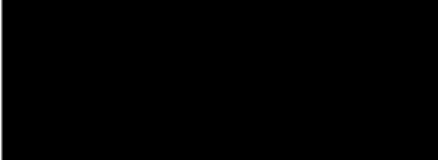




GROUND INVESTIGATION REPORT

for the site at
FORMER COLT INTERNATIONAL, NEW LANE, HAVANT PO9 2LZ

on behalf of
DREW SMITH GROUP

Report Reference: GWPR3514/GIR/March 2020			Status: FINAL
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EXECUTIVE SUMMARY	
Proposed Development	At the time of reporting, March 2020, the proposed development will comprise the construction of ~100No. residential houses in the centre and the west of the site, and ~20No. commercial units in the east/south-east, with associated access roads, car parking areas and soft landscaping.
Geology	The BGS Geological Map for the Fareham area (Sheet No. 316) revealed that the site is located on superficial Head Deposits overlying bedrock of the London Clay Formation. Superficial River Terrace Deposits were noted ~300m to the south-east. No areas of Made or Worked Ground were noted within 250m of the site.
Hydrogeology	A review of the DEFRA 'Magic Map' revealed that site was located within a Secondary (A) Aquifer to the east, and within a Secondary (Undifferentiated) Aquifer in the western portion, both comprising of the superficial Head Deposits. The underlying bedrock deposits of the London Clay Formation was classified as Unproductive Strata.
Radon	The site was not located in an area where Radon protection measures were likely to be required.
Soils Encountered	The ground conditions encountered within the boreholes generally conformed to that anticipated from examination of the geology map. The intrusive site investigation and trial hole records from previous ground investigations by WYG (Ref: A090070-182), Campbell Reith (Ref: 12663) and Ground and Water Limited (ref. GWPR3192/CAR/December 2019.) revealed that the geology of the site comprised distinct zones of cohesive and granular soils. A capping of Made Ground was noted to overly granular Head Deposits overlying bedrock deposits of the London Clay Formation was present as a band trending northeast to southwest and ~60m wide bisecting the site. The remainder of the site comprised a capping of Made Ground overlying cohesive Head Deposits overlying the bedrock deposits of the London Clay Formation.
Foundation Design	Following Geotechnical Analysis of the zone of granular Head Deposits over London Clay, it was considered that the granular soils of the Head Deposits generally comprised a suitable bearing stratum for moderately to highly loaded spread foundation system. However, across the remainder of the site where cohesive Head Deposits were noted overlying the London Clay Formation, consideration should be given to a piled foundation system as they were considered to comprise a more reliable and possibly more cost-effective foundation solution for the proposed development, given the low bearing capacities calculated. See section 6.2 for bearing capacities and anticipated settlements for the spread foundations and section 6.3 for bearing capacities and anticipated settlements for piled foundation solutions.
Sub-Surface Concrete	Sub-surface concrete for shallow foundations <2.00m bgl should be designed based on a sulphate Design Class of DS-1, according to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' and the total potential sulphate results for the natural ground. An ACEC classification of AC-1 should be used, according to the pH recorded within the samples tested. Sub-surface concrete for a piled foundation solution should be designed based on a sulphate Design Class of DS-4, according to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' and the total potential sulphate results for the natural ground. An ACEC classification of AC-4 should be used, according to the pH recorded within the samples tested.

The above information must be read in conjunction with the full report.

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Drew Smith Group to conduct a Ground Investigation at Former Colt International, New Lane, Havant PO9 2LZ. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref: GWQ5173A dated 13th January 2020.

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

A full scale Desk Study and contamination assessment were not part of the remit of this report.

It should be noted that this report includes information from previous reports:

- WYG Phase 1 Ground Investigation and Assessment Report, Ref: A090070-182, dated June 2017;
- Campbell Reith Updated GQRA and Outline Remediation Strategy Report, Ref: 12663, dated May 2019;
- Ground and Water Limited Contamination Assessment Report, ref. GWPR3192/CAR/December 2019.

The techniques adopted for the investigation were chosen considering the requirements of the client, anticipated ground conditions, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised a ~31,100m² irregular-shaped plot of land, oriented in an north-west to south-east direction, located to the south-west of Bartons Road, south-east of Martin Road and north-west of New Lane. The site was located to the north-east of Havant, Hampshire.

The national grid reference for the centre of the site was approximately SU 72615 07997. A site location plan is given within Figure 1. A plan showing the site boundary can be seen in Figure 2.

2.2 Site Description

The site formally comprised a factory and warehouse structure with associated offices, car parking and hard landscaping areas. All buildings on-site had been demolished at the time of site works, August 2019, with the site covered by a concrete slab over the footprint of the former structures and all tarmac parking areas/concrete hardstanding still present. An Electricity sub-station was noted in the south-western portion of site. An aerial view of the site is given within Figure 3.

2.3 Proposed Development

At the time of reporting, March 2020, the proposed development will comprise the construction of ~100No. residential houses in the centre and the west of the site, and ~20No. commercial units in the east/south-east, with associated access roads, car parking areas and soft landscaping. A plan of the proposed development is shown within Figure 4.

2.4 Geology

The BGS Geological Map for the Fareham area (Sheet No. 316) revealed that the site is located on superficial Head Deposits overlying bedrock of the London Clay Formation. Superficial River Terrace Deposits were noted ~300m to the south-east. No areas of Made or Worked Ground were noted within 250m of the site.

Head Deposits – Chichester area

Head Deposits occur widely in valley floors, on valley sides and on interfluvies. It is probably much more widespread than shown on the map. In general, clay-with-flints passes downslope into head, locally without a separating break of slope. Head accumulated largely by solifluction and hillwash, mainly under periglacial conditions during the Quaternary glaciations. Its composition varies according to the local sources of material and mode of landscape evolution. It is typically composed of reddish brown to yellow-brown, gravelly silty, sandy clay or diamicton, commonly with variable proportions of coarser material (chiefly broken flint nodules). Borehole records suggest that the head deposits are generally less than 3m thick, but may be over 5m locally.

Undifferentiated River Terrace Deposits

Extensive spreads of River Terrace Deposits occur along the Rivers Test, Itchen and Hamble. Eleven terraces have been provisionally recognised in the area. The deposits are variable in thickness, ranging from 1 to 5m, and generally consist of gravels, predominantly sub-angular to sub-rounded flints, with a considerable sand content. Poorly sorted clayey and sandy silts and silty clays overlie some of the terraces.

London Clay Formation – Hampshire Basin

In the Hampshire Basin area, the London Clay Formation comprises blue, brown and grey clay with yellow and grey sands and silts interspersed with pebble beds. Localised developments of sandstone also occur. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The basement beds of the London Clay Formation are sandy with rounded flints.

A BGS borehole located ~150m south-east of site (in similar geology) revealed 0.15m of Topsoil to overlie a firm brown clay with medium to coarse flint gravels and cobbles to 1.37m bgl. This was then underlain by a brown fine-grained sand for the remainder of the borehole, a depth of 3.05m bgl. No groundwater was encountered within the borehole.

Another BGS borehole located ~300m west of site revealed 0.15m of Topsoil to overlie a medium-dense to dense light brown to blue-grey silty fine-grained sand to 9.14m bgl. This was underlain by a stiff to very stiff blue-grey sandy clay for the remaining depth of the borehole (12.19m bgl). Groundwater was noted at a depth of 1.70m bgl. A groundwater strike was noted at 1.52m bgl, standing at between 2.44 – 4.57m bgl at the end of subsequent days of drilling works.

2.5 Hydrogeology and Hydrology

A review of the DEFRA 'Magic Map' revealed that site was located within a **Secondary (A) Aquifer** to the east, and within a **Secondary (Undifferentiated) Aquifer** in the western portion, both comprising of the superficial Head Deposits. The underlying bedrock deposits of the London Clay Formation was classified as **Unproductive Strata**.

Superficial drift deposits are described as permeable unconsolidated (loose) deposits e.g. sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities. **Secondary (A) Aquifers** consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

Undifferentiated Secondary Aquifers are assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both a minor aquifer and non-aquifer in different locations due to the variable characteristics of the rock type.

Unproductive Strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Examination of the Defra records showed that the site was located within an **Inner Zone Ic (Subsurface Activity)** Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater. This relates to the Principal Aquifer associated with the Lewes Nodular Chalk Member and Tarrant Chalk Member underlying the Unproductive Strata of the London Clay Formation.

The nearest surface water feature to the site was a drain located ~10-20m to the east of the site (Thought to be the River Lavant, according to previous reports). Emsworth Harbour was noted ~2.65km to the south of site.

Examination of the Environment Agency records showed that the site was located within a Flood Zone 1 (an area with a **low** probability of flooding). However the land immediately to the south-east of site was noted to comprise a **Flood Zone 2** and **Flood Zone 3**, associated with the drain running to the east.

Environment Agency Flood Zone 2, defined as; land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

Environment Agency Flood Zone 3 shows the extent of a river flood with a 1 in 100 (1% or greater chance of occurring in any year or a sea flood with a 1 in 200 (0.5%) or greater chance of occurring in any year.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at shallow to moderate depth (~2 – 4m below existing ground level (bgl)) and it was considered that the groundwater was flowing in an overall southerly direction towards Emsworth Harbour.

2.6 Radon

BRE 211 (2015) Map 4 of Hampshire, Berkshire and south Oxfordshire revealed the site **was not** located within an area where mandatory protection measures against the ingress of Radon were likely to be required. The site **was not** located within an area where a risk assessment was required.

2.7 Results of previous Site Investigations

WYG Phase 1 & 2 Ground Investigation and Assessment Report, Ref: A090070-182, dated June 2017:

A Phase 1 Desk Study Investigation Report was undertaken by WYG in November 2016, which collated publically available information to review the risks associated with ground conditions with potential to impact upon the redevelopment of the site for combined high density residential and commercial use. The Desk Study confirmed the requirement for intrusive ground investigations to allow a further assessment of risks. This data was collated and interpreted in order to define a Conceptual Site Model, undertake qualitative risk assessment and semi-quantitative risk assessment grading the pollutant linkages in accordance with a risk matrix. This was then used to inform a subsequent intrusive investigation. The pertinent points taken from the report summarising these works are discussed in this section of the report.

At the time of the site walkover in September 2016 and subsequent investigation in February 2017, the site was occupied by the Colt International factory, warehouse and office buildings with associated hardstanding, car parks and access roads. The local topography (which slopes to the south-east) is accommodated by a retaining wall on the north-west boundary, and an embankment running across the site.

In the southern portion of site was a building of brick and metal cladding construction used for fire testing of finished products. Adjacent to this building was an external cylindrical plastic (but likely

double-skinned) Above Ground Storage Tank (AST) for 'fuel oil', of approximately 1000 litres capacity positioned on a breeze block plinth. South of the main factory building was a small brick outhouse, understood to have housed a diesel generator that previously provided a 'back up' power supply. Adjacent west of the outhouse was a former brick bund containing several brick plinths that supported and housed a large cylindrical diesel AST. The tank was no longer present.

