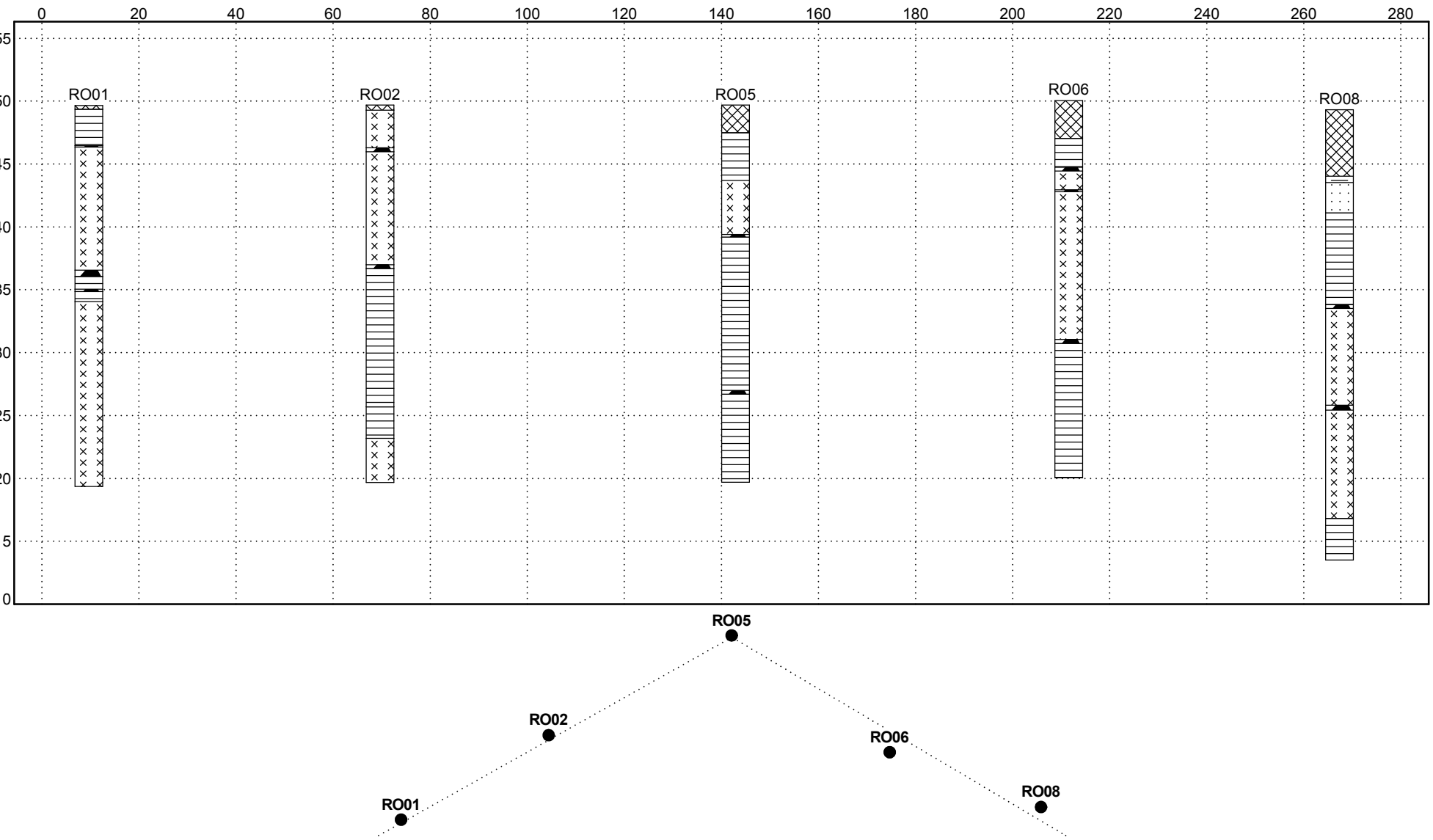
N

**SUBSURFACE SECTION B - B'**

Client: CDP Ltd.

Project: Capitol Park, Junction 37 - M1, Barnsley

Number: 2450-5




JPG (Leeds) Ltd.

