Discovery CE

Geotechnical & Environmental Engineers

GROUND INVESTIGATION
RYBROOK, HANDY CROSS, HIGH WYCOMBE

Carried Out For: **DEALERSHIP DEVELOPMENTS LIMITED**

June 2021 **Report Reference: 20008J-02**

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Carried Out For: **DEALERSHIP DEVELOPMENTS LIMITED**

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Discovery CE
Geotechnical & Environmental Engineers

REPORT
GROUND INVESTIGATION
RYBROOK, HANDY CROSS, HIGH WYCOMBE

EXECUTIVE SUMMARY

ENGAGEMENT OF DISCOVERY CE LIMITED
Discovery CE (DCE) was instructed by PCS CONSULTING ENGINEERS (PCS) on behalf of Dealership Developments Ltd to carry out a Ground Investigation at a site known as Rybrook, Handy Cross, High Wycombe.

SITE DESCRIPTION
The site is situated off Marlow Hill (A404) (to the north west of the site) approximately 1.7 km southwest of the centre of High Wycombe, with approximate Grid Reference 485770 191430. The north western boundary of the site is formed by Marlow Hill (A404). The remaining boundaries are formed by a service road which loops back onto the A404.The site occupies an area of approximately 1.73 Ha and generally slopes downwards from the north to south, with shallow. There are several areas of concrete slab in the north and associated surrounding hardstanding remaining from the former sports centre. There is a large slab area and some bituminous surfaced roads left in the south. The whole site is secured with large wooden hoardings around the whole boundary.

GEOLOGY, HYDROLOGY & HYDROGEOLOGY
British Geological Survey (BGS) sheet no 255, BEACONSFIELD (1:50 000, Solid and Drift Edition) indicates the site to be directly underlain by the Clay-with-flints Formation - Clay, Silt, Sand And Gravel which in turn overlies the Seaford Chalk Formation And Newhaven Chalk Formation (undifferentiated) – Chalk

FIELDWORK & LABORATORY TESTING
The fieldwork comprised 6 No. cable percussive boreholes to a maximu depth of 20.45 m, 11 No. dynamic sampler boreholes and 14 No trial pits with infiltration testing carried out in 6 of these pits. Geotechnical and chemical laboratory testing was also undertaken. Gas and groundwater monitoring was undertaken on 4 No. occasions.

GROUND AND GROUNDWATER CONDITIONS
The ground conditions at the site where in general accordance with those anticipated from the geological mapping and previous investigations. This included Made Ground up to 2.09 m thick (not fully penetrated) overlying Clay with Flints deposits which in turn overlies structureless and/or structured CHALK

No groundwater was encountered during the investigation or subsequent monitoring.

CONTAMINATION ASSESSMENT
The intrusive investigation has not revealed any obvious signs of contamination at the site. Chemical testing on soils has revealed low concentrations of chemical determinands in the samples tested and none of these samples were found to contain concentrations in excess of the Generic Assessment criteria adopted for the sites end use. As a consequence the human health risk at the site is considered NEGLIBIBLE based on these findings.

Chemical testing on soils has revealed generally very low concentrations of chemical determinands at the site and no significant sources or potential sources of contamination have been identified either during the Phase 1 Desk study or intrusive works at the site. Additionally, whilst a Principal aquifer underlies the site, this is largely (although not always) overlain by clay with flints deposits (protective of the aquifer) and groundwater is at a depth in excess of 20 m below existing ground level (no groundwater was encountered to this depth during the works and subsequent monitoring). Given these various factors the risk to controlled waters from the low concentrations of determinands recorded at the site is considered to be VERY LOW and no further action is considered necessary.

Should any suspected contamination be identified during site enabling or redevelopment works, further investigation, testing and assessment should be carried out to determine if any additional action or remediation is required.

GAS ASSESSMENT
The gas monitoring indicates that the site should be classified as Characteristic Situation 1 (CS1) using a modified Wilson and Card classification scheme defined in CIRIA C665.

GEOTECHNICAL ENGINEERING ASSESSMENT
Development proposals are not yet finalised for the project and are subject to ongoing change and design development. It is understood that the development will include a cut and fill exercise to create a development platform, however site levels have not yet been finalised at the time of writing.

Ground Strength	Recorded SPT N values from across the site indicate a broad increase in strength with depth to around 10 m bgl, particularly within the structured chalk below which there is no clear trend..
Spread Foundations	Foundations should not be placed in untreated Made Ground. Spread foundations (pad or strip foundations) may be placed within the Clay with flint deposits or structureless chalk provided the foundation formation is inspected during construction by a suitably qualified geotechnical engineer and any soft or loose spots removed and replaced with suitable compacted granular materials or lean mix concrete. Subject to this, an allowable bearing capacity of 120 kN/m2 is considered appropriate for foundations up to 2.5 m x 2.5 m placed at a depth of between 1.5 and 2 m below existing ground level. Total settlement would then be anticipated to be less than 25 mm. A higher allowable bearing capacity may be achieved by placing foundations on the structured chalk and an allowable bearing capacity of 250 kN/m2 is considered appropriate for foundations up to 2.5 m x 2.5 m placed in this material. This is present at varying depths across the site but may be within a reasonable excavation depth following cut works or before filling works depending on the proposed finished levels. The elevation of the top of the structured chalk is difficult to interpret from the boreholes put down due to sample disturbance. Should the design proposals include exploitation of this higher allowable bearing capacity, it is recommended that additional trial pitting investigation is carried out at the site once the cut and fill details are finalised and the current site operator has vacated the site allowing free access.
Ground Improvement	Ground improvement (stone or concrete columns, dynamic or rapid impact compaction) is not considered necessary at the site but may be considered in light of design development issues, particularly with respect to the cut and fill works. Should ground improvement be considered further, the advice of specialist contractors should be sought.
Pile Foundations	Pile foundations are not generally considered necessary at the site, however they may turn out to be preferable from a practical perspective for part or all of the development if the cut and fill operation results in the adoption of shallow foundations being impractical. A 12 m long 450 mm dia CFA pile would have a safe working load of around 700 kN
Floor Slab	A Ground bearing floor slab may be adopted at the site provided the Made Ground is excavated and recompacted and that any fill materials placed beneath proposed floor slabs as part of the cut and fill operation are placed to a suitable Earthworks Specification. Following such it would be anticipated that a modulus of subgrade reaction of 37 MN/m2/m would be appropriate. A ground bearing floor slab carrying up to 50 kN/m2 would be anticipated to perform satisfactorily following a suitably designed and executed earthworks operation
Pavement Design	Provided a suitable Earthworks specification is designed and implemented a design CBR of 4 to 5% should be achievable for the re-engineered Made Ground and Clay with Flints deposits. Similar CBRs should be achievable for the structureless chalk, provided it is not allowed to deteriorate during the works. Extreme care should be taken when working with the structureless or structured chalk as it is very sensitive to deterioration on exposure and as a result of trafficking or overworking. If the chalk is allowed to deteriorate during works, CBR could drop to 1 % or below.
Earthworks	Based on field descriptions and laboratory test results, the Made Ground and Clay with flints deposits potentially classify variously as Class 1A, 1B, 1C, 2A, 2B, 2C and with appropriate screening and control, class 6N, 6P or 7A. The structureless and structured chalk potentially classifies as Class 7A and the structured chalk potentially as Class 3. (All classes in accordance with the Specification for Highways Works series 600). Some sorting and screening of the materials would likely be required to fully comply with the earthworks classes°. A high degree of skill and care will be required to specify and control earthworks in chalk
Dewatering and Excavations	Groundwater was not encountered during the ground investigation so groundwater control measures are not likely to be required during site works although there may be a need to deal with surface runoff in wet conditions. Excavation sides were found to generally stable in the short term during trial pitting however side support should be provided where personnel entry is required, or excavations are adjacent to infrastructure. Side support is also likely required for excavation taken through any coarse-grained materials
Sulphate Assessment	Made Ground classifies as Design Sulphate class DS-2, with corresponding Aggressive Chemical Environment for Concrete AC-1-s. Clay with flints deposits and Chalk classifies as DS1 with corresponding Aggressive Chemical Environment for Concrete AC-1-s

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GROUND INVESTIGATION
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1 INTRODUCTION

1.1 Engagement of Discovery CE Limited

Discovery CE (DCE) was instructed by PCS CONSULTING ENGINEERS (PCS) on behalf of Dealership Developments Ltd to carry out a Ground Investigation at a site known as Rybrook, Handy Cross, High Wycombe. The site location is shown on Key Plan Figure A1 in Appendix A.

The offer to carry out the work is contained in DCE proposal Ref: 20008J-QLO01-R1 Dated26th November 2020, with the instruction to proceed contained in an email from PCS Dated: 12th January 2021.

1.2 Objectives and Limitations

The overall objectives of the work presented in this report were to carry out a ground investigation to gather geo-environmental and geotechnical data to allow assessment of the underlying ground conditions at the site with respect to Geotechnical issues and possible environmental issues relevant to the proposed development. Specifically, the objectives were to:

1. carry out intrusive investigation to identify the general near surface geological conditions beneath the subject site;

2. carry out in-situ and geotechnical laboratory testing to allow assessment of the geotechnical conditions beneath the subject site;

3. carry out chemical laboratory testing to allow assessment of the possible contamination conditions beneath the subject site;

4. monitor ground gas conditions at the site to determine the gas regime for the proposed development;

5. recover hydrogeological data through groundwater level monitoring to allow refinement of the groundwater regime at the subject site;

6. provide an interpretation of the geotechnical data recovered and present recommendations for foundation design, ground treatment, floor slab, pavement design, earthworks design, and conditions with respect to chemical attack on buried concrete;

7. provide an interpretation of the contamination data; and

8. provide conclusions and recommendations for further work if considered necessary.

The conclusions and recommendations provided in this report are based on the conditions encountered at the exploratory hole locations and intrusive work has been restricted to the level of detail considered necessary to achieve the stated objectives. The possibility of significant variations occurring between exploratory holes cannot be discounted and additional assessment may be necessary should such variation be revealed after preparation of this report.

1.3 Sources of Information

The following sources of information have been used in the preparation of this report.