An electricity sub-station was located on the eastern edge of the former diesel tank bund.

A review of historic Ordnance Survey maps dating back to 1867 indicated limited residential development on the site prior to redevelopment as a manufacturing facility for Colt International in the mid-1960s. The site layout remained largely unchanged since this period. It was reported that during the Second World War a cottage building in the north west of the site was requisitioned by the mining department of HMS Vernon Mining Department and used for military storage purposes.

Although not listed as a potential source of ground contamination, the presence of asbestos materials in building materials was also recognised. A number of current and commercial premises are located in the site vicinity, and of particular note is the Marsh Plant immediately south, Eaton on the opposite side of New Lane, and a gas holder approximately 300m south of the site. Based on the local topography (sloping south east) and the known hydrogeological setting (that includes a public water abstraction to the south west) a southerly groundwater flow direction is inferred. Therefore, commercial premises in the site vicinity are considered to be down gradient in terms of inferred groundwater flow and it is considered relatively unlikely that the site has been impacted by offsite sources of contamination.

Subsequent Phase 2 intrusive works were undertaken between the 1st and 3rd of February 2017 and comprised 14No. Window sample locations to depths ranging between 0.30 and 5.00m bgl with Standard Penetration Testing (SPTs) and installation of 7No. dual purpose ground-gas and groundwater monitoring wells. Samples were obtained for laboratory assessment and 2No. return monitoring visits were undertaken. Ground conditions encountered during the investigation were consistent with those identified in the published literature and comprised a 0.40 to 2.00m thick layer of Made Ground over Head Deposits overlying the London Clay Formation at depths ranging between 0.80 and 2.80m bgl. The London Clay Formation persisted to the full depth of the investigation. Groundwater was encountered at depths ranging between 0.50 and 1.50m bgl during the investigation and between ground level and 2.79m bgl during return visits.

Campbell Reith Updated GQRA and Outline Remediation Strategy Report, Ref: 12663, dated May 2019:

Based on the findings of the previous Desk Study and Ground Investigation Reports undertaken by WYG, further (Phase 3) intrusive investigation and testing was done by Campbell Reith in order to increase sampling density and depth of trial holes.

During the summer of 2018 supplementary ground investigation was conducted with the objective of addressing the recommendations of the WYG 2017 report:

- Two Cable Percussive boreholes to a maximum depth of 17.50m bgl
- Seven Windowless Sampler boreholes to a maximum depth of 5.45m bgl
- Four Hand-dug Pits to a maximum depth of 1.20m bgl
- Nine machine dug Trial Pits to a maximum depth of 3.10m bgl

- Four Groundwater and ground gas monitoring visits.

The two deep Cable Percussive boreholes were progressed to 12.50 and 17.50m bgl, both encountering Made Ground overlying Superficial Head Deposits (BH202 only) and London Clay Formation to the base of the boreholes.

Nine exploratory locations (three Windowless Samplers, three Trial Pits and one Cable Percussive borehole) were progressed across the building footprint to provide additional coverage where the area had previously not been investigated. Trial pits TP209, TP210 and TP211 were progressed into the bank to the west of the monsoon drain, with the intention of investigating the drainage. There were no visual observations of contamination in the bank.

Superficial deposits were not considered to be present in significant thickness in the western car park. Variable Head Deposits were present across the bulk of the centre of the site, often trial pits did not prove the maximum depth of superficial deposits (~2.00 to 3.00m bgl). The borehole in the centre of the site demonstrated the base of the superficial deposits to be 3.20m bgl. A 12.50m deep borehole in the centre of the site encountered London Clay Formation from 3.20 to 12.50m bgl. The deep borehole in the western car park encountered London Clay Formation from 1.30 – 4.50m bgl, followed by brown mottled orange-brown silty, fine to coarse sand, from 4.50 to 11.50m, inferred to be the Bognor Sand Member. The London Clay Formation of stiff dark greenish-grey slightly sandy clay is present from 11.50 to 17.50m bgl.

Ground and Water Limited Contamination Assessment Report, ref. GWPR3192/CAR/December 2019:

A fourth phase of intrusive works and risk assessment was undertaken by Ground and Water Limited. **The purposes of contamination testing was to increase sampling density and reduce uncertainty. The data from the Phase 2 WYG and Phase 3 Campbell Reith investigations were combined with that from the Phase 4 Ground and Water Limited investigation.**

Phase 4 Fieldwork Undertaken

Additional fieldwork was undertaken on the 29th – 30th August and 2nd September 2019 and comprised the construction of 20 No. Windowless Sampler Boreholes (WS1 – WS20) to a depth of between 1.80 – 3.00m bgl.

Sampling Procedures

The methodology for sampling locations can be seen tabulated overleaf. A trial hole location plan is given within Figure 5.

Methodology for Sampling Locations and Chemical Laboratory Testing (Ground and Water Ltd)				
Trial Hole	Depth (m bgl)	Sampling Strategy	Site Use (Existing)	Site Use (Proposed)
WS1	2.80	Targeted sampling strategy	Access road/car park to south of former office building.	Commercial units and associated access roads/car parking.
WS2	2.45			
WS3	3.00		Concrete pad for former factory building.	
WS4	2.45		Concrete hardstanding adjacent to Electricity Sub-station.	Residential housing and associated garden areas.
WS5	1.80			
WS6	2.45			
WS7	2.45			Residential flats and associated car parking.
WS8	2.45			Residential housing and associated garden areas.
WS9	2.45		Concrete pad for former factory building.	Residential flats and associated car parking.
WS10	2.45			Residential housing and associated garden areas.
WS11	2.00			Residential flats and associated car parking.
WS12	2.45			Residential housing and associated garden areas.
WS13	2.45			
WS14	2.00			
WS15	2.00			Residential flats and associated car parking.
WS16	2.45			
WS17	2.45		Tarmac car parking area.	Residential housing and associated garden areas.
WS18	2.45			
WS19	2.45			
WS20	2.45			

Soil Conditions

The ground conditions encountered during the investigation are described in this section. For the purposes of discussion, the succession of conditions encountered in the trial holes in descending order can be summarised as follows:

Made Ground Head Deposits (WS1-WS2, WS4-WS6, WS8-WS17, WS20) London Clay Formation (WS6-WS7, WS18-WS20)

Made Ground

Made Ground was encountered in all trial holes from beneath a 0.18 – 0.30m thick capping of Concrete within WS1 – WS16, and a 0.10 – 0.20m thick capping of Tarmac in WS17 – WS20, to a depth of between 0.30 – 1.50m bgl (and for the entire depth of WS3 to 3.00m bgl). The soils were noted to be variable across the site, but most generally comprised a light to dark brown, grey-brown, pale yellow and orange to reddish-brown, sandy gravelly clay to sandy gravel (locally a gravelly slightly clayey sand). The sand was fine to coarse grained and the gravel was fine to coarse, angular to rounded flint rejects, brick, concrete, tarmac, metal, ceramic fragments, chalk fragments and charcoal/carbonaceous material. A hydrocarbon/creosote odour was noted within WS1, WS3 and WS16.

Within WS5 from 0.80 – 1.00m, WS9 from 0.25 – 0.40m, WS17 from 0.15 – 0.40m, WS18 from 0.20 – 0.70m and WS19 from 0.10 – 0.40m bgl, the Made Ground was recovered as a matrix-dominated chalk fill (Dm Grade according to CIRIA C574).

Head Deposits

Soils representative of the superficial Head Deposits were noted underlying the Made Ground to a depth of 1.80m bgl within WS6 and 1.00m bgl within WS20, and for the remaining depth of WS1-WS2, WS4-WS5 and WS8-WS17, a depth of between 1.80 – 2.80m bgl. A mixture of cohesive and granular deposits were noted.

Cohesive soils were noted underlying the Made Ground for the remaining depth of WS1-WS2, WS4 and WS8, and to a depth of between 1.00 – 1.80m bgl within WS5-WS6, WS9 and WS17, and generally comprised a light to mid-brown, mid to dark grey-brown and orange-brown sandy gravelly clay. The sand was fine to coarse grained and the gravel was occasional to frequent, fine to coarse, angular to sub-rounded (locally rounded) flint and occasional carbonaceous material.

Granular soils were noted underlying the cohesive deposits for the remaining depth of WS5, WS9 and WS17, and underlying the Made Ground for the remaining depth of WS10-WS16, and generally comprised an orange-brown, grey-brown and mid-brown mottled (locally slightly clayey) gravelly silty sand. The sand was fine to medium grained and the gravel was fine to coarse, angular to rounded flint.

A slight hydrocarbon odour was noted from ~1.50 - 2.00m bgl within WS1.

London Clay Formation

Soils of the London Clay Formation were noted underlying the Made Ground/ Head Deposits for the remaining depth of WS6-WS7 and WS18-WS20, and comprised a blue-grey, orange and grey-brown (locally slightly sandy) clay. The sand was fine grained. Shell fragments were noted at 1.70m bgl within WS20, and claystone fragments at 2.00m bgl within WS18 and WS20.

Roots were noted to a depth of between 0.50 – 2.00m bgl within WS6-WS8 and WS17-WS20. A summary of root depths within individual trial holes is tabulated below:

Summary of Root Depth		
Trial Hole	Depth of Trial Hole (m bgl)	Depth of Roots (m bgl)
WS6	2.45m	1.00m
WS7	2.45m	0.80m
WS8	2.45m	0.80m
WS17	2.45m	0.50m
WS18	2.45m	2.00m (Decayed)
WS19	2.45m	2.00m
WS20	2.45m	1.00m

A groundwater strike was noted at 1.70m bgl within WS8, and wet soils were encountered within WS1, WS2, WS10, WS13, WS16 and WS19 at depths of between 0.70 – 2.80m bgl. A summary of groundwater depths is tabulated below:

Summary of Groundwater encountered		
Trial Hole	Depth of GW strike (m bgl)	Depth of wet soils (m bgl)
WS1	-	2.40 – 2.80m
WS2	-	1.00 – 2.45m bgl
WS8	1.70m	-
WS10	-	0.80 – 1.10m
WS13	-	1.50m
WS16	-	1.50 – 2.00m
WS19	-	0.70 – 1.50m

3.0 FIELDWORK

3.1 Scope of Works

Site works were undertaken on the, 20th – 22nd and 29th January 2020 and comprised the drilling of 3No. Cable Percussion boreholes (BH1 BH4 & BH5) to a depth of 15.00m bgl, 2No. Cable Percussion boreholes (BH2 & BH3) to a depth of 20.00m and 18.00m bgl respectively, and 9No. Trial Pits (TP1 – TP9) to depths of 1.50m – 2.50m bgl.