CIVIL & STRUCTURAL ENGINEERING

N

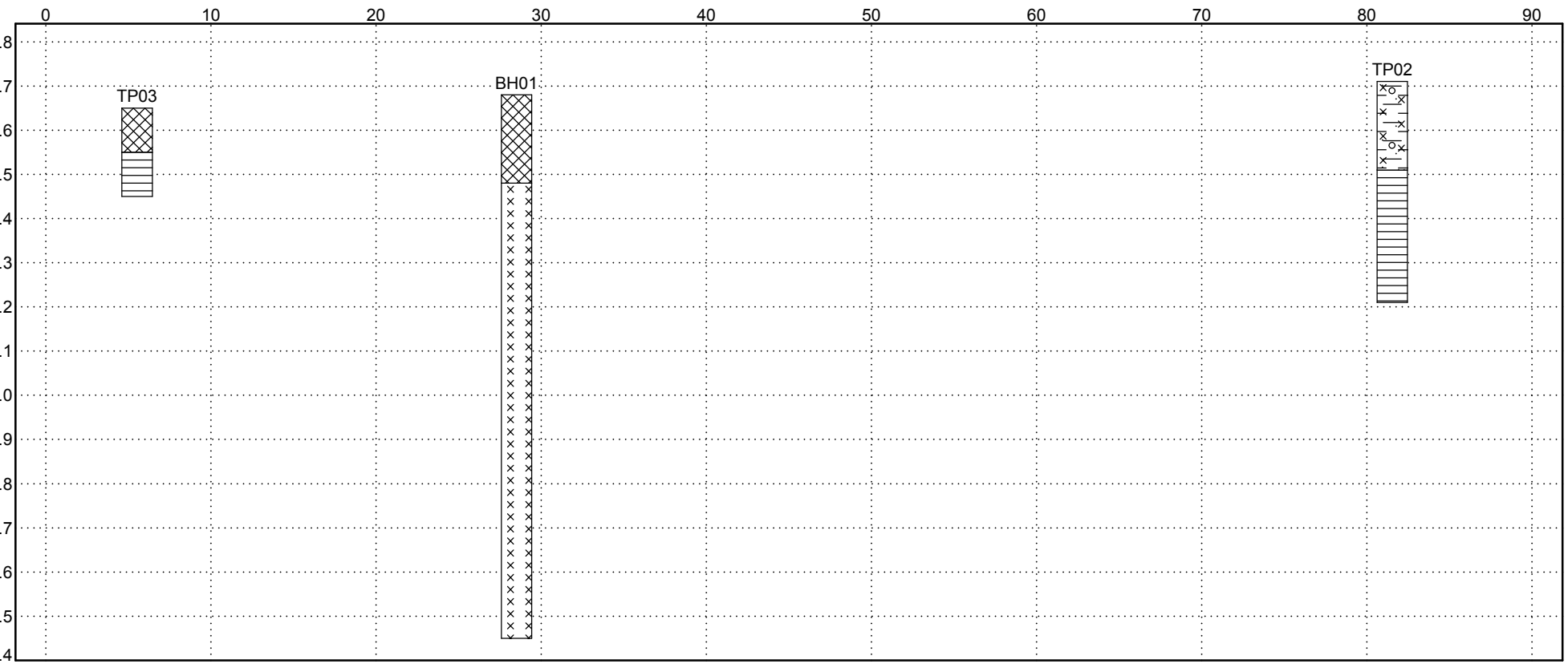
**SUBSURFACE SECTION C - C'**

Client: CDP Ltd.

Project: Capitol Park, Junction 37 - M1, Barnsley

Number: 2450-5

AGS3 LITHOLOGY SITEMAP 2450-5 CAPITOL PARK JUNCTION 37 - M1, BARNSLEY.GPJ GINT STD AGS 3_1.GDT 3/5/17







JPG (Leeds) Ltd.
CIVIL & STRUCTURAL ENGINEERING

N

**SUBSURFACE SECTION D - D'**

Client: CDP Ltd.

Project: Capitol Park, Junction 37 - M1, Barnsley

Number: 2450-5

AGS3 LITHOLOGY SITEMAP 2450-5 CAPITOL PARK JUNCTION 37 - M1, BARNSLEY.GPJ GINT STD AGS 3_1.GDT 3/5/17