1. DCE Report ref 20008J-01 “Desk Study and Preliminary Risk Assessment” dated March 2021; and

2. Axis 3 Design drawing, “Site Plan Proposal”, Rev. M, Ref: P280-01 dated 05/11/2020 in Appendix B.

2 SITE

2.1 Site Walkover and Description

The site is situated off Marlow Hill (A404) (to the north west of the site) approximately 1.7 km southwest of the centre of High Wycombe, with approximate Grid Reference 485770 191430 (see Figure A1 in Appendix A). The north western boundary of the site is formed by Marlow Hill (A404). The remaining boundaries are formed by a service road which loops back onto the A404.

The site occupies an area of approximately 1.73 Ha and generally slopes downwards from the north to south.

The site is currently occupied by the following:

1. Approximately two thirds of the site area, in the north, is currently a secure area used to store and modify/refit vans. There is a portacabin/office for site staff; and
2. The southern part (approximately one-third) of the site is open ground.

There are several areas of slab in the north and associated surrounding hardstanding remaining from the former sports centre. There is a large slab area and some tarmacked roads left in the south.

The whole site is secured with large wooden hoardings around the whole boundary. In addition, within the hoardings, the northern van area is secured with palisade fencing and CCTV masts.

An aerial photograph of the current site layout is shown in Figure 1 overleaf.

Figure 1 Site Aerial Photograph

2.1.1 Northern Area

Most of the northern area is occupied by vans. The business running on this area takes new vans and retrofits then with internal racking, tool racks, linings, floors, etc. for onward sale.

The northern area is split up into three broad areas of elevation. The highest part of the northern site is in its north. The southern half of the northern area is at a lower elevation approximately 1.5 to 2 m lower than the north. In the east of the central band is the lowest area a further 1.5 to 2 m lower than the surrounding area.

Photographs of the various areas are shown in Plates 1 to 10.

Plate 1 East of northern site looking west

Plate 2 East of northern site looking northwest

Note: lowest elevation part of the northern area of the site in the foreground with he mid lelevation in the distance.

Plate 3 **Centre of northern site looking northeast**

Plate 4 **West of northern area looking southeast into southern area**

Plate 5 **West of northern area looking north**

Note: Highest elevation part of the northern area of the site in the background with the mid elevation in the foreground.

Plate 6 **North of northern area looking south**

2.1.2 Southern Area

The southern area could not be accessed directly during the walkover. Observations were made from the northern area, through the security fencing.

Plate 7 **Southern area from the north with concrete base in foreground**

Plate 8 **North of southern area looking west**

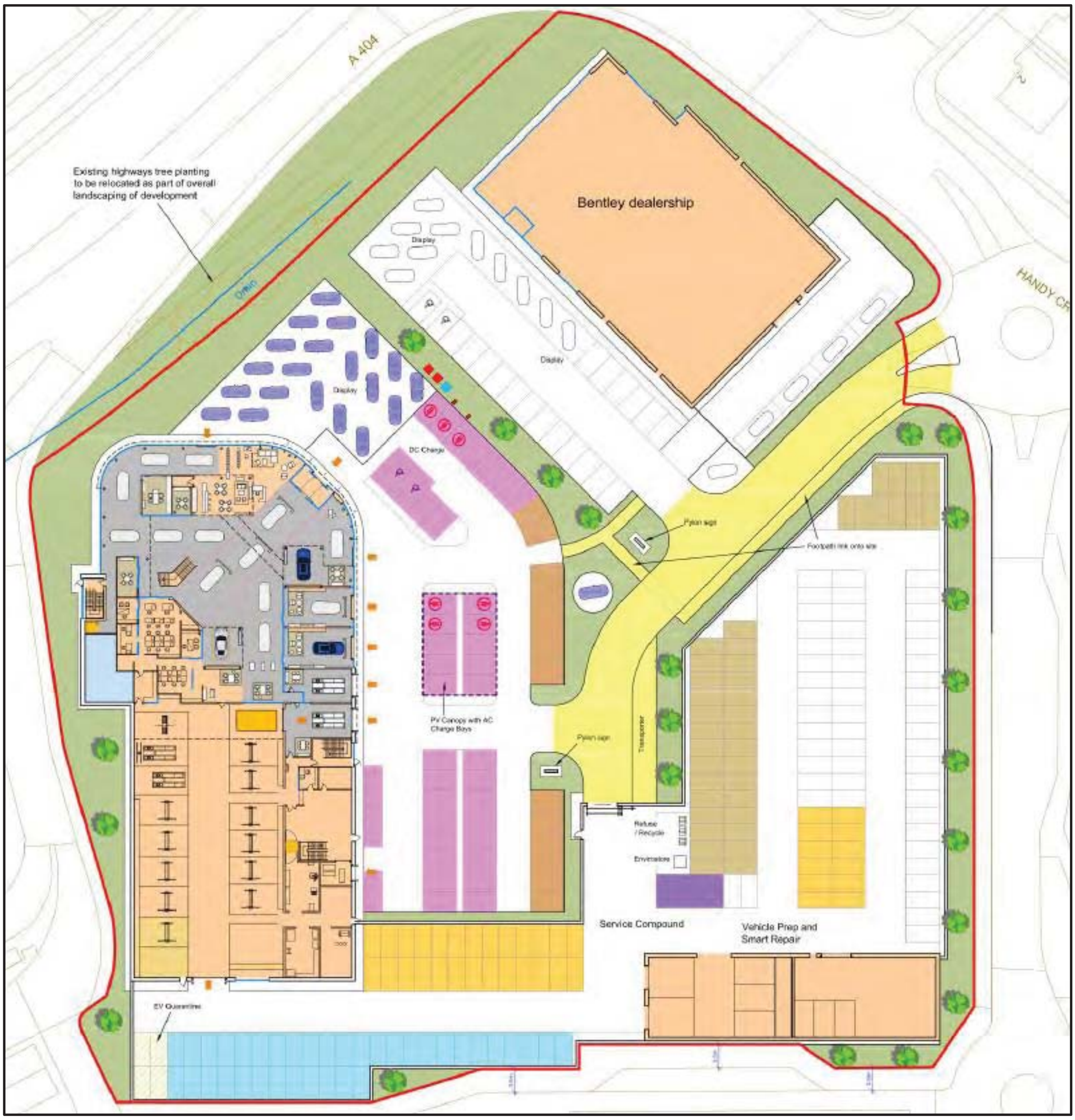
Plate 9 **Northwest of southern area looking south**

Plate 10 **Northeast of southern area looking south**

2.2 Development Proposal

It is understood that Rybrook will undertake a commercial development for the sale and servicing of luxury cars to include 3 No. buildings and associated hardstanding. The currently proposed layout is presented in the Axis 3 Design drawing, “Site Plan Proposal”, Rev. M, Ref: P280-01 dated 05/11/2020 in Appendix B. The proposed layout is shown below in Figure 2.

Figure 2 Current Proposed Layout



3 GEOLOGY, HYDROLOGY & HYDROGEOLOGY

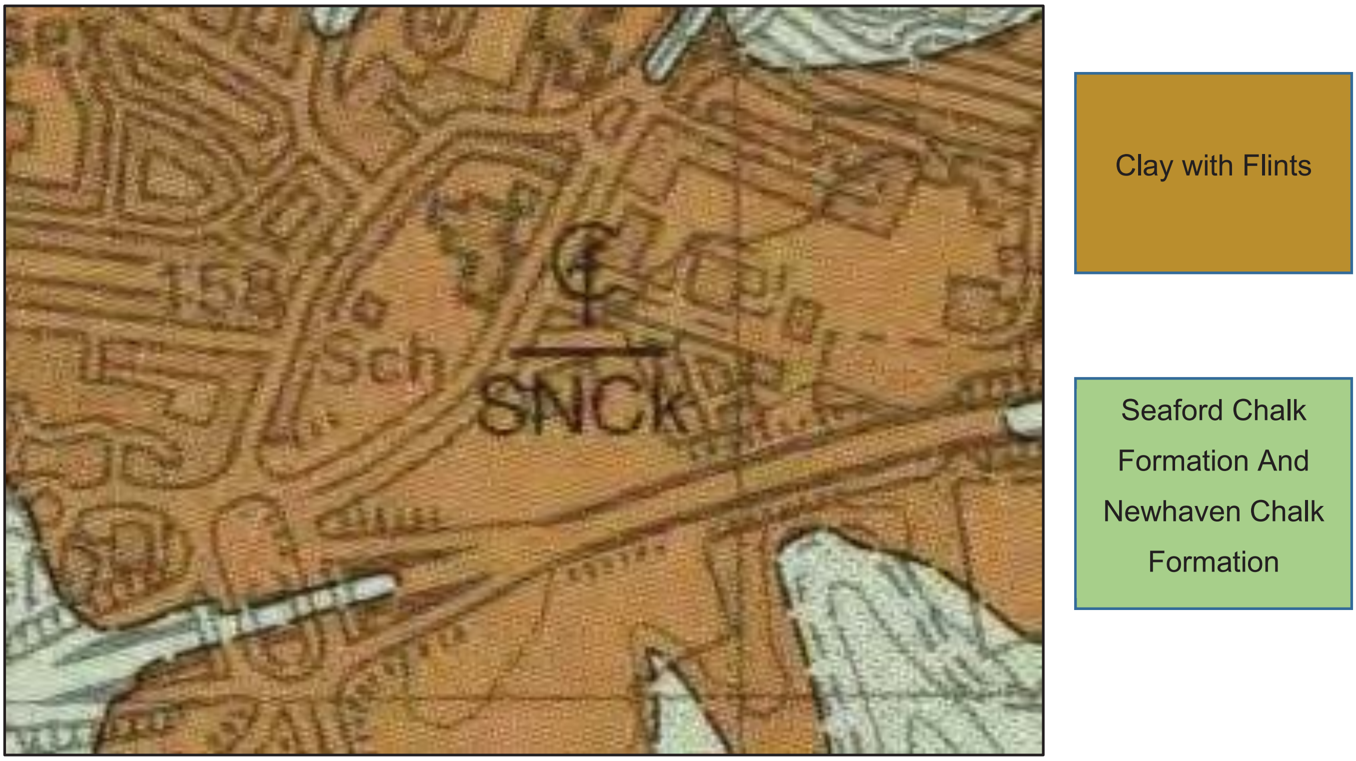
3.1 Geology

British Geological Survey (BGS) sheet no 255, BEACONSFIELD (1:50 000, Solid and Drift Edition) indicates the site to be directly underlain by the Clay-with-flints Formation - Clay, Silt, Sand And Gravel which in turn overlies the Seaford Chalk Formation And Newhaven Chalk Formation (undifferentiated) - Chalk.