Borehole and trial pit location plans can be seen in Figures 6 and 7.

Groundwater monitoring standpipe was installed to 5.00m bgl in BH1 – BH5. The construction of the wells installed can be seen tabulated below.

Groundwater Monitoring Well Construction				
Trial Hole	Depth of Installation (mbgl)	Thickness of slotted piping with gravel filter pack (m)	Depth of plain piping with bentonite seal (m bgl)	Piping external diameter (mm)
BH1	5.00m	4.00m	1.00m	63mm
BH2	5.00m	4.00m	1.00m	63mm
BH3	5.00m	4.00m	1.00m	63mm
BH4	5.00m	4.00m	1.00m	63mm
BH5	5.00m	4.00m	1.00m	63mm

The location of the boreholes described can be seen in Figure 6.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, the exploratory position was relocated away from these areas.

As a further precautionary measure, the boreholes were scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

The trial holes were logged by Richard Tucker of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the boreholes generally conformed to that anticipated from examination of the geology map. A capping of Made Ground was noted to overly superficial Head Deposits overlying bedrock deposits of the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. The borehole log can be seen in Appendix B and the trial hole location plans can be viewed in Figures 6 and 7.

For the purposes of discussion, the succession of conditions encountered in the boreholes in descending order can be broadly summarised as follows:

Topsoil (BH5)
Made Ground (BH1 – BH4 & TP1 – TP9)
Head Deposits
London Clay Formation

Topsoil

Topsoil was noted from ground level to a proven depth of 0.20m bgl.

Made Ground

Made Ground was noted from ground level to depths of 0.35 – 1.60m bgl, in all trial holes except BH5. A capping of crushed demolition rubble was noted across the site and generally comprised a greyish brown to light brown silty sandy gravel. The sand was fine to coarse grained. The gravel was fine to coarse, sub-angular to sub-rounded, slate, brick, flint, and concrete. Occasional fragments of metal, glass and plastic.

In BH1 between 0.40 – 1.60m bgl and in BH2 between 0.20 – 0.50m bgl the made ground generally comprised a brown and orangish brown sandy gravelly silty clay. The sand was fine to coarse grained. The gravel was fine to coarse, sub-angular to rounded, flint.

In TP2, TP4 between 0.50 – 0.70m and in TP7 between 0.40 – 0.55m bgl the Made Ground comprised a yellow slightly gravelly sand. The sand was fine to medium grained. The gravel was fine to medium, angular to sub-angular, flint.

In TP8 between 0.50 – 1.20m bgl and in TP9 0.70 – 0.85m bgl the Made Ground generally comprised a light brown and off white sandy gravelly clay. The sand was fine to coarse. The gravel was fine to coarse, sub-angular to rounded, chalk (20%) and flint (80%).

Head Deposits (Cohesive)

Cohesive soils representative of the superficial Head Deposits were recorded from a depth of 1.00 – 1.60m bgl, to a proven depths of 2.00 – 10.70m in BH1, BH3 – BH5 and from depths of 1.50 – 1.80m bgl to the base of the trial hole in TP8 & TP9. The soils generally comprised an orangish brown, brown and grey sandy gravelly silty clay. Gravel is fine to coarse, sub-angular to rounded, flint. Cobble of flint in TP9.

Head Deposits (Granular)

Granular soils representative of the superficial Head Deposits were recorded from a depth of 0.50m – 1.20m bgl to proven depths of 2.10m – 6.00m bgl in BH2 & TP8 and from 0.35 – 0.90m bgl to unproven depths of 1.50m – 2.50m bgl in TP1 – TP7.

London Clay Formation

Soils representative of the bedrock deposits of the London Clay Formation were encountered in BH1 – BH5 from a depth of 2.00m – 10.70m bgl, to the base of the borehole at a depth of 15.00m – 20.00m bgl. The soils generally comprised a dark grey silty clay with fine selenite. Shell fragments were noted from 8.00 – 12.00m bgl. Becoming sandy from 18.00m bgl in BH2.

The intrusive site investigation and trial hole records from previous ground investigations by WYG (Ref: A090070-182), Campbell Reith (Ref: 12663) and Ground and Water Limited (ref. GWPR3192/CAR/December 2019.) revealed that the geology of the site comprised distinct zones of cohesive and granular soils. A capping of Made Ground was noted to overly granular Head Deposits overlying bedrock deposits of the London Clay Formation was present as a band trending ~northeast to southwest and ~60m wide bisecting the site. The remainder of the site comprised a capping of Made Ground overlying cohesive Head Deposits overlying the bedrock deposits of the London Clay Formation.

A surface geology plan showing the extent of the granular soils across the site is shown in Figure 8.

For details of the composition of the, Made Ground and the natural ground at particular points, reference must be made to the trial hole logs within Appendix B.

4.2 Roots Encountered

No roots were encounter during the intrusive investigation.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.3 Groundwater Conditions

Perched water and groundwater was encountered at varying depths during the site investigation in all trial holes except BH3, TP2, TP3, TP6, TP7 & TP9. Due to water added into the boreholes to aid drilling, it was not possible to fully determine the groundwater conditions.

Depth of Perched/Groundwater within Trial Holes		
Trial Hole	Water Encountered	Water Depth (m bgl)
BH1	Groundwater 1 Hour after drilling	11.50
BH2	Groundwater Seepage	8.00
BH4	Groundwater	12.50, 13.20 and 13.80
BH5	Groundwater	3.00
TP1	Perched water	0.80
TP4	Minor Groundwater	2.40
TP5	Perched water from historic soakaway	1.00
TP8	Minor Perched water seepage	1.00 – 1.20

At the time of reporting in March 2020, 2No return monitoring visits had been undertaken. The results are shown tabulated below.

Depth of Groundwater Strikes/Standing Groundwater Within Trial Holes			
Trial Hole	Date	Depth of Groundwater	Depth to Base of Trial Hole/Standpipe (m bgl)
BH1	29/01/20	4.85	4.93
	27/02/20	4.79	5.05
BH2	29/01/20	1.14	2.13
	27/02/20	0.90	2.04
BH3	29/01/20	0.66	4.25
	27/02/20	0.87	4.20
BH4	29/01/20	1.45	4.88
	27/02/20	0.42	5.01
BH5	29/01/20	1.20	4.80
	27/02/20	1.24	4.95

It was likely that these all relate to perched water within sand and/or silt bands within the superficial Head Deposits and the London Clay Formation, rather than being a true representation of the level of a saturated aquifer beneath the site.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

It should be noted that exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. It should be noted that changes in groundwater level do occur for a number of reasons including seasonal effects and variations in drainage.

The site investigation and subsequent monitoring visit was carried out in January 2020, when groundwater levels should be at their annual maximum (highest elevation). The long-term groundwater elevation might increase at some time in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within Made Ground found at

other locations around the site.

4.4 Obstructions

No natural or artificial sub-surface obstructions were noted during the drilling of the borehole.

5.0 IN-SITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

Standard Penetration Tests (SPTs)

Standard Penetration Testing (SPT) was carried out in BH1 – BH5 at 1.00m intervals to 5.00m bgl and at 1.50m bgl thereafter. The results of the SPT's have not been amended to take into account hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix B.

Windowless Sampler Boreholes provide samples of the ground for assessment, but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg falling through a distance of 760 mm. The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 75 mm up to a depth of 450 mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

The cohesive soils of the Head Deposits and the London Clay Formation were classified based on the table below.

Undrained Shear Strength from Field Inspection/SPT results Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))		
Classification	Undrained Shear Strength (kPa)	Field Indications
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

The granular soils of the superficial Head Deposits were classified based on the table below.

Correlation between normalised SPT blow counts (N_{160}) and granular classification.	
Classification	Equivalent SPT Blow Counts (N_1)
Extremely Dense	>58
Very Dense	42 – 58
Dense	25 – 42
Medium	8 – 25
Loose	3 – 8
Very Loose	0 – 3

An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results					
Strata	SPT "N" Blow Counts	Equivalent Undrained Shear Strength (kPa) Cohesive Soils	Soil Type		Trial Hole/s
			Cohesive	Granular	
Shallow Head Deposits (Cohesive)	7 – 11 9 9 – 11	35 – 55 45 45 – 55	Low to Medium Low Medium	-	BH3 (1.20m – 2.00m bgl) BH4 (1.20m bgl) BH5 (1.20m – 2.00m bgl)
Head Deposits (Cohesive)	16 – 50 11 – 15	80 – 250 55 – 75	High to Very High Medium – High	-	BH1 (2.00m – 9.50m bgl) BH5 (3.00m – 4.00m bgl)
Head Deposits (Granular)	22 – 30	-	-	Medium Density to Dense	BH2 (1.50 – 4.50m bgl)
Shallow London Clay Formation	7	35	Low	-	BH4 (2.00m bgl)
London Clay Formation	33 – 38 24 – 50 11 – 82 11 – 50 15 – 45	163 – 190 120 – 250 55 – 410 55 – 250 75 – 255	Very High High to Very High Medium to Extremely High Medium to Very High High to Very High	-	BH1 (11.00m – 14.50m bgl) BH2 (6.00m – 19.50m bgl) BH3 (3.00m – 18.00m bgl) BH4 (3.00m – 15.00m bgl) BH5 (5.00m – 14.00m bgl)

Following review of the data from the previous site investigations by WYG, Campbell Reith and Ground and Water, it was considered that the in-situ geotechnical testing results were consistent with the previous investigations.

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

The test results are presented on the trial hole logs within Appendix B.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and DETS Limited, was undertaken on samples recovered from the soils encountered on site. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:2016/2018.

Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	9
Water Soluble Sulphate & pH	BS1377:2018:Part 3:Clause 5	3
BRE Special Digest 1 (incl. pH, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH ₄ , W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	3

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on one sample of the Head Deposits (BH5/3.00m bgl) and nine samples of the London Clay Formation (BH1/13.00m, BH2/9.00m, BH2/20.00m, BH3/6.00m, BH3/18.00m, BH4/4.00m, BH4/15.00m, BH5/12.00m bgl) can be seen tabulated below.

Atterberg Limit Tests Results Summary							
Soil Description	Moisture Content (%)	Passing 425 μ m sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						BRE	NHBC
Head Deposits	31	61	21.96	MH	Very Stiff 1.093	Medium	Medium
London Clay Formation	25 – 34	85 – 100	12.75 – 36.26	CI – CH	Soft - Stiff 0.466 – 0.885	Low to Medium	Low to Medium

NB: NP – Non-plastic

BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)

Soil Classification based on British Soil Classification System.

Consistency Index (Ic) based on BS EN ISO 14688-2:2004.

5.2.2 Comparison of Soil's Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated overleaf.

The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth/ Description	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
Head Deposits BH5/3.00m bgl Lab description: Brown slightly fine sandy gravelly silty CLAY (gravel is fmc and rounded to subangular)	34	18	30.00	0.53	Overconsolidated
London Clay Formation BH1/13.00m bgl Lab description: Dark grey slightly fine sandy silty CLAY	25	19	26.88	0.22	Overconsolidated
London Clay Formation BH2/9.00m bgl Lab description: Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and subangular)	27	18	22.31	0.40	Overconsolidated
London Clay Formation BH2/20.00m bgl Lab description: Dark grey slightly gravelly fine sandy silty CLAY (gravel is fm and subangular)	27	20	28.48	0.25	Overconsolidated
London Clay Formation BH3/6.00m bgl Lab description: Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and subangular)	26	22	35.00	0.11	Heavily Overconsolidated
London Clay Formation BH3/18.00m bgl Lab description: Dark grey slightly fine sandy silty CLAY	25	21	12.75	0.31	Overconsolidated
London Clay Formation BH4/4.00m bgl Lab description: Light brown slightly gravelly fine sandy silty CLAY (gravel is fm and subangular)	26	21	36.26	0.14	Heavily Overconsolidated
London Clay Formation BH4/15.00m bgl Lab description: Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and subangular)	31	19	21.96	0.55	Overconsolidated
London Clay Formation BH5/12.00m bgl Lab description: Dark grey silty CLAY	30	21	34.00	0.26	Overconsolidated

Liquidity Index testing revealed no evidence for moisture deficit within the overconsolidated sample of the Head Deposits, and the nine overconsolidated and heavily overconsolidated samples of the London Clay Formation tested.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated below.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	Moisture Content (MC) (%)	Liquid Limit (LL) (%)	40% Liquid Limit (LL)	Result
Head Deposits BH5/3.00m bgl Lab description: Brown slightly fine sandy gravelly silty CLAY (gravel is fmc and rounded to subangular)	34	48	19.2	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH1/13.00m bgl Lab description: Dark grey slightly fine sandy silty CLAY	25	47	18.8	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH2/9.00m bgl Lab description: Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and subangular)	27	41	16.4	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH2/20.00m bgl Lab description: Dark grey slightly gravelly fine sandy silty CLAY (gravel is fm and subangular)	27	52	20.8	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH3/6.00m bgl Lab description: Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and subangular)	26	57	22.8	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH3/18.00m bgl Lab description: Dark grey slightly fine sandy silty CLAY	25	36	14.4	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH4/4.00m bgl Lab description: Light brown slightly gravelly fine sandy silty CLAY (gravel is fm and subangular)	26	58	23.2	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH4/15.00m bgl Lab description: Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and subangular)	31	55	22	MC > 0.4 x LL (No Significant Moisture Deficit)
London Clay Formation BH5/12.00m bgl Lab description: Dark grey silty CLAY	30	55	22	MC > 0.4 x LL (No Significant Moisture Deficit)

The table above revealed no evidence of a moisture deficit within the sample of the Head Deposits, and the nine samples of the London Clay Formation tested.

5.2.3 Sulphate and pH Tests

A water-soluble sulphate and pH test were undertaken on one sample of the Head Deposits (BH1/6.00m bgl) and two samples of the London Clay Formation (BH2/6.00m & BH3/15.00m bgl). A water-soluble sulphate concentration of 0.23 – 0.47g/l with a pH of 7.52 – 7.63 was recorded.

5.2.4 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) one sample of the Head Deposits (BH1/2.00m bgl) and two samples of the London Clay Formation (BH3/10.00m & BH4/2.00m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification. The results of the chemical analysis undertaken are given within Appendix C and a summary is tabulated overleaf.

Summary of Results of BRE Special Digest Testing				
Determinand	Unit	BH1/2.00m bgl	BH3/10.00m bgl	BH4/2.00m bgl
pH	-	8.5	8.0	7.9
Ammonium as NH ₄	mg/kg	< 0.5	< 0.5	< 0.5
Sulphur	%	0.03	0.48	< 0.02
Chloride (water soluble)	mg/kg	33	12	10
Magnesium (water soluble)	mg/l	4.9	7.5	3.5
Nitrate (water soluble)	mg/kg	< 3	< 3	< 3
Sulphate (water soluble)	g/l	0.20	0.10	0.01
Sulphate (total)	mg/kg	672	640	< 200

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

Following review of the ground conditions from the previous site investigations by WYG, Campbell Reith and Ground and Water, it was considered that the ground conditions and geotechnical characteristics recorded from the intrusive ground investigation were concordant with those within the previous site investigations.

- Topsoil was recorded from ground level to a proven depth of 0.20m bgl in BH5. Made Ground was recorded from ground level to a depth of 0.35 – 1.60m bgl within all trial holes except BH5.

As a result of the inherent variability of any Topsoil and Made Ground present at other locations at the site, these materials are usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Made Ground (or Topsoil) and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Made Ground may be found at other locations on the site, especially close to former structures/foundations and service runs.

- Cohesive soils representative of the superficial Head Deposits were recorded from a depth of 1.00 – 1.60m bgl, to a proven depths of 2.00 – 10.70m in BH1, BH3 – BH5 and from depths of 1.50 – 1.80m bgl to the base of the trial hole in TP8 & TP9. The soils generally comprised an orangish brown, brown and grey sandy gravelly silty clay. Gravel is fine to coarse, sub-angular to rounded, flint. Cobble of flint in TP9.

In-situ SPT testing revealed that the cohesive soils of the shallow superficial Head Deposits exhibited a low to medium undrained shear strength (35 – 55kPa) at a depth of 1.20 – 2.00m bgl within BH3, BH4 and BH5.

In-situ SPT testing revealed that the cohesive soils of the deep superficial Head Deposits exhibited a medium to very high undrained shear strength (55 – 250kPa) at a depth of 2.00 – 9.50m bgl within BH1 and BH5.

The cohesive soils of the Head Deposits were determined to have **medium volume change potential** in accordance with NHBC Standards Chapter 4.2 and with BRE Digest 240.

Due to the low SPT 'N' values recorded at shallow depths <2.00m bgl it was considered that the cohesive soils of the superficial Head Deposits were not a suitable bearing stratum for footings/foundations and should be bypassed.

- Granular soils representative of the superficial Head Deposits were recorded from a depth of 0.50m – 1.20m bgl to proven depths of 2.10m – 6.00m bgl in BH2 & TP8 and from 0.35 – 0.90m bgl to unproven depths of 1.50m – 2.50m bgl in TP1 – TP7.

In-situ SPT testing revealed that the granular soils of the Head Deposits exhibited were Medium density at a depth of 1.50 – 4.50m bgl within BH2.

- Soils representative of the bedrock deposits of the London Clay Formation were encountered in BH1 – BH5 from a depth of 2.00m – 10.70m bgl, to the base of the borehole at a depth of 15.00m – 20.00m bgl. The soils generally comprised a dark grey silty clay with fine selenite. Shell fragments were noted from 8.00 – 12.00m bgl. Becoming sandy from 18.00m bgl in BH2.

In-situ SPT testing revealed that the cohesive soils of the shallow London Clay Formation exhibited low undrained shear strengths (35kPa) at a depth of 2.00m bgl within BH4.

In-situ SPT testing revealed that the cohesive soils of the deep London Clay Formation exhibited medium to extremely high undrained shear strengths (55 – 410kPa) at a depth of 3.00 – 19.50m bgl within BH1 – BH5.

The cohesive soils of the London Clay Formation were determined to have a **low to medium volume change potential** in accordance with NHBC Standards Chapter 4.2 and with BRE Digest 240.

Geotechnical analyses revealed these soils to be firm to stiff in all samples except within BH1/13.00m bgl which was revealed to be soft. All samples were revealed to be overconsolidated to heavily overconsolidated in BH1, BH2, BH3, BH4 and BH5. The soft clays identified in BH1/13.00m bgl are likely to be due to the presence of water softening the clays.

Therefore, the soils of the London Clay Formation are considered to be a suitable bearing stratum for moderately to highly loaded footings/foundations. Settlements on loading are likely to be moderate.

The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or desiccation and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Perched water and groundwater was encountered at varying depths during the site investigation in all trial holes except BH3, TP2, TP3, TP6, TP7 & TP9. Due to water added into the boreholes to aid drilling, it was not possible to fully determine the groundwater conditions.

Depth of Perched/Groundwater within Trial Holes		
Trial Hole	Water Encountered	Water Depth (m bgl)
BH1	Groundwater 1 Hour after drilling	11.50
BH2	Groundwater Seepage	8.00
BH4	Groundwater	12.50, 13.20 and 13.80
BH5	Groundwater	3.00
TP1	Perched water	0.80
TP4	Minor Groundwater	2.40
TP5	Perched water from historic soakaway	1.00
TP8	Minor Perched water seepage	1.00 – 1.20

2No return monitoring visits had been undertaken. The results are shown tabulated below.

Depth of Groundwater Strikes/Standing Groundwater Within Trial Holes			
Trial Hole	Date	Depth of Groundwater	Depth to Base of Trial Hole/Standpipe (m bgl)
BH1	29/01/20	4.85	4.93
	27/02/20	4.79	5.05
BH2	29/01/20	1.14	2.13
	27/02/20	0.90	2.04
BH3	29/01/20	0.66	4.25
	27/02/20	0.87	4.20
BH4	29/01/20	1.45	4.88
	27/02/20	0.42	5.01
BH5	29/01/20	1.20	4.80
	27/02/20	1.24	4.95

It should be noted that the trial pits excavated during the intrusive investigation were dry with only minor perched water seepage within the cohesive soils of the Made Ground and a minor groundwater seepage at 2.40m bgl within TP8.

Due to the minor groundwater seepage at depth there is potential for limited running sands within excavations within the sands of the superficial Head Deposits at depths of >2.40m bgl.

- No roots were encounter during the intrusive investigation.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or desiccation and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are briefly discussed below and within the next section of this report.

6.2 Spread Foundations

At the time of reporting, March 2020, the proposed development will comprise the construction of ~100No. residential houses in the centre and the west of the site, and ~20No. commercial units in the east/south-east, with associated access roads, car parking areas and soft landscaping. A plan of the proposed development is shown within Figure 4.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7.

The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m².

The soils of the London Clay Formation should be treated as having **medium volume change potential** in accordance with BRE240 and NHBC Standards Chapter 4.2

Due to the soils having volume change potential in accordance with NHBC Standard Chapter 4.2 and BRE240, foundations therefore must not be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account in final design. The base of foundation excavations must extend at least 300mm into non-root penetrated cohesive soils.

Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping. Should trees be removed from the footprint of the proposed building then an alternative foundation system, such as piles should be considered.

No roots were noted in any of the trial holes during the intrusive site investigation.

Made Ground was noted from ground level to depths of 0.35 – 1.60m bgl, in all trial holes except BH5.