No records of artificial or Made Ground have been found within this site area. However it is known that Made Ground is likely due to the presence of a former sports centre and evidence from the site walkover.

There are no records of faults or landslips within 500m of the study site.

Figure 3 Site Geology



3.2 Hydrogeology and Hydrology

The underlying Chalk bedrock has been classified by the EA as a Principal aquifer. The maximum permeability of the bedrock and solid geology is high with a well-connected fracture flow type.

The superficial deposits (Clay with Flints) is defined by the EA as an Unproductive aquifer.

EA aquifer definitions are given below:

> *"Principal – Geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale. Generally principal aquifers were previously major aquifers"*
>
> *"Unproductive - These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow".*
>
> *"Groundwater vulnerability is described as High– Areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits".*

Currently there are no active Groundwater Abstractions within 1500 m of the subject site boundary. There are no surface water abstractions within 2000 m of the subject site boundary.

The site is within a Source Protection Zone (Total Catchment).

There is a WFD Groundwater body on-site listed as South-West Chilterns Chalk with an overall rating of poor as of 2015 records.

The nearest watercourse to the site is an inland river 2 m NW to the site, followed by another inland river 50 m W as seen in Figure 4 below. These appear to relate to local surface water drainage.

Figure 4 Surface water map

However, the site is within a WFD Surface water body catchment for Thames (Reading to Cookham), Thames and South Chilterns.

4 FIELDWORK & LABORATORY TESTING

4.1 Fieldwork

The fieldwork was carried out in general accordance with BS5930 (2015) and comprised the following works. Details of the fieldwork methodologies are presented in Appendix D.

Table 1 Fieldwork Undertaken

Works	Objectives
Drilling of 6 No cable percussion boreholes (BH101 to BH106) 3 no. with gas and groundwater wells (BH101, BH103 & BH106)	To log the strata encountered and carry out in-situ testing to characterize the geotechnical conditions beneath site in proposed building locations to allow foundation design parameters to be obtained. To obtain samples for chemical and geotechnical testing. To install gas and groundwater monitoring wells..
Installation of 11 No. dynamic sample boreholes (DS201 to DS211), 5 No with installations (DS201, DS202, DS206, DS207, DS210, DS211)	To provide additional coverage across the site, to be used in conjunction with the cable percussive boreholes. To obtain samples for chemical testing. To install gas and groundwater monitoring wells..
Excavation of 14 No. trial pits (TP302 to TP316 inc TP313a and TP314a ex TP301, TP303, TP307, TP315)	To provide additional coverage across the site, allow infiltration testing to be carried out, allow detailed inspection of chalk. To obtain samples for geotechnical & chemical testing.
Gas and Groundwater monitoring and sampling	Monitoring of boreholes including groundwater sampling on 4 No. occasions spread over a 2 month period to provide data to characterise contaminant status and its variation over time and spatially and allow gas conditions to be characterised. To allow the underlying groundwater elevations to be identified and monitored for variation over time.

4.2 Geotechnical Laboratory Testing

A programme of geotechnical laboratory testing has been carried out in accordance with BS1377 (1990) “Methods of Tests for Soils for Civil Engineering Purposes” at a UKAS registered testing laboratory. The tests listed below were carried out at the results are presented in Appendix E.

Table 2 Geotechnical Laboratory Testing

BS1377 Ref	Test Description	Number of tests
Part 2 section 3	Moisture Content	10
Part 2 Sections 4 & 5	Atterberg Limit Determination	10
Part 2 Section 9	Particle Size Distribution	5
Part 2 Section 3.3	Saturation Moisture Content	7
Part 4	2.5 Kg Compaction testing	2

4.3 Chemical Laboratory Testing

Chemical testing has been carried out on selected samples for determinands based on the identified Contaminants of Concern listed below. Note that the suite of testing varies according to the CoCs relevant for the particular exploratory hole location.

The list of CoCs identified includes asbestos, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, speciated total petroleum hydrocarbons (TPHs), speciated polycyclic aromatic hydrocarbons (PAHs) and BRE-SD1 parameters.

Soil samples were recovered in plastic tubs and/or amber glass jars as advised by the testing laboratory. Water samples were recovered into plastic and amber glass bottles as advised by the testing laboratory. All samples were stored in temperature-controlled conditions (<6°C) once collected and during despatch to the laboratory.

Chemical Laboratory testing for soils was carried out using MCERTS accredited tests whenever possible failing this UKAS and/or ISO17025 accredited tests were used. For water samples UKAS and/or ISO17025 accredited tests were used. Details of the accreditation status for specific tests are presented on the laboratory analysis report sheets.

A total of 44 soil samples have been analysed during this investigation, the results of which are presented in Appendix F. No groundwater was encountered during the work so no groundwater analysis has been carried out.

5 GROUND AND GROUNDWATER CONDITIONS

5.1 Ground Conditions and Material Properties

The ground conditions at the site where in general accordance with those anticipated from the geological mapping and previous investigations. This included Made Ground overlying Clay with Flints deposits which in turn overlies structureless and/or structured CHALK. A summary of the ground conditions encountered in presented in Table 3 below with further discussion presented in the following sections.

Table 3 Summary of Ground Conditions

Strata & General Description	Depth Encountered (m bgl)	Thickness Range (m)
1 MADE GROUND Predominantly course MADE Ground generally comprising concrete overlying brown, light grey to dark grey and black GRAVEL (locally SAND and GRAVEL) with varying proportions of sand and CLAY. Gravels are generally angular to subrounded fine to coarse of limestone, chalk, quartzite, flint, tile, concrete and rare wood. – Not encountered at one location TP308	Ground Level	Absent to 1.5 (>2.09 in DS204)
2 CLAY WITH FLINTS Firm brown, dark brown locally white slightly gravelly and gravelly CLAY. Gravel is angular to subangular of flint. Generally absent through centre of site (see Drawing 2008J-05)	0.05 to 1	0.1 to 0.95 (2.2 m BH101)
3 STRUCTURELESS CHALK Encountered as both Dc (clast) and Dm (Matrix) structureless chalk. Structureless chalk composed of firm white mottled orange brown gravelly SILT (Dm) or white mottled yellow brown silty GRAVEL of chalk.	0.3 to 2.5	0.3 to 2.2 (locally absent)
4 STRUCTURED CHALK Generally very weak low density white CHALK (Grade C) Note that the depth to the structured chalk is very difficult to interpret from boreholes	0.3 to 4	> 18.95 m (not fully penetrated)

Cross sections through the site are presented on drawings 20008J-2 and 20008J-03 while the tentative elevation to the top of the structured CHALK is shown on drawing 20008J-04 and the occurrence of the Clay with Flints deposits is represented on drawing 20008J-05 all presented in Appendix B .

5.1.1 Made Ground

Made Ground was encountered at all locations across the site with the exception of TP308 and was found to be predominantly coarse (GRAVEL or SAND and GRAVEL) but with some fine horizons (typically firm CLAYS). The Made Ground was found generally to be between 0.5 and 1.5 m in thickness but was locally deeper in DS204 where it was not fully penetrated and proven to a depth of 2.09 m bgl (see drawing 20008J-01)

In-situ tests results are summarised below in Table 4.

Table 4 Made Ground – Testing summary

Test		Result
SPT test	No. of tests	2
	Range of Results	18 to > 50 (note obstruction)
Hand Vane	No. of tests	3
	Range of Results	63 to 105 kN/m^2

5.1.2 Clay with Flints

Clay with flints deposits were encountered at approximately half of the exploratory hole locations and were absent in the central portion of the site (see drawing 20008J-05).

The deposits were found to be predominantly firm to stiff slightly gravelly of gravelly CLAYS and generally around 0.5 to 0.95 m in thickness.

In-situ and relevant laboratory tests are summarised below in Table 5.

Table 5 Clay with Flints Testing summary

Test		Result
SPT test	No. of tests	4
	Result Range	13 to 19 (average 15)
Hand Vane	No. of tests	10
	Result Range	55 to 108 kN/m^2 (average 77 kN/m^2)
OMC		
Atterberg Limit (%)	No. of tests	4
	Moisture Content	21 to 32%
	Liquid Limit	51 to 108 %
	Plastic Limit	21 to 39 %
	Plasticity Index	30 to 69 %

5.1.3 Structureless Chalk

Structureless chalk was encountered across the site as both grade Dc (silty GRAVEL) and Grade Dm (gravelly SILT) and was locally absent. The depth to the base of the structureless chalk/ top of the structured chalk (see drawing 20008J-04) has been interpreted from the boreholes and dynamic sample data but given the disturbance caused by the drilling process (for both the cable percussion and dynamic sample boreholes) the depth to the base of the horizon should be treated with caution.

A summary of testing within the structureless chalk are summarised below in Table 6.

Table 6 Structureless Chalk – Testing Summary

Test		Result
SPT test	No. of tests	13
	Result Range	5 to 22 (10)
Compaction Testing	No Of tests	2
	OMC	23 %
	MDD	1.59 to 1.6 Mg/m^3
Atterberg Limit (%)	No. of tests	1
	Moisture Content	29%
	Liquid Limit	32%
	Plastic Limit	NP %
	Plasticity Index	N/A

5.1.4 Structured Chalk

Structured chalk was encountered at all positions where the structureless chalk was fully penetrated. The elevation to the top of the structured chalk is presented on drawing 20008J which broadly indicates that the elevation of the top of the material falls from approximately 148 m AOD at the north of the site to around 145 m AOD at the south of the site. It was generally encountered as very weak low and medium density CHALK with a broadly increasing SPT 'N' value profile with depth (see Figure 2).

A summary of the testing carried out on the structured chalk is presented on Table 7.