The intrusive site investigation and trial hole records from previous ground investigations by WYG (Ref: A090070-182), Campbell Reith (Ref: 12663) and Ground and Water Limited (ref. GWPR3192/CAR/December 2019.) revealed that the surface geology of the site comprised distinct zones of cohesive and granular soils. A band of granular Head Deposits was revealed to be present bisecting the site ~60m in width trending ~northeast to southwest. A surface geology plan showing the extent of the granular soils across the site is shown in Figure 8.

An indicative Geotechnical Analysis was performed for a strip foundation solution, 5.0m long by 0.75m and 1.00m wide and a 1.5m by 1.5m pad foundation solution on both the granular and the cohesive soils; the following results regarding the allowable limit bearing capacity and serviceability loads - settlements were derived. The calculations were based upon the SPT results obtained from BH2 for the granular soils and BH3 for the cohesive soils. The test results are presented on the trial hole logs within Appendix B.

Limit State: Bearing Capacities Calculated for Granular Soils (based on BH2)		
Depth (m BGL)	Foundation System	Limit Bearing Capacity (kN/m ²)
1.00	5.00m by 0.75m Strip	154.98
	5.00m by 1.00m Strip	162.55
	1.50m by 1.50m Pad	200*
1.50	5.00m by 0.75m Strip	200*
	5.00m by 1.00m Strip	200*
	1.50m by 1.50m Pad	200*

*Bearing capacity limited to 200kN/m²

Serviceability State: Settlement Parameters Calculated for Granular Soils (based on BH2)			
Depth (m BGL)	Foundation System	Limit Bearing Capacity (kN/m ²)	Total Settlement (mm)
1.00	5.00m by 0.75m Strip	150	3.33
	5.00m by 1.00m Strip	160	4.64
	1.50m by 1.50m Pad	200	5.68
1.50	5.00m by 0.75m Strip	200	4.03
	5.00m by 1.00m Strip	200	5.35
	1.50m by 1.50m Pad	200	4.78

Limit State: Bearing Capacities Calculated for Cohesive Soils (based on BH3)		
Depth (m BGL)	Foundation System	Limit Bearing Capacity (kN/m ²)
1.00	5.00m by 0.75m Strip	75.47
	5.00m by 1.00m Strip	76.15
	1.50m by 1.50m Pad	83.85
1.50	5.00m by 0.75m Strip	69.88
	5.00m by 1.00m Strip	70.47
	1.50m by 1.50m Pad	79.88
2.00	5.00m by 0.75m Strip	81.72
	5.00m by 1.00m Strip	82.39
	1.50m by 1.50m Pad	93.14

Serviceability State: Settlement Parameters Calculated for Cohesive Soils (Based on BH3)					
Depth (m BGL)	Foundation System	Load (kN/m ²)	Settlement (mm) (Full Oedometric)	Settlement (mm) (Elastic)	Settlement (mm) (Elastic + Full Oedometric)
1.00	5.00m by 0.75m Strip	70	16.10	4.44	20.54
	5.00m by 1.00m Strip	65	17.20	5.21	22.41
	1.50m by 1.50m Pad	70	17.60	5.86	23.46
1.50	5.00m by 0.75m Strip	65	10.90	3.91	14.81
	5.00m by 1.00m Strip	70	14.40	5.53	19.93
	1.50m by 1.50m Pad	70	13.30	5.84	19.11
2.00	5.00m by 0.75m Strip	80	10.10	3.87	13.97
	5.00m by 1.00m Strip	80	11.80	4.94	16.74
	1.50m by 1.50m Pad	90	13.10	5.61	18.71

Following Geotechnical Analysis of the zone of granular Head Deposits over London Clay, it was considered that the granular soils of the Head Deposits generally comprised a suitable bearing stratum for moderately to highly loaded spread foundation system.

However, across the remainder of the site where cohesive Head Deposits were noted overlying the London Clay Formation, consideration should be given to a piled foundation system as they were considered to comprise a more reliable and possibly more cost-effective foundation solution for the proposed development, given the low bearing capacities calculated.

The foundation method to be adopted however, as well as the final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and the likely serviceability and settlement requirements of the proposed structure.

Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced.

Perched water and groundwater were encountered at varying depths during the site investigation in all trial holes except BH3, TP2, TP3, TP6, TP7 & TP9. Due to water added into the boreholes to aid drilling, it was not possible to fully determine the groundwater conditions.

Subsequent groundwater monitoring visits recorded water levels between 0.42 – 4.85m bgl. It was

concluded that these were related to perched water within the cohesive soils of the Head Deposits and the London Clay Formation.

It was considered unlikely that the excavation of foundations would not encounter groundwater, however, perched water may be encountered within the Made Ground, especially after periods of prolonged rainfall.

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation and higher rates of rainfall are expected, perched water could accumulate thus dewatering could be required to facilitate the construction and prevent the base of the excavation blowing before the slab was cast.

General Recommendations for Spread Foundations:

- Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.
- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for soft spots and to check for the presence of roots.
- Any groundwater or surface water ingress must be prevented from entering foundation trenches. Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time, the shear strength and hence the bearing capacity would be reduced, and this could result in increased settlements.
- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.
- Foundations must not be cast over foundations of former structures and/or other hard spots.
- Given the medium volume change potential of the soils of the Head Deposits and the London Clay Formation, a suspended slab should be considered. The volume change potential of the shallow surface soils must be taken into account in final design (underfloor void diameter/compressible material/void formers etc.).
- **Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present and proposed trees.**

6.3 Piled Foundations

Given the low bearing capacities calculated for the cohesive of the Head Deposits and the London Clay Formation consideration should be given to a piled foundation system within the cohesive soils as they were considered to comprise a more reliable and possibly a more cost-effective foundation solution for the proposed development.

Indicative allowable pile loads for guidance are provided within this report.

The construction of a piled foundation is a specialist job, and the advice of a reputable contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the foundation design, as the actual pile working load will depend on the particular type of pile and method of installation adopted.

The foundation would comprise a piled foundation with reinforced ground beams. In general, for the cumulative pile capacity calculations, shaft friction over desiccated levels should be ignored and piles should not be terminated within desiccated soils where moisture recovery following tree removal could occur.

Indicative / guidance limit loads and settlements for a bored pile to depths of 10.50, 12.50, 14.50 and 16.50m bgl are given within the table below and have been based on SPT in the vicinity of BH3.

An allowance for negative skin friction within the top ~1.00m has been included within the calculations where it could pass through Made Ground. An adhesion factor of **0.45** has been applied to all cohesive units.

The Classic Theory considers a Factor of safety of ~2.5. Please note that the Total Vertical limit Load calculated is not just the accumulation of the Tip Load and Lateral Load, while it incorporates a factor of safety of its own. The FOS however for the total vertical load on its own is ~2.7.

Bored Pile – Limit Loads and Settlement Parameters (BH3)						
Depth (m bgl)	Diameter (m)	Limit States (kN)			Settlement (Poulos Davis (1968))	
		Tip Limit Load	Lateral Limit Load	Total Vertical Limit Load	Load (kN)	Total (mm)
10.50	0.30	29.58	131.85	143.75	140	1.5
	0.45	66.55	197.77	224.56	220	2.7
	0.60	118.32	263.69	311.32	310	2.8
12.50	0.30	34.05	180.92	193.77	190	1.9
	0.45	76.62	271.38	300.30	300	2.0
	0.60	136.22	361.85	413.24	410	3.6
14.50	0.30	44.94	252.46	272.67	270	2.2
	0.45	101.13	378.69	424.15	420	2.3
	0.60	179.78	504.92	585.74	580	3.6
16.50	0.30	48.71	330.24	350.67	350	2.3
	0.45	109.59	495.35	541.33	540	2.8
	0.60	194.83	660.47	742.20	740	2.9

Any piled solution will need to penetrate sufficiently into the competent cohesive soils of the Head Deposits and the London Clay Formation in order for sufficient skin friction to get activated.

The bearing values given in the table above are applicable to single piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of approximately 0.80 and a calculation made to check the factor of safety against block failure.

The piles in general will need to be designed in accordance with the volume change potential of the soils encountered, depth of desiccation, root penetration, etc. Temporary casing may be required where the upper portion of the pile passes through the Topsoil/ Made Ground, particularly where perched water is encountered, to prevent necking of the concrete.

6.4 Excavations and Stability

Shallow excavations in the Made Ground are likely to be marginally stable at best. Long, deep excavations through the Made Ground and the soils of the Head Deposits and the London Clay Formation are likely to become unstable. The risk of instability additionally increases with the presence of shallow groundwater.

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

Based on the results of the ground investigation and the groundwater monitoring visit, groundwater was considered unlikely to be encountered in the excavation / construction of shallow foundations. However, some amount of perched water may be expected within the Made Ground, confined by the underlying clay, after a period of prolonged rainfall.

6.5 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

The superficial Head Deposits in the eastern portion of the site were classified as a **Secondary (A) Aquifer** with the Superficial Head Deposits to the west were classified as a **Secondary (Undifferentiated) Aquifer**.

The underlying bedrock deposits of the London Clay Formation was classified as **Unproductive Strata**.

Given the cohesive nature of the superficial Head Deposits and the London Clay Formation they were considered unlikely to be a suitable medium for the disposal of storm water. However, the granular superficial Head Deposits may prove a suitable disposal medium for storm water.

Soakaway testing in accordance with BRE365 Standards were considered to be required to confirm this.

The principles of sustainable urban drainage system (SUDS) should be applied to reduce the risk of flooding from surface water ponding.

Sustainable Drainage the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy:

- store rainwater for later use;
- use infiltration techniques, such as porous surfaces in non-clay areas;
- attenuate rainwater in ponds or open water features for gradual release;

- attenuate rainwater by storing in tanks or sealed water features for gradual release;
- discharge rainwater direct to a watercourse;
- discharge rainwater to a surface water sewer/drain;
- discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

6.6 Sub-Surface Concrete

For the classification given below, the “mobile” and “natural” case was adopted given the geology encountered and the residential use of the site.

The total potential sulphates (3x sulphur) were found to be <0.06 – 0.09% within the Head Deposits (BH1/2.00m & BH4/2.00m bgl) and 1.44% within the London Clay Formation (BH3/10.00m bgl).

The water-soluble sulphates were found to be 10 - 230mg/l within the Head Deposits (BH1/2.00m, BH1/6.00m & BH4/2.00m bgl) and 100 – 470mg/l within the London Clay Formation (BH2/6.00m, BH3/10.00m & BH3 15.00m bgl).

The pH values were found to be 7.52 – 8.5 within the Head Deposits (BH1/2.00m, BH1/6.00m & BH4/2.00m bgl) and 7.58 – 8.00 within the London Clay Formation (BH2/6.00m, BH3/10.00m & BH3 15.00m bgl).

Sub-surface concrete for shallow foundations <2.00m bgl should be designed based on a sulphate Design Class of DS-1, according to BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’ and the total potential sulphate results for the natural ground. An ACEC classification of AC-1 should be used, according to the pH recorded within the samples tested.

Sub-surface concrete for a piled foundation solution should be designed based on a sulphate Design Class of DS-4, according to BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’ and the total potential sulphate results for the natural ground. An ACEC classification of AC-4 should be used, according to the pH recorded within the samples tested.

6.7 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.8 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

6.9 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust was generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.



NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

March 2020

Site Location Plan

Ref:

GWPR3514

Figure 1

ground&water



NOT TO SCALE

APPROXIMATE
SITE BOUNDARY

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

March 2020

Ref:

GWPR3514

Site Development Area

Figure 2

ground&water



NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

March 2020

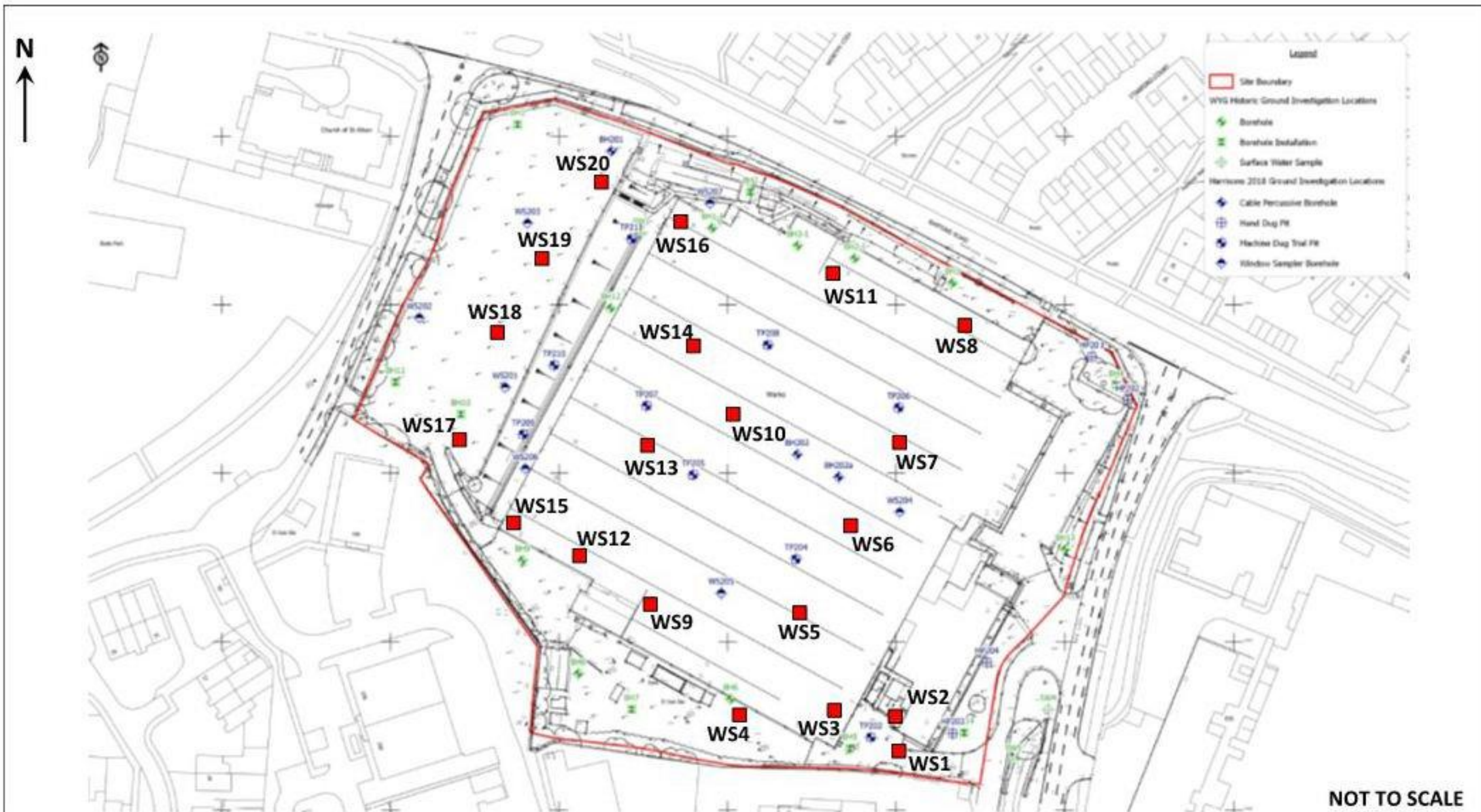
Ref:

GWPR3514

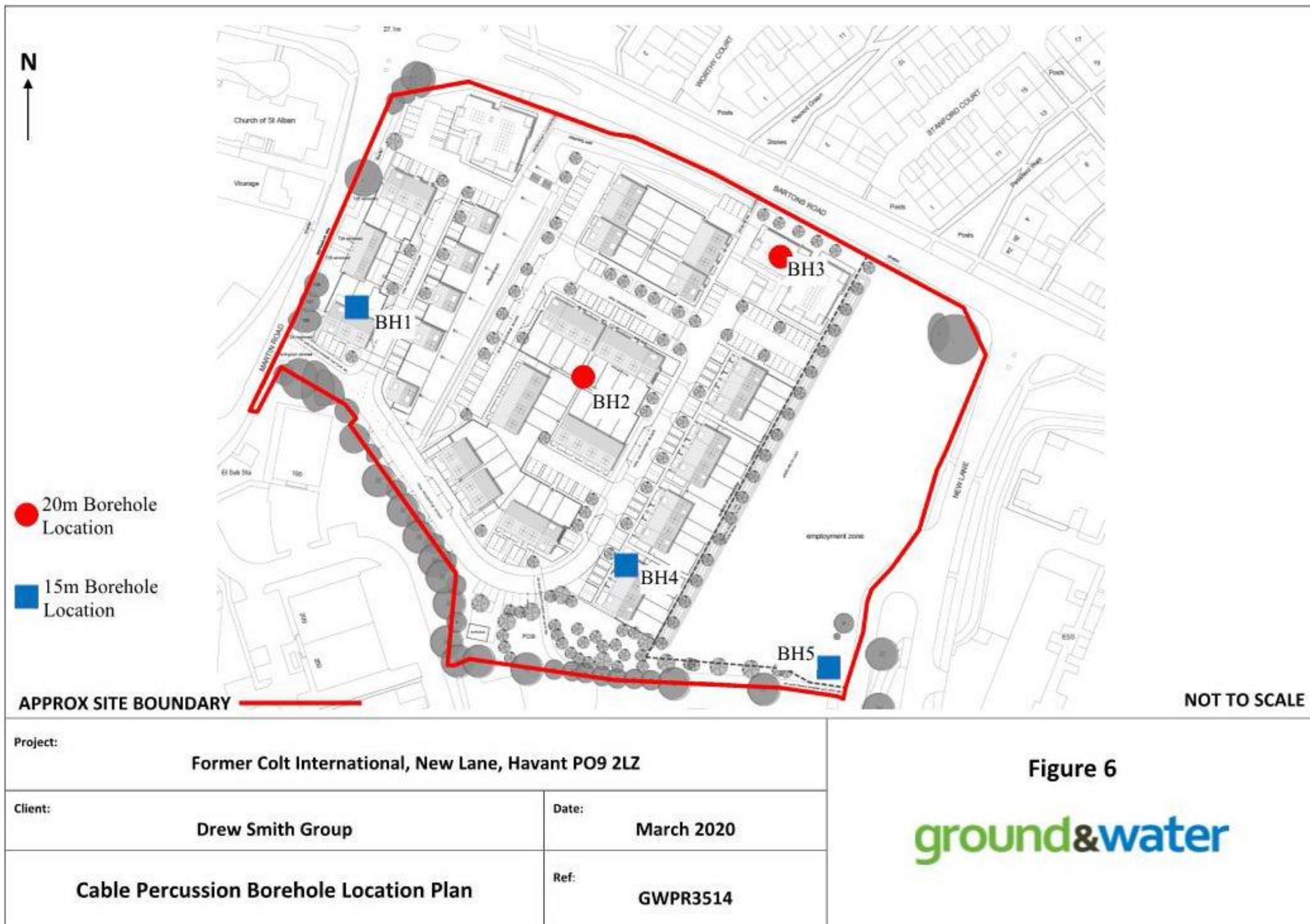
Aerial View of the Site

Figure 3

ground&water



Project:		Former Colt International, New Lane, Havant PO9 2LZ		Figure 5
Client:	Drew Smith Group	Date:	March 2020	
Trial Hole Location Plan – Phase 4		Ref:	GWPR3514	





Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

March 2020

Trial Pit Location Plan

Ref:

GWPR3514

Figure 7

ground&water



Extent of sand
identified
from site
investigation



APPROX SITE BOUNDARY

NOT TO SCALE

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

March 2020

Surface Geology Plan

Ref:

GWPR3514

Figure 8

ground&water

APPENDIX A

Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly, any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report ("you" or "the Recipient") are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to Former Colt International, New Lane, Havant PO9 2LZ.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

Only our client may rely on this report and should this report or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B

Fieldwork Logs

Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH1	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.20	D		0.40			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, slate, brick, flint, and concrete. Occasional fragments of metal, glass and plastic.	1	
		0.50	D							
		1.00	D							
		2.00	D	N=16 (2,2/2,4,4,6)	1.60			HEAD DEPOSITS: Orangish brown and brown gravelly silty CLAY. Gravel is fine to coarse, sub-angular to rounded, flint.	2	
		2.00	SPT							
		3.00	D							
		3.00	SPT							50 (10,12/50 for 250mm)
		4.00	D							
		4.00	SPT							N=33 (4,5/7,9,9,8)
		5.00	D							
		5.00	SPT							N=31 (4,6/7,8,8,8)
		6.00	D							
		6.50	SPT							N=32 (5,6/8,7,8,9)
		7.00	D							
		8.00	D							
8.00	SPT	N=29 (4,5/6,7,8,8)								
9.00	D									
9.50	SPT	N=30 (5,5/7,7,8,8)								
10.00	D						10			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks No roots noted. Groundwater was noted at 11.50m bgl one hour after drilling.										
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Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH1	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					10.70		LONDON CLAY FORMATION: Dark grey silty CLAY. Fine selenite throughout. Shell fragments from 12.00m bgl.		
		11.00 11.00	D SPT	N=31 (4,5/7,8,8,8)				11	
		12.00	D		12				
		12.50	SPT	N=33 (4,5/7,8,9,9)					
		13.00	D		13				
		14.00	D		14				
		14.50	SPT	N=38 (5,6/8,10,9,11)					
		15.00	D		15.00			15	
		End of Borehole at 15.000m							15
									16
									17
									18
									19
									20

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
No roots noted. Groundwater was noted at 11.50m bgl one hour after drilling.

Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 21/01/2020			
Location: New Lane, Havant PO9 2LZ				Contractor:							
Project No. : GWPR3514				Crew Name:				Drilling Equipment:			
Borehole Number BH2		Hole Type CP		Level		Logged By RJT		Scale 1:50		Page Number Sheet 1 of 2	

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20		MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, slate, brick, flint, and concrete.	1	
	0.50	D		0.50		MADE GROUND: Orangish brown and grey sandy gravelly clay. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (20%), concrete (20%), flint (60%).			
	1.00	D		0.80					
	1.50	SPT	N=24 (3,9/5,6,6,7)			HEAD DEPOSITS: Orangish brown slightly gravelly silty clayey SAND. Sand is fine to medium grained. Gravel is fine to coarse, sub-angular to rounded, flint.	2		
	2.00	D							
	2.50	SPT	N=31 (4,9/8,7,7,9)						
	3.00	D				HEAD DEPOSITS: Orangish brown slightly clayey silty SAND. Sand is fine to medium grained. Occasional fine to coarse, sub-rounded to rounded, flint.	3		
	3.50	SPT	N=30 (4,5/7,8,8,7)						
	4.00	D							
	4.50	SPT	N=22 (3,9/5,6,6,5)			LONDON CLAY FORMATION: Orangish brown and grey silty sandy CLAY. Sand is fine to medium grained.	4		
	5.00	D		5.00					
	6.00	D							
	6.00	SPT	N=24 (3,4/5,6,6,7)		6.00	LONDON CLAY FORMATION: Dark grey silty CLAY. Fine selenite noted. Small shell fragments from 8.00m bgl.	5		
	7.00	D							
	7.50	SPT	N=25 (3,5/5,6,7,7)						
	8.00	D				LONDON CLAY FORMATION: Dark grey silty CLAY. Fine selenite noted. Small shell fragments from 8.00m bgl.	6		
9.00	D								
9.00	SPT	N=28 (4,6/6,7,7,8)							
10.00	D						7		
								8	
								9	
								10	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No roots noted. Groundwater seepage at 8.00m bgl.

Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH2	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 2 of 2

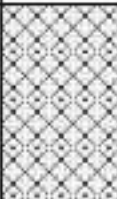
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		10.50	SPT	N=30 (9,5/7,7,8,8)						
		11.00	D							11
		12.00	D							12
		12.00	SPT	N=37 (5,5/8,9,9,11)						
		13.00	D							13
		13.50	SPT	N=37 (13 for 27mm/7,9,10,11)						
		14.00	D							14
		15.00	D							15
		15.00	SPT	N=48 (7,8/10,11,13,14)						
		16.00	D							16
		16.50	SPT	N=50 (8,9/50 for 267mm)						
		17.00	D							17
		18.00	D							18
		18.00	SPT	N=50 (7,9/50 for 251mm)						
		19.00	D							19
		19.50	SPT	N=50 (9,8/50 for 254mm)						
		20.00	D							20
							End of Borehole at 20.000m			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
No roots noted. Groundwater seepage at 8.00m bgl.

Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH3	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.20	D	N=9 (2,1/2,2,3,2)	1.00			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, slate, brick, flint, and concrete.	1	
		0.50	D							
		1.00	D							
		1.20	SPT							
		2.00	D	N=7 (2,2/1,2,2,2)	3.00			HEAD DEPOSITS: Brown to orangish brown and grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to rounded, flint.	2	
		2.00	SPT							
		3.00	D							
		3.00	SPT							
		3.00	D	N=11 (2,3/3,2,3,3)		LONDON CLAY FORMATION: Dark grey slightly sandy silty CLAY. Sand is fine grained. Selenite noted from 3.00m bgl. Shell fragments noted from 9.00m bgl.	3			
		4.00	SPT							
		4.00	D							
		4.00	SPT							
		5.00	D	N=12 (3,3/2,3,4,3)						4
		5.00	SPT							
		6.00	D							
		6.00	SPT							
5.00	D	N=14 (3,4/3,3,4,4)						5		
5.00	SPT									
6.00	D									
6.00	SPT									
6.00	D	N=14 (3,3/4,3,3,4)				6				
6.50	SPT									
7.00	D									
7.00	SPT									
8.00	D	N=18 (4,3/5,4,4,5)				7				
8.00	SPT									
9.00	D									
9.00	SPT									
9.00	D	N=21 (4,5/6,5,5,5)				8				
9.50	SPT									
10.00	D									
10.00	SPT									
									9	
									10	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks No roots noted. No groundwater encountered.										
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Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH3	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		11.00 11.00	D SPT	N=29 (5,6/7,7,8,7)					11
		12.00	D						12
		12.50	SPT	N=28 (7,8/7,6,7,8)					
		13.00	D						13
		14.00 14.00	D SPT	N=44 (10,10/10,12,10,12)					14
		15.00	D						15
		15.50	SPT	N=46 (10,10/11,11,12,12)					
		16.00	D						16
		17.00 17.00	D SPT	N=48 (10,12/12,11,12,13)					17
		18.00 18.00	D SPT	82 (10,15/82 for 225mm)					18
					18.45			End of Borehole at 18.450m	19
									20

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
No roots noted. No groundwater encountered.

Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH4	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 1 of 2

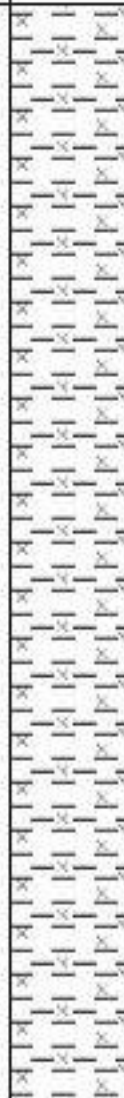
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		1.00	D		1.00			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, slate, brick, flint, and concrete. Occasional fragments of metal, glass and plastic.	1
		1.20	SPT	N=8 (2,3/2,2,2,2)				HEAD DEPOSITS: Orangish brown sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-rounded, flint and claystone.	
		2.00	D		2.00			LONDON CLAY FORMATION: Greenish grey sandy CLAY. Sand is fine to medium grained.	2
		2.00	SPT	N=9 (2,1/2,3,2,2)					
		3.00	D						3
		3.00	SPT	N=12 (3,3/4,3,2,3)					
		4.00	D						4
		4.00	SPT	N=14 (3,4/3,4,4,3)					
		5.00	D		5.00			LONDON CLAY FORMATION: Orangish brown and grey silty sandy CLAY. Sand is fine to medium grained.	5
		5.00	SPT	N=14 (4,3/3,4,3,4)					
		6.00	D		6.00			LONDON CLAY FORMATION: Dark grey silty CLAY. Small shell fragments from 9.00m bgl and fine selenite crystals from 10.00m bgl.	6
		6.50	SPT	N=17 (4,4/4,4,4,5)					
		7.00	D						7
		8.00	D						8
		8.00	SPT	N=18 (5,4/4,5,4,5)					
		9.00	D						9
		9.50	SPT	N=22 (5,6/5,5,5,7)					
		10.00	D						10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks No roots noted. Groundwater encountered at 12.50m, 13.20m and 13.80m bgl.										
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Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH4	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description					
		Depth (m)	Type	Results									
		11.00 11.00	D SPT	N=28 (7,8/7,7,6,8)	15.45				11				
		12.00	D						12				
		12.50	SPT	N=39 (8,8/10,8,10,11)					13				
		13.00	D						14				
		14.00 14.00	D SPT	N=45 (10,11/11,12,10,12)					15				
		15.00 15.00	D SPT	N=50 (10,12/50 for 285mm)					16				
		End of Borehole at 15.450m							17				
									18				
									19				
									20				

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
No roots noted. Groundwater encountered at 12.50m, 13.20m and 13.80m bgl.

Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH5	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 1 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20			0.20			TOPSOIL: (Drillers Description).	
		1.00	D		1.00			MADE GROUND: Orangish brown and grey sandy gravelly clay. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-rounded, glass (1%), brick (19%) and flint (80%).	1
		1.20	SPT	N=9 (2,1/2,3,2,2)					
		2.00	D					HEAD DEPOSITS: Orangish brown and grey sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to rounded, flint. Notably soft at 3.00m bgl.	2
		2.00	SPT	N=11 (2,3/3,2,3,3)					
		3.00	D						3
		3.00	SPT	N=11 (3,4/3,3,2,3)					
		4.00	D						4
		4.00	SPT	N=15 (3,3/4,4,4,3)					
		4.50			4.50			LONDON CLAY FORMATION: Dark grey silty CLAY. Very fine selenite crystals from 5.00m bgl.	5
		5.00	D						6
		5.00	SPT	N=15 (3,4/3,4,4,4)					
		6.00	D						7
		6.50	SPT	N=17 (4,5/4,5,4,4)					
		7.00	D						8
		8.00	D						9
		8.00	SPT	N=15 (4,5/4,4,3,4)					
		9.00	D						10
		9.50	SPT	N=23 (4,4/5,6,5,7)					
		10.00	D						

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks No roots noted. Groundwater encountered at 3.00m bgl.										
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Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 21/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Drilling Equipment:	
Borehole Number BH5	Hole Type CP	Level	Logged By RJT	Scale 1:50	Page Number Sheet 2 of 2

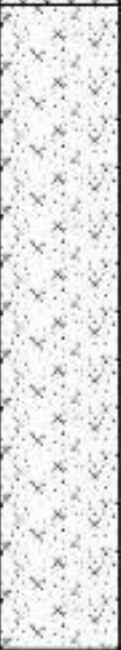
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description						
		Depth (m)	Type	Results										
		11.00 11.00	D SPT	N=29 (5,5/6,7,8,8)	15.45				11					
		12.00	D						12					
		12.50	SPT	N=30 (5,6/7,7,8,8)										
		13.00	D						13					
		14.00 14.00	D SPT	N=45 (8,10/10,10,12,13)					14					
		15.00	D						15					
		End of Borehole at 15.450m								16				
										17				
										18				
										19				
								20						

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
No roots noted. Groundwater encountered at 3.00m bgl.

Trial Pit Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 29/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Equipment:	
Location Number TP1	Location Type TP	Level	Logged By RJT	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.40			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, slate (5%), brick (20%), flint (25%), and concrete (40%). Occasional fragments of metal, glass and plastic.	1
					0.90			MADE GROUND: Light brownish grey silty sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to rounded, concrete (20%), brick (20%) and flint (60%).	
					2.50			HEAD DEPOSITS: Orange and grey silty sand. Sand is fine to medium grained. Becomes silty at 2.00m bgl	
								End of Borehole at 2.500m	2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks No roots noted. Perched water encountered at 0.80m bgl.							
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Trial Pit Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 29/01/2020			
Location: New Lane, Havant PO9 2LZ			Contractor:						
Project No. : GWPR3514			Crew Name:			Equipment:			
Location Number TP2		Location Type TP		Level		Logged By RJT		Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.50			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (25%), flint (25%), and concrete (50%). Occasional fragments of metal, glass and plastic.	1
					0.70			MADE GROUND: Yellow slightly gravelly sand. Sand is fine to medium grained. Gravel is fine to medium, angular to sub-angular, flint.	
								HEAD DEPOSITS: Orange and grey SAND. Sand is fine to medium grained.	
					2.10			End of Borehole at 2.100m	2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks						
No roots were noted. No Groundwater was encountered.						