Table 7 Structured Chalk – Testing Summary

Test		Result
SPT test	No. of tests	88
	Result Range	9 to 50 (generally 14 to 43, average 29)
Dry Density	No. of tests	7
	Result Range	1.36 to 1.75 Mg/m^3 (average 1.6 Mg/m^3)
MC/SMC (%)	No. of tests	7
	Moisture Content	24 to 36%
	SMC	20 to 37 %
Atterberg Limit* (%) (note remoulded)	No. of tests	5
	Moisture Content	21 to 25%
	Liquid Limit	31 to 32%
	Plastic Limit	NP to 22 %
	Plasticity Index	10 to 12

5.2 Groundwater Conditions

Groundwater was not encountered during fieldwork or subsequent groundwater monitoring visits.

6 CONTAMINATED LAND ASSESSMENT

6.1 Legislation & Approach

Contaminated Land is defined in Part 2A of the Environmental Protection Act 1990 as "any 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:

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused".

It should be noted that under the Water Act 2003, part (b) of the above definition is to be amended to also include the word "significant".

Land contamination and its risk to human health is a material consideration under the planning regime as it applies to the intended use of a site which requires that risk assessment for planning purposes should be consistent with the requirements under Part 2A and that as a minimum, after carrying out the development and commencement of its use, the land should not be capable of being determined as ***Contaminated Land*** under Part 2A of the EPA 1990.

The National Planning Policy Framework (NPPF – 2012 and updates) puts the onus on local planning authorities to develop their own guidance and processes for dealing with potentially contaminated land under planning.

6.2 Conceptual Site Model

The conceptual site model (CSM) has been developed in parallel to this work and has been reported in the DCE Report "Desk Study & Preliminary Risk Assessment", Ref: 20008J-01. The findings of the Desk Study & Preliminary Risk Assessment were used to inform a more detailed contamination investigation.

Therefore, the soils and groundwater samples were collected from the proposed locations based on observations on site and information from the desk study.

Testing results from soil were screened against generic human health criteria for a proposed commercial land use. Testing results from groundwater were screened against generic EQS and Drinking Water criteria.

The screening process was undertaken to determine whether soils and groundwaters encountered during may be viable sources of contamination requiring additional consideration.

The screening process is described in Appendix G.

6.3 Sources

As discussed in the Desk Study Report, the site was predominantly a greenfield site, until the sports centre was built in the 1970s and then demolished in 2016. Made Ground is assumed will be found locally across the site, this may contain contaminants of concern (CoCs). Historically, the site and surrounding area was used for agriculture as such there is a low potential for pollution.

A broad suite of CoCs have been selected based on this and the site history, including:

> arsenic, cadmium, copper, chromium, chromium (VI), lead, nickel, mercury, vanadium, zinc, asbestos. aromatic hydrocarbons (PAH) and total petroleum hydrocarbons (TPH).

6.4 Pathways

The key pathway for migration of CoCs include the following:

Human Health

1. Ingestion;
2. Inhalation; and
3. Direct skin exposure (dermal contact).

Environmental

1. On site vertical leaching of CoCs in soils to shallow groundwater; and
2. Lateral migration of impacted groundwater towards surface water receptors.

6.5 Receptors

The key potential receptors identified are:

Human Health

1. Current and future site users; and

2. Site development and maintenance workers.

Environmental

1. Groundwater directly beneath the site (principal Aquifer in the Chalk); and

2. Nearby surace waters to north/northwest.

6.6 Generic Human Health Quantitative Risk Assessment

6.6.1 Human Health

The results of the chemical testing on soils have been compared with published Generic Assessment Criteria (GAC) as an initial screen to determine if more detailed assessment is required. Full details of the screening exercise are presented in Appendix G. None of the results exceeded their relevant screening criteria.

6.7 Generic Human Health Assessment Discussion and Conclusions

The intrusive investigation has not revealed any obvious signs of contamination at the site. Chemical testing on soils has revealed low concentrations of chemical determinands in the samples tested and none of these samples were found to contain concentrations in excess of the Generic Assessment criteria adopted for the sites end use. As a consequence the human health risk at the site is considered NEGLIBIBLE based on these findings.

6.8 Generic Controlled Waters Quantitative Risk Assessment

No groundwater has been encountered during the investigation and therefore no chemical testing of groundwater has been possible.

6.9 Generic Controlled Waters Assessment Discussion and Conclusions

Chemical testing on soils has revealed generally very low concentrations of chemical determinands at the site and no significant sources or potential sources of contamination have been identified either during the Phase 1 Desk study or intrusive works at the site. Additionally, whilst a Principal aquifer underlies the site, this is largely (although not always) overlain by clay with flints deposits (protective of the aquifer) and groundwater is at a depth in excess of 20 m below existing ground level (no groundwater was encountered to this depth during the works and subsequent monitoring).

Given these various factors the risk to controlled waters from the low concentrations of determinands recorded at the site is considered to be **VERY LOW** and no further action is considered necessary.

6.10 Unforseen Contamination

Should any suspected contamination be identified during site enabling or redevelopment works, further investigation, testing and assessment should be carried out to determine if any additional action or remediation is required.

6.11 Gas Assessment

A ground gas assessment has been undertaken to assess risks associated with carbon dioxide and methane to new buildings and their users. 4 No. gas monitoring visits have been undertaken across a period of 2 months. Atmospheric pressures recorded over the duration the monitoring visits were recorded to range between 992 mb and 1022 mb. The results of the gas monitoring are presented in Appendix D. No methane or gas flow was recorded during any visit and the maximum carbon dioxide concentration recorded was 2.2 %.

Interpretation of gas monitoring was carried out in accordance with the recommendations contained within CIRIA C665 (2007) '*Assessing risks posed by hazardous ground gases to buildings*' and BS8485 (2015) '*Code of Practice for The Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings'*. The guidance includes the calculation of volumetric flow rates of ground based on maximum recorded gas concentrations and maximum recorded gas flow rates. Limiting factors are applied to the gas monitoring results and a characteristic situation is then applied to the site.

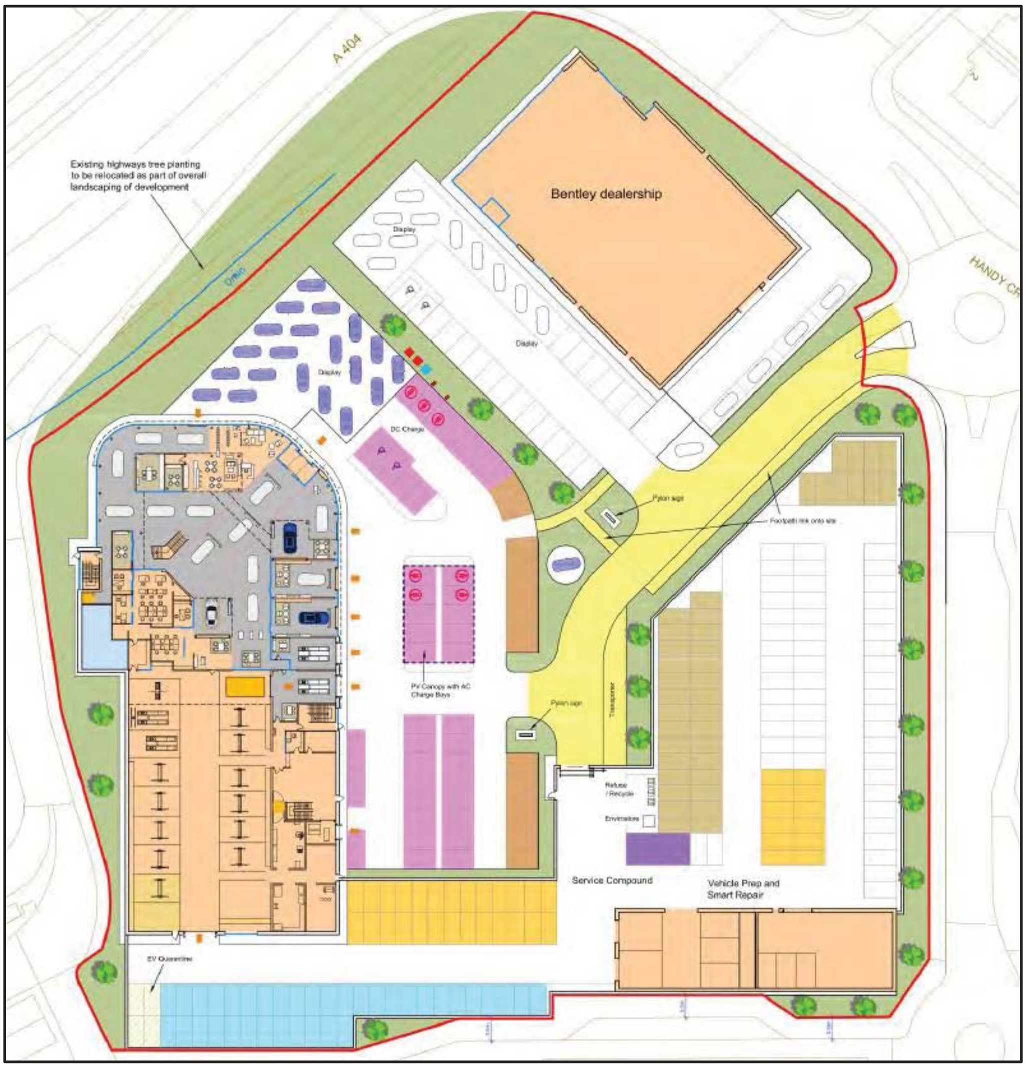
The gas monitoring indicates that the site should be classified as Characteristic Situation 1 (CS1) using a modified Wilson and Card classification scheme defined in CIRIA C665.

7 GEOTECHNICAL ENGINEERING ASSESSMENT

7.1 Development Proposals

Development proposals are not yet finalised for the project and are subject to ongoing change and design development. An initial layout is indicated below as a reference point, but the development will comprise a car dealership development. It is understood that the development will include a cut and fill exercise to create a development platform, however site levels have not yet been finalised at the time of writing.