Trial Pit Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 29/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Equipment:	
Location Number TP3	Location Type TP	Level	Logged By RJT	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.35			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, tile (5%), brick (20%), flint (25%), and concrete (40%). Occasional fragments of metal, glass and plastic.	1
					2.50			HEAD DEPOSITS: Orangish brown and grey SAND. Sand is fine to medium grained.	2
								End of Borehole at 2.500m	3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks No roots were noted. No Groundwater was encountered.							
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Trial Pit Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 29/01/2020			
Location: New Lane, Havant PO9 2LZ			Contractor:						
Project No. : GWPR3514			Crew Name:			Equipment:			
Location Number TP4		Location Type TP		Level		Logged By RJT		Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.50			MADE GROUND: Greyish brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, slate (5%), tile (5%), brick (20%), flint (20%), and concrete (40%). Occasional fragments of metal, glass and plastic.	1
					0.70			MADE GROUND: Yellow gravelly sand. Sand is fine to medium grained. Gravel is fine to medium, angular to sub-angular, flint.	
					2.50			HEAD DEPOSITS: Orangish brown and grey SAND. Sand is fine to medium grained.	
							End of Borehole at 2.500m		3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks						
No roots were noted. Minor groundwater seepage at 2.40m bgl.						

Trial Pit Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 29/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Equipment:	
Location Number TP5	Location Type TP	Level	Logged By RJT	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.60			MADE GROUND: Pinkish grey sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (25%), flint (25%), and concrete (50%). Occasional fragments of metal, glass and plastic.	1
					1.50			HEAD DEPOSITS: Orangish brown and grey SAND. Sand is fine to medium grained.	
								End of Borehole at 1.500m	2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks No roots noted. Perched water from historic soakaway encountered at 1.00m bgl.							
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Trial Pit Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 29/01/2020			
Location: New Lane, Havant PO9 2LZ			Contractor:						
Project No. : GWPR3514			Crew Name:			Equipment:			
Location Number TP6		Location Type TP		Level		Logged By RJT		Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.50		 MADE GROUND: Greyish brown clayey slightly sandy cobbly gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (30%), flint (20%), and concrete (50%). Cobble was sub-angular to sub-round, brick and concrete. Occasional clay lenses and fragments of metal, glass and plastic.	1	
					2.00		 HEAD DEPOSITS: Orangish brown and redish orange silty SAND. Sand is fine to medium grained.		
							End of Borehole at 2.000m	2	
								3	
								4	
								5	

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks No roots noted. No groundwater encountered.							
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Trial Pit Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 29/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Equipment:	
Location Number TP7	Location Type TP	Level	Logged By RJT	Scale 1:25	Page Number Sheet 1 of 1

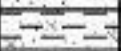
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.40			MADE GROUND: Light brownish grey sandy cobbly gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (30%), flint (25%), and concrete (45%). Cobble sub-angular to sub-rounded brick and concrete. Occasional fragments of metal, glass and plastic.	
					0.55			MADE GROUND: Yellow gravelly sand. Sand is fine to coarse grained. Gravel is fine to medium, angular to sub-rounded flint.	
								HEAD DEPOSITS: Orangish brown and greyish brown SAND. Sand is fine to medium grained.	
					2.10			End of Borehole at 2.100m	

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks No roots noted. No groundwater encountered.							
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Trial Pit Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 29/01/2020	
Location: New Lane, Havant PO9 2LZ		Contractor:			
Project No. : GWPR3514		Crew Name:		Equipment:	
Location Number TP8	Location Type TP	Level	Logged By RJT	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.50			MADE GROUND: Light brownish grey sandy cobbley gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (30%), flint (25%), and concrete (45%). Cobble sub-angular to sub-rounded brick and concrete. Occasional fragments of metal, glass and plastic.	1
					1.20			MADE GROUND: Light brown and off white sandy gravelly clay. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to rounded, chalk (20%) and flint (80%).	
					2.10			HEAD DEPOSITS: Orangish brown and grey clayey SAND.	2
					2.20			HEAD DEPOSITS: Orangish brown and grey silty sandy CLAY. Sand is fine to medium grained. End of Borehole at 2.200m	
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks No roots noted. Minor perched water seepage at 1.00 - 1.20m bgl.							
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Trial Pit Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 29/01/2002			
Location: New Lane, Havant PO9 2LZ			Contractor:						
Project No. : GWPR3514			Crew Name:			Equipment:			
Location Number TP9		Location Type TP		Level		Logged By RJT		Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.70			MADE GROUND: Light brownish grey sandy cobbly gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (30%), flint (25%), and concrete (45%). Cobble sub-angular to sub-rounded brick and concrete. Occasional fragments of metal, glass and plastic.	1
					0.85			MADE GROUND: Off white and greenish grey sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, brick (10%), flint (20%) and chalk (70%).	
					1.50			HEAD DEPOSITS: Greenish grey and blueish grey slightly sandy slightly cobbly gravelly CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to rounded, flint. Occasional sub-angular to rounded cobble of flint.	
					1.80			HEAD DEPOSITS: Orangish brown and greenish grey gravelly CLAY. Gravel is fine to coarse, angular to sub-angular, flint.	
							End of Borehole at 1.800m		2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks						
No roots noted. No groundwater encountered.						



APPENDIX C
Geotechnical Laboratory Test Results



Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No. 27852	Project Name Former Colt International, New Lane, Havant PO9 2LZ	Programme	
		Samples received	07/02/2020
Project No. GWPR3514	Client Ground & Water Ltd	Schedule received	05/02/2020
		Project started	07/02/2020
		Testing Started	26/02/2020

Hole No.	Sample				Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
	Ref	Top m	Base m	Type							
BH1	-	13.00	-	D	Dark grey slightly fine sandy silty CLAY	34	100	48	18	30	
BH2	-	9.00	-	D	Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and sub-angular)	25	96	47	19	28	
BH2	-	20.00	-	D	Dark grey slightly gravelly fine sandy silty CLAY (gravel is fm and sub-angular)	27	97	41	18	23	
BH3	-	6.00	-	D	Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and sub-angular)	27	89	52	20	32	
BH3	-	18.00	-	D	Dark grey slightly fine sandy silty CLAY	26	100	57	22	35	
BH4	-	4.00	-	D	Light brown slightly gravelly fine sandy silty CLAY (gravel is fm and sub-angular)	25	85	36	21	15	
BH4	-	15.00	-	D	Dark grey slightly gravelly slightly fine sandy silty CLAY (gravel is fm and sub-angular)	26	98	58	21	37	
BH5	-	3.00	-	D	Brown slightly fine sandy gravelly silty CLAY (gravel is fmc and rounded to sub-angular)	31	61	55	19	36	
BH5	-	12.00	-	D	Dark grey silty CLAY	30	100	55	21	34	

 UKAS TESTING	Test Methods: BS1377: Part 2: 1990; Natural Moisture Content : clause 3.2 Atterberg Limits: clause 4.3 and 5.0	Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Tel: 01923 711 288 Email: James@k4soils.com	Checked and Approved Initials J.P Date: 27/02/2020
	2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)		MSF-5-R1(b)

		Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results Tested in accordance with BS1377 : Part 3 : 2018, Clause 7.6 & Clause 12							
Job No. 27852		Project Name Former Colt International, New Lane, Havant PO9 2LZ						Programme Samples received 07/02/2020 Schedule received 05/02/2020 Project started 07/02/2020 Testing Started 21/02/2020	
Project No. GWPR3514		Client Ground & Water Ltd							
Hole No.	Ref	Top m	Base m	Type	Soil description	Dry Mass passing 2mm %	SO4 Content mg/l	pH	Remarks
BH1	-	6.00	-	D	Yellowish brown silty SAND	100	230	7.52	
BH2	-	6.00	-	D	Dark grey slightly fine sandy silty CLAY	100	330	7.63	
BH3	-	15.00	-	D	Dark grey slightly fine sandy silty CLAY	100	470	7.58	
						Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Tel: 01923 711 288 Email: James@k4soils.com			Checked and Approved Initials J.P Date: 27/02/2020
2519		Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)						MSF-5-R29	



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DETS Report No: 20-01566

Site Reference: Former Colt International, New Lane, Havant PO9 2LZ

Project / Job Ref: GWPR3514

Order No: None Supplied

Sample Receipt Date: 07/02/2020

Sample Scheduled Date: 07/02/2020

Report Issue Number: 1

Reporting Date: 13/02/2020

Authorised by:



Dave Ashworth
Technical Manager

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Soil Analysis Certificate						
DETS Report No: 20-01566	Date Sampled	21/01/20	21/01/20	21/01/20		
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Former Colt International, New Lane, Havant PO9 2LZ	TP / BH No	BH1	BH3	BH4		
Project / Job Ref: GWPR3514	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	2.00	10.00	2.00		
Reporting Date: 13/02/2020	DETS Sample No	461511	461512	461513		

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/a	MCERTS	8.5	8.0	7.9	
Total Sulphate as SO ₄	mg/kg	< 200	NONE	672	640	< 200	
Total Sulphate as SO ₄	%	< 0.02	NONE	0.07	0.06	< 0.02	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	199	104	14	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.20	0.10	0.01	
Total Sulphur	%	< 0.02	NONE	0.03	0.48	< 0.02	
Ammonium as NH ₄	mg/kg	< 0.5	NONE	< 0.5	< 0.5	< 0.5	
Ammonium as NH ₄	mg/l	< 0.05	NONE	< 0.05	< 0.05	< 0.05	
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	33	12	10	
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	16.6	5.8	5	
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	< 3	< 3	< 3	
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	< 1.5	< 1.5	< 1.5	
W/S Magnesium	mg/l	< 0.1	NONE	4.9	7.5	3.5	

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

Subcontracted analysis (S)



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-01566

Ground & Water Ltd

Site Reference: Former Colt International, New Lane, Havant PO9 2LZ

Project / Job Ref: GWPR3514

Order No: None Supplied

Reporting Date: 13/02/2020

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
\$ 461511	BH1	None Supplied	2.00	16.6	Brown sandy clay
\$ 461512	BH3	None Supplied	10.00	18.9	Brown loamy clay
\$ 461513	BH4	None Supplied	2.00	18.2	Light grey sandy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{IS}

Unsuitable Sample ^{US}

\$ samples exceeded recommended holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-01566

Ground & Water Ltd

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Project / Job Ref: GWPR3514

Order No: None Supplied

Reporting Date: 13/02/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diethylenecarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received