Figure 5 Proposed Layout

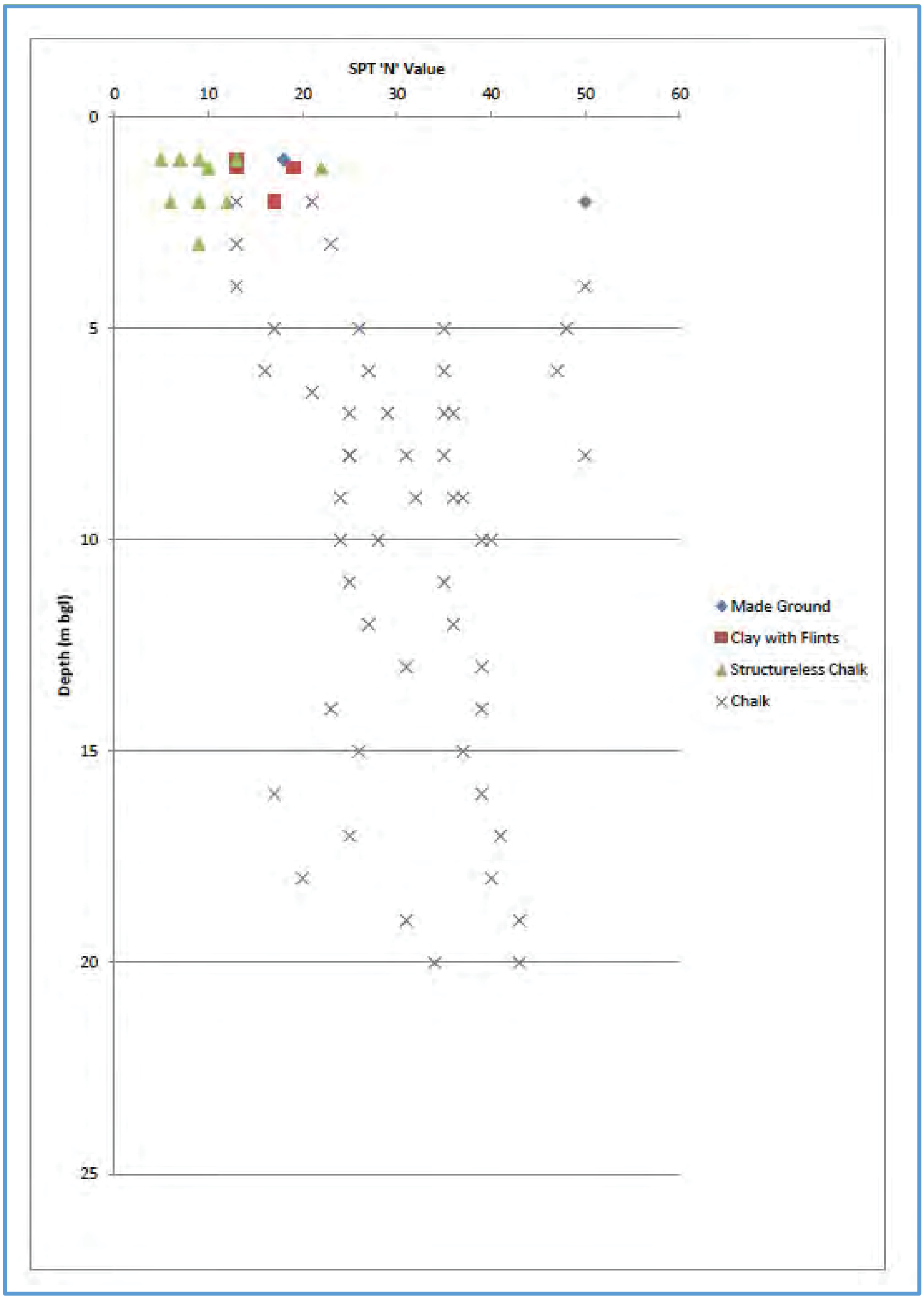


Whilst the final development levels have not yet been finalised, it is understood that floor levels for the proposed structures may be set at around 149 m AOD, potentially with some structures including an undercroft set at around 146 m AOD. These suggest that cut and fill at the site may be in the region in the region of 3 m cut to fill. (Note this will be subject to refinement and may change significantly during the design process). Note that the ultimate engineering solution for the site will be heavily dependant on the nature of the cut and fill operation carried out and the implications of such works need to be fully considered by the designer once finalised.

7.2 Ground Strength Profile

Recorded SPT N values from across the site indicate a broad increase in strength with depth to around 10 m bgl, particularly within the structured chalk below which there is no clear trend (Figure 6 below and Figure A2 in Appendix A).

Figure 6 Plot of SPT N and Undrained Shear Strength values with depth



7.3 Spread Foundations

Foundations should not be placed in untreated Made Ground due to the inherent risks of variability of these materials. Spread foundations (pad or strip foundations) may be placed within the Clay with flint deposits or structureless chalk provided the foundation formation is inspected during construction by a suitably qualified geotechnical engineer and any soft or loose spots removed and replaced with suitable compacted granular materials or lean mix concrete. Subject to this, an allowable bearing capacity of 120 kN/m^2 is considered appropriate for foundations up to 2.5 m x 2.5 m placed at a depth of between 1.5 and 2 m below existing ground level. Total settlement would then be anticipated to be less than 25 mm.

A higher allowable bearing capacity may be achieved by placing foundations on the structured chalk and an allowable bearing capacity of 250 kN/m^2 is considered appropriate for foundations up to 2.5 m x 2.5 m placed in this material. This is present at varying depths across the site but may be within a reasonable excavation depth following cut works or before filling works depending on the proposed finished levels. As discussed in Section 5 the elevation of the top of the structured chalk is difficult to interpret from the boreholes put down due to sample disturbance. Should the design proposals include exploitation of this higher allowable bearing capacity, it is recommended that additional trial pitting investigation is carried out at the site once the cut and fill details are finalised and the current site operator has vacated the site allowing free access.

7.4 Pile Foundations

Pile foundations are not generally considered necessary at the site, however they may turn out to be preferable from a practical perspective for part or all of the development if the cut and fill operation results in the adoption of shallow foundations being impractical. Driven or bored piles (including Continuous Flight Auger (CFA) piles) may be considered at the site. The precise nature of the piling technique adopted will be dependent on various factors including cost, magnitude of the pile load, magnitude of lateral loading conditions affecting driveability and the need or otherwise to minimise spoil arisings. Brief details of the advantages and disadvantages of the various techniques are summarised below for guidance, however for detailed advice, a specialist piling contractor should be consulted. Possible piling methods for the development are listed in Table 8.

Table 8 Piling Methods

Pile Type	Advantages	Disadvantages
Driven	Generally Inexpensive Rapid Installation No Spoil arisings Operations not hindered by groundwater Can be driven in very long lengths	Noise and Vibration during driving High stresses can be generated during driving resulting in damage. Heave can result affecting nearby structures or services. Load and bending capacity is limited for small diameter piles. Large diameter piles limited by driveability considerations. Obstructions can prevent installation
Bored	Length can be readily varied to suit bearing stratum Arisings can be inspected Large bases can be formed allowing very large pile capacities to be developed Obstructions can be broken using appropriate tools Minimal noise and vibration No ground heave Can be installed in very long lengths	Arisings generated can be expensive to dispose of Concrete can 'neck" in poor ground Soil bore requires support in granular or soft soils Lack of support can result in settlement of adjacent structures Water bearing soils can present difficulties requiring special measures Disturbance of pile base can limit end bearing is come circumstances
CFA	Less expensive than conventional bored piling. Ground support is continuous Minimal Noise and vibration No ground heave Arisings can be inspected	Arisings generated can be expensive to dispose of Concrete can 'neck" in poor ground Obstructions can prevent full depth from being achieved. Pile length limited to around 25 m Enlarged bases not possible

Based on the conditions encountered at the site the following pile design parameters are considered indicative for preliminary design of cfa piles. Note that given the variability in ground conditions across the site the pile designer would need to carry out additional assessment to account for the variations in the thickness of geologies across the site.

Table 9 Pile Design Parameters Summary

Strata	CFA concrete Piles
Made Ground	No positive strength contribution for bearing pile design. Skin Friction = -5 kN/m^3 (negative) Bulk weight = 17 kN/m^3
Clay with flints	Alpha = 0.9, Cu = 60 kN/m^2, Bulk weight = 20 kN/m^3
Structureless Chalk	Beta = 0.45, Bulk = 19 kN/m^3
Structured Chalk	Beta = 0.8, Q_{ult} = 3000 kN/m^2 Bulk weight = 20 kN/m^3

Based on these parameters a 12 m long 450 mm dia CFA pile would have a safe working load of approximately 700 kN increasing to about 900 kN for a 600 mm dia pile and assuming an overall factor of safety of 3.

Appropriate pile testing is recommended to confirm the design assumptions in accordance with the recommendations presented in the ICE Specification for piling and embedded retaining walls – Third Edition. The advice of specialist piling contractors should be sought prior to design finalisation.

7.5 Floor Slab

A Ground bearing floor slab may be adopted at the site provided the Made Ground is excavated and recompacted and that any fill materials placed beneath proposed floor slabs as part of the cut and fill operation are placed to a suitable Earthworks specification. Following such it would be anticipated that a modulus of subgrade reaction of 37 MN/m^2/m would be appropriate. A ground bearing floor slab carrying up to 50 kN/m^2 would be anticipated to perform satisfactorily following a suitably designed and executed earthworks operation.

7.6 Ground Improvement

Ground improvement (stone or concrete columns, dynamic or rapid impact compaction) is not considered necessary at the site but may be considered in light of design development issues, particularly with respect to the cut and fill works. Should ground improvement be considered further, the advice of specialist contractors should be sought.

7.7 Pavement Design

Provided a suitable Earthworks specification is designed and implemented a design CBR of 4 to 5% should be achievable for the re-engineered Made Ground and Clay with Flints deposits. Similar CBRs should be achievable for the structureless chalk, provided it is not allowed to deteriorate during the works. Extreme care should be taken when working with the structureless or structured chalk as it is very sensitive to deterioration on exposure and as a result of trafficking or overworking. If the chalk is allowed to deteriorate during works, CBR could drop to 1 % or below.

7.8 Earthworks

Based on field descriptions and laboratory test results, the Made Ground and Clay with flints deposits potentially classify variously as Class 1A, 1B, 1C, 2A, 2B, 2C and with appropriate screening and control, class 6N, 6P or 7A. The structureless and structured chalk potentially classifies as Class 7A and the structured chalk potentially as Class 3. (All classes in accordance with the Specification for Highways Works series 600). Some sorting and screening of the materials would likely be required to fully comply with the earthworks classes.

Standard Proctor compaction tests using a 2.5 kg rammer carried out on samples of structureless chalk indicated an optimum Moisture Contents of 23 % and Maximum Dry densities 1.59 and 1.6 Mg/m^3 with natural moisture content between 25 and 29 %. This indicates that the structureless chalk should perform well under compaction, although care would be required to ensure that the material is not allowed to dry out or wet up excessively once exposed.

Atterberg limit determination for the clay with flints deposits indicate that its natural moisture content (NMC) is generally +/- 4 % of the plastic limit (PL), suggesting it also should respond well to compaction - although one sample was found to be dry with NMC of PL – 8 so local moisture conditioning may be required.

The field observations and testing have indicated that the materials likely to be used in an earthworks operation are variable so will require a high degree of earthworks control (through appropriate specification and execution of the earthworks) to ensure adequate performance. Typically, difficulties lie in the range of maximum dry densities that exist for variable earthworks materials that result in difficulties in selection of appropriate laboratory Maximum Dry Density results to relate to in-situ density tests. It is critical therefore that earthworks are carried out by an earthworks contractor experienced in compaction control in such materials and that the works are closely supervised to ensure their successful implementation. Additionally, the chalk materials are extremely sensitive to deterioration on handling and can be subject to collapse if compacted to dry of optimum, or subject to rapid weakening if placed too wet of optimum. It is recommended that once details of the proposed earthworks levels are confirmed that additional trial pitting is carried out to better characterise the materials likely to be used in the earthworks operations. Given the current site congestion this would be best carried out after the current site operator vacates the site. It is recommended that any prospective earthworks contractor carries out their own investigations to gain further understanding of the nature of the soils to be re-used at the site and from such works makes appropriate allowance for any processing measures considered necessary.

7.9 Excavations

Groundwater was not encountered during the ground investigation so groundwater control measures are not likely to be required during site works although there may be a need to deal with surface runoff in wet conditions. Excavation sides were found to generally stable in the short term during trial pitting however side support should be provided where personnel entry is required, or excavations are adjacent to infrastructure. Side support is also likely required for excavation taken through any coarse-grained materials.

7.10 Infiltration Testing

Infiltration testing was carried out in general accordance with BRE 365 at 6 locations. The infiltration rates recorded are summarised on Table 11.

Table 10 Infiltration Test Summary

Trial Pit ref	Fill 1	Fill 2	Fill 3
TP305	3.7×10^{-5} m/s	2.4×10^{-5} m/s	1.9×10^{-5} m/s
TP306	6.3×10^{-4} m/s	6.4×10^{-4} m/s	7.9×10^{-4} m/s
TP308	1.4×10^{-4} m/s	1.2×10^{-4} m/s	1.1×10^{-4} m/s
TP309	1.2×10^{-5} m/s	Not Done	Not Done
TP314A	5.6×10^{-5} m/s	5.2×10^{-5} m/s	3.1×10^{-5} m/s
TP316	2.8×10^{-4} m/s	2.2×10^{-4} m/s	2.6×10^{-4} m/s

The testing indicates that the chalk will provide a suitable infiltration medium with a lower bound infiltration rate of 1×10^{5} m/s being indicated.

7.11 Sulphate Assessment

This classification of the site in terms of concrete in aggressive ground is based on the guidance provided within the BRE Special Digest 1 (BRE SD1). The characteristic chemical laboratory test results for soil are presented on Table 12.

Table 11 Characteristic soil chemistry results

Determinand	Units	Made Ground	Clay with Flints	Chalk
pH	pH Units	8.7	8.8	8.9
Water Soluble SO4 (2:1 Extract)	g/l	0.55	0.03	0.055
Water Soluble SO4 (2:1 Extract)	mg/l	550	30	55

Made Ground classifies as Design Sulphate class DS-2, with corresponding Aggressive Chemical Environment for Concrete AC-1-s. Clay with flints deposits and Chalk classifies as DS1 with corresponding Aggressive Chemical Environment for Concrete AC-1-s.

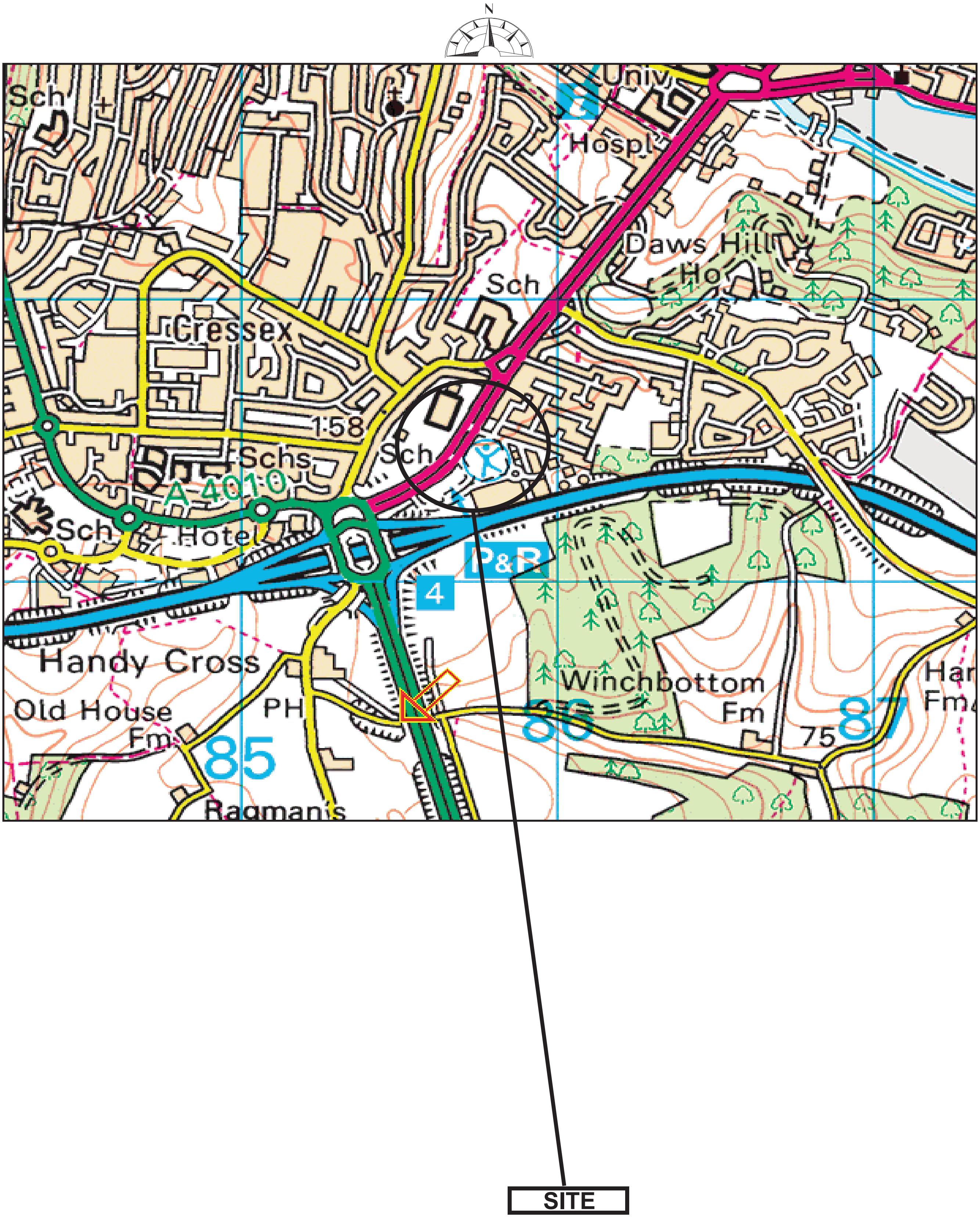
For **Discovery CE Limited**

Mike Forrester
BSc (Hons) PGC
Senior Geo-Environmental Engineer

Cathal Gillespie
BEng MSc (Eng)
Director

APPENDIX A - FIGURES

Discovery CE Geotechnical & Environmental Engineers The Granary, Broadwell House Farm Broadwell, Rugby CV238HF www.dce-services.co.uk	**Project** HANDY CROSS HIGH WYCOMBE **Title** KEY PLAN **Client** DEALERSHIP DEVELOPMENTS LIMITED	**Project Number** 20008J **Sheet No** 1 of 1 **Date** 01/06/2021



Notes

Reproduced from the Ordnance Survey 1:50,000 scale Landranger with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office,

Figure

A1

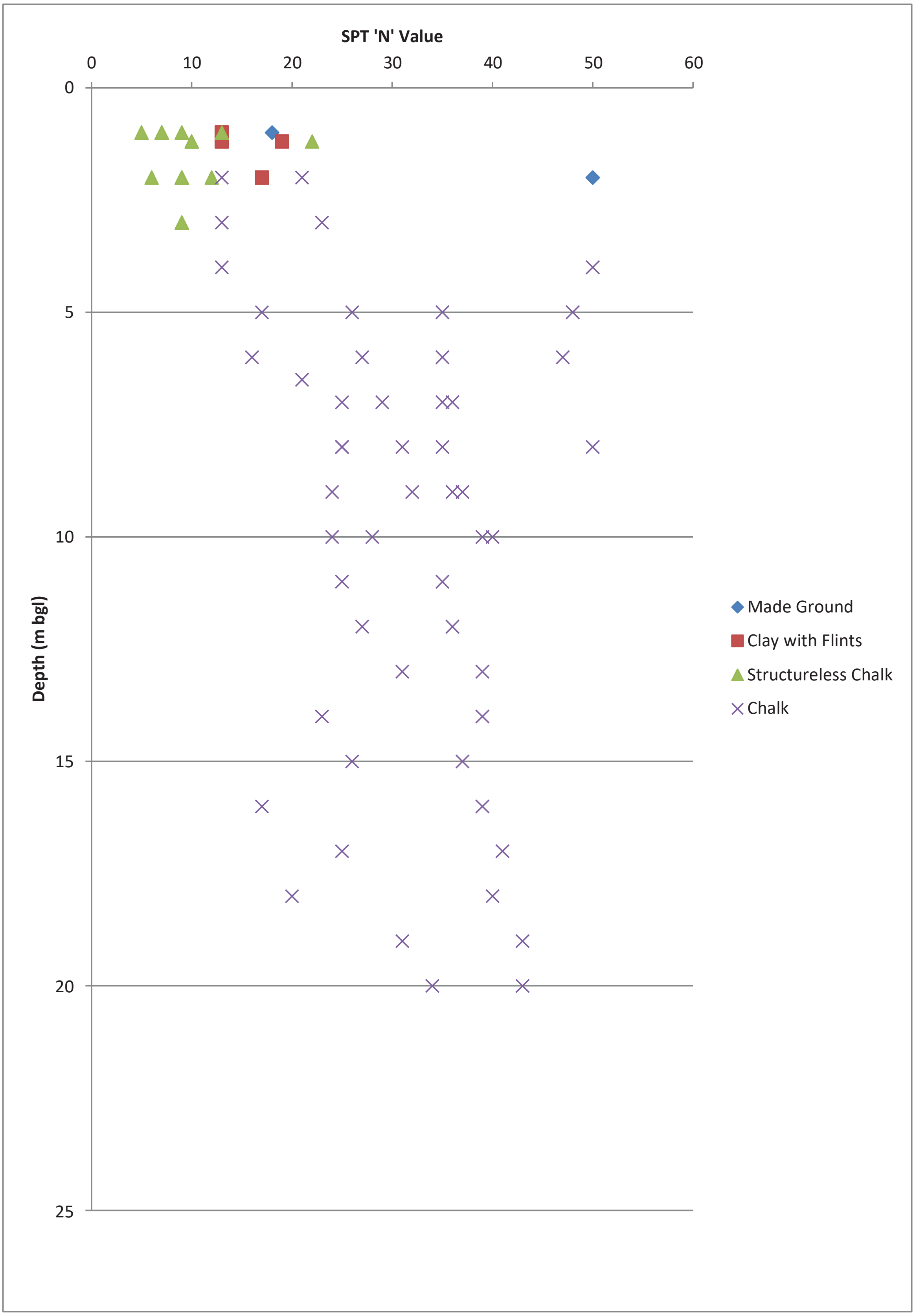


Figure A2
Plot of SPT 'N' Value Versus Depth
Carried out for Dealership Developments Ltd
Handy Cross High Wycombe

APPENDIX B - DRAWINGS

POINT	EASTINGS	NORTHINGS	LEVEL
BH101	485761.11	191511.50	151.66
BH102	485783.66	191480.06	149.85
BH103	485722.61	191422.96	147.97
BH104	485763.99	191378.81	148.14
BH105	485807.23	191390.21	147.63
BH106	485837.52	191403.55	147.67
DS201	485751.36	191497.90	151.26
DS202	485800.14	191493.58	150.14
DS203	485748.62	191437.94	148.04
DS204	485734.96	191409.05	148.02
DS205	485796.99	191430.92	148.05
DS206	485774.94	191384.88	148.37
DS207	485762.34	191420.41	148.05
DS208	485795.70	191453.70	147.02
DS209	485769.22	191367.04	145.37
DS210	485713.25	191440.65	150.27
DS211	485750.04	191467.24	150.46
TP311	485732.67	191388.97	148.34
TP302	485762.89	191472.15	150.47
TP304	485749.69	191468.09	150.55
TP305	485726.03	191462.64	150.58
TP306	485767.00	191443.76	148.16
TP308	485830.53	191416.15	147.52
TP309	485829.76	191465.63	148.27
TP310	485835.44	191437.28	147.96
TP312	485813.39	191409.84	148.07
TP313	485821.97	191399.78	147.71
TP314	485743.08	191353.34	146.23
TP314A	485755.81	191362.77	145.69
TP316	485792.90	191391.05	148.36

General notes

Base Plan extracted from Greenhatch drawing 37619_UG Rev 0

Legend to symbols

BH105 — Cable Percussive Borehole

DS203 — Dynamic Sample Borehole

TP314 — Trial Pit

Revision	Description

Title: EXPLORATORY HOLE LOCATION PLAN

Project: RYBROOK, HANDY CROSS HIGH WYCOMBE

Client: DEALERSHIP DEVELOPMENTS LIMITED

Discovery CE — Geotechnical & Environmental Engineers

Date	Drawing No.	Scale
4/05/21	20008J-01	NTS
Drawn By	**Checked by**	**Sheet Size**
CT	CG	A3

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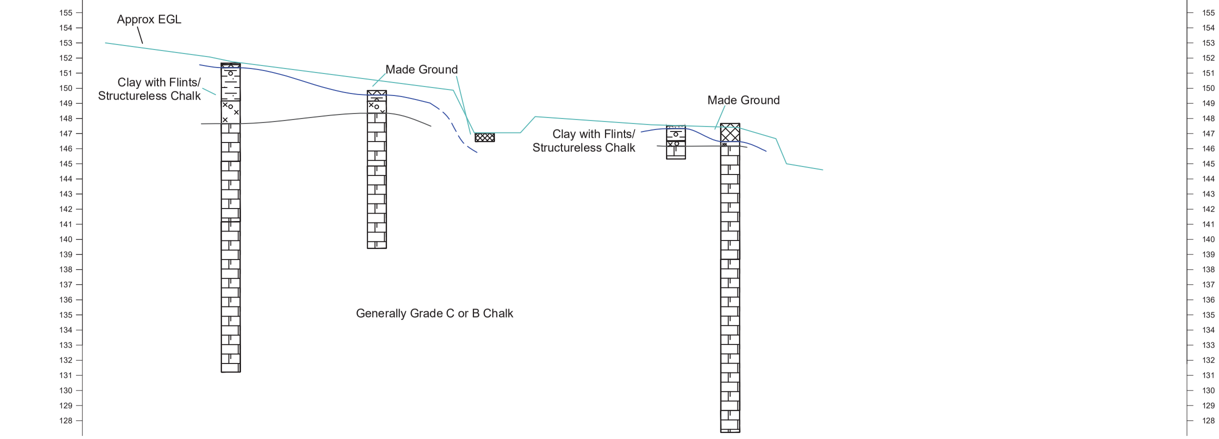
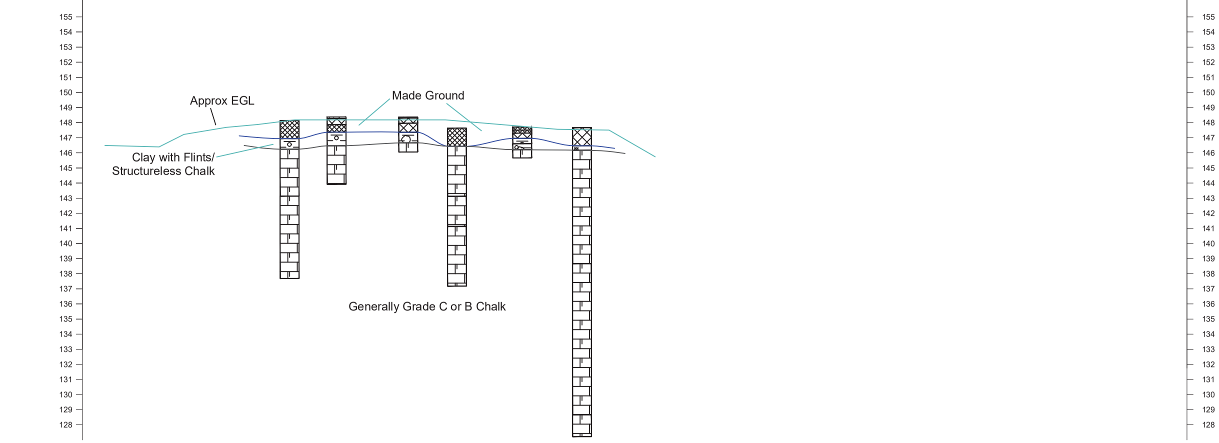
A — A'

CHAINAGE	39.30	77.98	106.54	157.18	171.53
I.D.	BH101	BH102	DS208	TP308	BH106
ELEVATION	151.66	149.85	147.02	147.52	147.67



B — B'

CHAINAGE	54.88	67.32	86.28	99.21	116.48	132.29
I.D.	BH104	DS206	TP316	BH105	TP313A	BH106
ELEVATION	148.14	148.37	148.36	147.63	147.71	147.67



General notes

For cross section locations see DCE drawing No. 20008J-01.

All units are in metres unless otherwise shown.

Strata boundaries between boreholes are illustrative and may vary from that shown. The possibility of significant variations occurring between exploratory holes cannot be discounted and additional assessment may be necessary.

Legend to symbols

- Made Ground
- Clay with flinits or Structureless Chalk
- CHALK Grades C and B

Revision	Description

Title: CROSS SECTIONS A-A' AND B-B'

Project: RYBROOK HANDY CROSS HIGH WYCOMBE

Client: DEALERSHIP DEVELOPMENTS LTD

Discovery CE — Geotechnical & Environmental Engineers

Date	Drawing No.	Scale
26/05/21	20008J-02	H1:1000 V1:250
Drawn By	**Checked by**	**Sheet Size**
CG	PDS	A2

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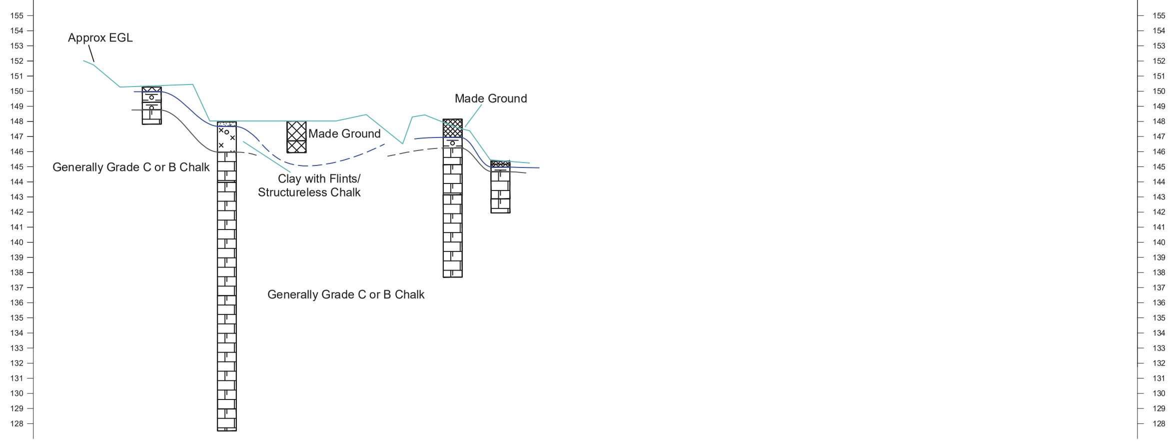
C — C'

CHAINAGE	31.36	51.25	69.70	111.05	121.72
I.D.	DS210	BH103	DS204	BH104	DS209
ELEVATION	150.27	147.97	148.02	148.14	145.37



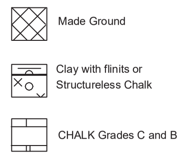
General notes

For cross section locations see DCE drawing No. 20008J-01.

All units are in metres unless otherwise shown.

Strata boundaries between boreholes are illustrative and may vary from that shown. The possibility of significant variations occurring between exploratory holes cannot be discounted and additional assessment may be necessary.

Legend to symbols



Revision	Description

Title: CROSS SECTION C-C'

Project: RYBROOK HANDY CROSS
HIGH WYCOMBE

Client: DEALERSHIP DEVELOPMENTS LTD

Discovery
Geotechnical & Environmental Engineers

Date	Drawing No.	Scale
26/05/21	20008J-03	H1:1000 V1:250
Drawn By	**Checked by**	**Sheet Size**
CG	PDS	A2

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General notes

Base Plan extracted from Greenhatch drawing 37619_UG Rev 0

Note that the elevation to structured chalk is very difficult to interpret from cable percussion boreholes and dynamic samples so plotted contours should be taken as indicative only

Legend to symbols

BH105	Cable Percussive Borehole
DS203	Dynamic Sample Borehole
TP314	Trial Pit

Revision	Description

Title

TENTATIVE ELEVATION OF STRUCTURED CHALK

Project

RYBROOK, HANDY CROSS HIGH WYCOMBE

Client

DEALERSHIP DEVELOPMENTS LIMITED

Discovery Geotechnical & Environmental Engineers

Date	Drawing No.	Scale
4/05/21	20008J-04	NTS
Drawn By	**Checked by**	**Sheet Size**
CT	CG	A3

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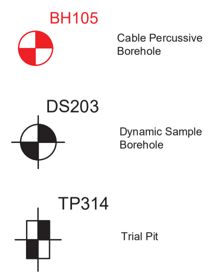
General notes

Base Plan extracted from Greenhatch drawing 37619_UG Rev 0

Legend to symbols



Revision	Description

Title: PRESENCE OF CLAY WITH FLINTS DEPOSITS

Project: RYBROOK, HANDY CROSS HIGH WYCOMBE

Client: DEALERSHIP DEVELOPMENTS LIMITED

Discovery Geotechnical & Environmental Engineers

Date	Drawing No.	Scale
4/05/21	20008J-05	NTS
Drawn By	**Checked by**	**Sheet Size**
CT	CG	A3

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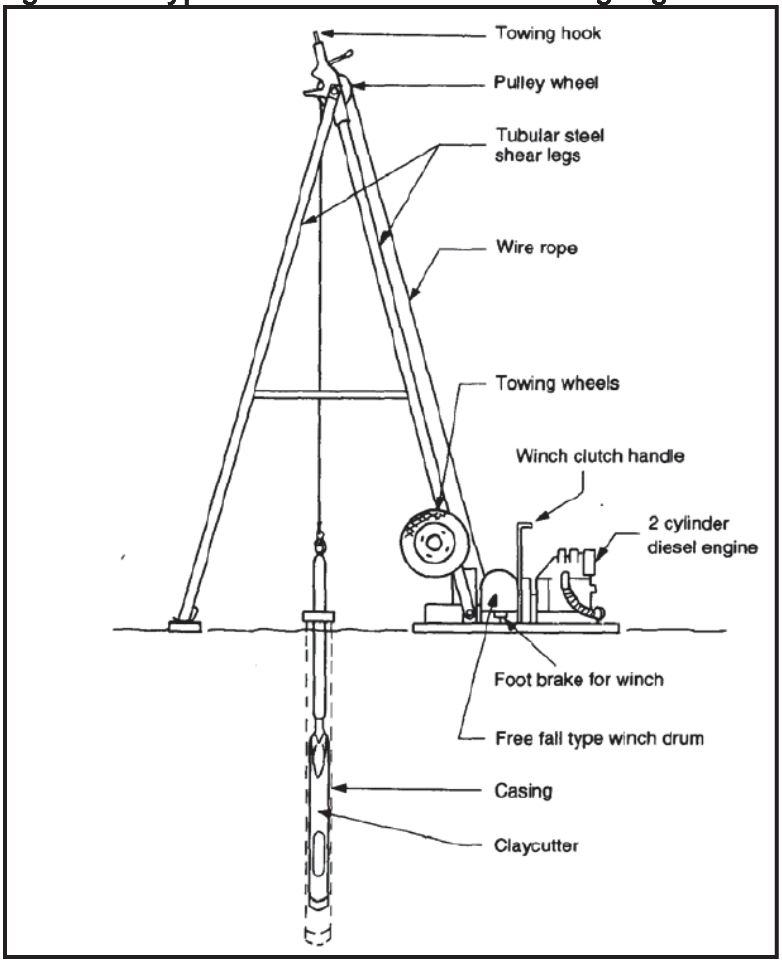
APPENDIX C - FIELDWORK METHODOLOGY

Cable Percussion Boreholes

If carried out, cable percussion boreholes were put down at the locations shown on the exploratory hole location plan (Appendix B) using a standard cable percussion drilling rig (Figure C1). Details of the Cable percussion drilling method is described in the following sections.

Figure C1: Typical Cable Percussion Drilling Rig



The boreholes are formed in 150 mm diameter using conventional light cable percussion techniques. In cohesive soils a clay cutter is used which involves dropping the tool into the clay and recovering the sample wedged inside the tool. In granular deposits a "shell" is used to advance the borehole. This operates efficiently only in the presence of water which is added to the borehole if the ground is dry. The shell is then "surged" by moving up and down by around 300 mm which has the effect of loosening the bottom of the borehole and causing the soil to go into suspension. Dropping the shell on the bottom of the borehole then forces the loosened soil up the tube of the shell, past a non return valve (or clack valve) allowing the sample to be recovered. The casing is advanced with the borehole in granular soils under its own weight or by driving.

Standard penetration testing is carried out in accordance with BS5930: 1999 using a split spoon sampler in cohesive soils and a solid 60 degree cone in granular materials. The tests are carried out generally at 1 m intervals in granular materials and generally at 2 m intervals in cohesive materials with occasional variations at the direction of the supervising engineer. The results of the standard penetration tests are presented as uncorrected “N” values on the borehole logs.

102 mm diameter “undisturbed” (U100) samples are recovered at 2 m intervals in cohesive deposits to allow detailed description and or laboratory testing to be carried out although the sampling frequency can vary. The samples are sealed with wax shortly after recovery to prevent moisture loss and stored at a temperature of greater than 4 degrees (to avoid freeze thaw effects) until despatch to the laboratory for testing. Records of U100 samples are presented on the borehole logs.

Small and bulk disturbed samples are recovered at regular intervals in each of the boreholes for logging and testing purposes as noted on the exploratory hole logs.

On completion of the boring 50 mm internal diameter groundwater monitoring wells may be installed in selected boreholes as detailed on the exploratory hole logs which are typically completed with a lockable stop cock cover concreted into place.

Full details of the borehole including soil descriptions to BS 5930, SPT test results and samples recovered are presented on the exploratory hole logs.

Dynamic Continuous Sampling Boreholes

If carried out the locations of the Dynamic continuous sampling boreholes are shown on the exploratory hole location plan. They are put down using a Competitor Dart Drilling rig (Figure C2).

Figure C2: Competitor Dart Rig

The sampling is progressed by driving a hollow steel tube with a plastic inner liner into the ground. Both cohesive and granular soils are “wedged” into the tubing, relying on the friction between the soil and liner to retain the sample on withdrawal of the tubing. Sample can be lost, particularly in loose granular soils if frictional resistance is not sufficient. The technique can be used in the absence of casing in cohesive soils, although the diameter of tubing is progressively reduced from 101 mm, through 92, 79, 70, 57 and 47 mm dia to ensure that frictional resistance on the sides of the sampling tubing does not exceed the capacity of the equipment to pull the tubing from the hole. Small diameter 115 mm diameter casing can be driven simultaneously with the sampling tube in soft or loose soils to a maximum depth of around 7 m. Standard penetration testing and recovery of “undisturbed” samples is possible in the correct conditions.

Full details of the dynamic continuous sampling holes including soil descriptions to BS 5930, SPT test results and samples recovered are presented on the exploratory hole location plan.

Trial Pitting

Trial pits are typically machine excavated using a JCB 3CX type mechanical excavator. Where hard surfacing is present at the trial pit locations, a hydraulic breaker attachment is used to penetrate the layer and allow subsequent excavation using either a 600 mm or 900 mm wide toothed excavator bucket. Excavation is progressed slowly to allow inspection of the geology revealed and samples were recovered at the discretion of the supervising engineer for subsequent laboratory analysis.

Excavations are typically taken to a maximum depth of 4 m bgl or in the event of obstructions or shallow groundwater being present, excavations are terminated at shallower depth. On completion, the trial pits are backfilled with lightly compacted arisings, tamped into place using the knuckle of the excavator bucket.

Full details of the trial pitting including soil descriptions to BS 5930 including details of samples recovered are presented in Appendix D

Gas and Groundwater Monitoring

Gas monitoring iss carried out using a Gas Data GFM430 infra red gas analyser to record concentrations of Carbon Dioxide, Oxygen, Methane and record atmospheric and downhole pressures together with borehole gas flow rates.

Prior to groundwater sampling, each borehole is purged and insitu readings recovered for pH, temperature, electrical conductivity, dissolved oxygen and redox potential. Samples are recovered once the parameters measured had stabilised.

Rising head permeability testing is commonly carried out in the boreholes on a return visit to site.

Details of any gas and groundwater monitoring or permeability testing is presented in Appendix D.

Topographical Survey

On completion of the fieldwork a topographical survey is usually carried out to determine the location and elevation of the boreholes and trial pits. Exploratory holes are surveyed to a Local Grid/ Ordnance Survey National Grid and the details are presented on the exploratory hole log drawing and on the exploratory hole logs.