



CONTAMINATION ASSESSMENT REPORT

for the site at

FORMER COLT INTERNATIONAL, NEW LANE, HAVANT PO9 2LZ

on behalf of

DREW SMITH GROUP

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1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Drew Smith Group on the 11th June 2019 to undertake a Contamination Assessment on a potential redevelopment site at Former Colt International, New Lane, Havant PO9 2LZ. The scope of the investigation was detailed within the Ground and Water Limited quotation GWQ4719, dated 11th June 2019.

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 redevelopment.

The results of the chemical laboratory testing undertaken on soil samples recovered from the site were evaluated to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified, as detailed in the Conceptual Site Model (CSM) developed within the WYG Phase 1 Ground Investigation and Assessment Report, Ref: A090070-182, dated June 2017, and the Campbell Reith Updated GQRA and Outline Remediation Strategy Report, Ref: 12663, dated May 2019. This contamination assessment report must be read in conjunction with these reports.

1.3 Conditions and Limitations

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

This report relies upon the WYG Phase 1 Ground Investigation and Assessment Report, Ref: A090070-182, dated June 2017, and the Campbell Reith Updated GQRA and Outline Remediation Strategy Report, Ref: 12663, dated May 2019. Total reliance has been placed on these reports and no liability can be taken for their shortcomings.

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, November 2019, 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 1c (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.

The WYG Desk Based Assessment identified potential on-site sources of contamination which are summarised as follows:

- Former cylindrical diesel AST (circa 10,000 gallons) situated south of the main factory building.
- Double skinned plastic AST (circa 1000 litres capacity) for storage of 'fuel oil' adjacent to the Fire Testing facility.
- Ancillary facilities associated with unknown activities external north west of the factory building.
- Fuel supply (including above ground pipelines) providing fuel to heaters within the building.
- Made Ground.

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.

Contamination testing on soils and groundwater as well as ground-gas monitoring was undertaken following the ground investigation, and revealed the following:

- Minor elevations of methane and carbon dioxide (0.9 and 2.5% respectively) were recorded during gas monitoring.
- Target Screen Values (TSVs) were exceeded samples of soil for residential end use with home-grown produce, mainly in samples of Made Ground.
- Minor quantities of asbestos fibres were detected in three samples of Made Ground.
- Minor exceedances of Environmental Quality Standards (EQS) and Drinking Water Standards (DWS) of groundwater and leachate samples were also recorded.

From the desk-based and intrusive investigations undertaken at the site, a number of contamination sources and potential contamination sources have been identified. These have been tabulated into a Conceptual Site Model as seen below:

Tabulated Conceptual Site Model – Plausible Pollutant Linkages Only		
Potential On-site Sources	Potential Absorption Pathways	Potential Receptors
Large former diesel AST (~10,000 gallons) situated south of the main factory building, & small double-skinned plastic AST (~1000 litres) for storage of 'fuel oil' situated on a plinth (not bunded) adjacent to the Fire Testing facility in the south of the site: • Total Petroleum Hydrocarbons (TPHs); • Poly-cyclic Aromatic Hydrocarbons (PAHs). Features of factory buildings, including oil-burning heaters and above-ground fuel pipes and the presence of an 'air pollution test facility': • Heavy Metals and Semi-Metals including: Arsenic, Cadmium, Chromium, Lead, Copper, Zinc, Beryllium, Mercury etc; • Poly-cyclic Aromatic Hydrocarbons (PAHs); • Total Petroleum Hydrocarbons (TPHs); • Asbestos (building materials). Electricity Sub-station present in south of site: • PCB Oils.	Leaching of onsite sources of contamination. Lateral and vertical migration of gases/vapours. Overland surface water runoff. Contaminant migration through preferential pathways (e.g. piles, underground service ducts, and drains). Contaminant transport through off site migration of groundwater. Atmospheric transport and inhalation of airborne dusts, vapours and fibres (indoors and outdoors). Direct contact (dermal contact and ingestion) with soil, dust and water. Inhalation of vapours arising from soil contamination.	Future site users (users/ occupants of future commercial/ residential premises). Construction workers during future development works. Groundwater (Head Deposits, Thanet Sand Formation, White Chalk; Aquifers, SPZ). Surface waters (River Lavant). On-site buildings and services. Offsite workers and residents.

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.

Based on contamination testing results from both the WYG and Campbell Reith investigations, the following Contamination Risk Summary was derived:

- End Users: A High risk has been identified associated with concentrations of lead, polycyclic aromatic hydrocarbons and asbestos in shallow soils.
- Groundwater: A Very Low risk has been identified due to the London Clay Formation acting as an aquitard preventing shallow groundwater affecting the aquifer at depth. Should piling be proposed, a piling risk assessment should be conducted.
- Surface Water: A Low to Moderate risk has been identified due to identified hydrocarbon contamination in shallow soils in the south east of the site. Although no impact to the nearby river has been identified to date.
- Ground Gas: The site has been classified as a CIRIA Characteristic Situation 1 (CS1), however elevated concentrations of methane and carbon dioxide require local consideration of increasing to Characteristic Situation 2.
- Services: Made Ground has hydrocarbon contamination which should be assessed for the potential requirement for protective water supply pipework.
- Groundworks: A Low to moderate risk has been identified based on the assumption that basic health and safety provisions are in place. Additional assessments with regard to asbestos in soils may be required.

This risk summary was **not** thought to significantly change the Conceptual Site Model tabulated based on the results of the WYG investigation. Based on this investigation the following outline remediation strategy was derived:

- Human health exposure: a cover system is recommended in order to mitigate the potential risks to end users from shallow soils. The depth and validation criteria should be determined with regard to the detailed layout when available. This should be submitted to and approved by the Local Planning Authority.
- Surface water risk: Although it has been shown that no discernible effect on the River Lavant, it is considered that there is a theoretical risk to surface waters from the odorous soils in the location of TP 202. It is recommended that localised source removal is conducted in the location of TP 202 and groundwater monitoring wells are installed between TP 202 and the River Lavant. The requirements of the monitoring should be agreed with the Local Planning Authority.
- Unforeseen Contamination: A watching brief for unforeseen contamination during slab removal is recommended. This is recommended to be conducted on a grid basis, where inspections should be made and evidence of unforeseen contamination should be investigated and remediated as required.

3.0 RESULTS OF PHASE 4 RISK ASSESSMENT

This section of the report details the results of a fourth phase of intrusive works and risk assessment undertaken by Ground and Water Limited.

For the purposes of contamination testing, in order to increase sampling density and improve accuracy the data from the Phase 2 WYG and Phase 3 Campbell Reith investigation was combined with that from the Phase 4 Ground and Water Limited investigation.

3.1 Fieldwork Undertaken

Fieldwork was undertaken on the 29th – 30th August and 2nd September 2019, and comprised the construction of 20No. Windowless Sampler Boreholes (WS1 – WS20) to a depth of between 1.80 – 3.00m bgl. The trial hole logs are given within Appendix B with a trial hole location plan provided within Figure 5.

3.2 Sampling Procedures

The methodology for sampling locations can be seen tabulated below and overpage, this includes our interpretation of the WYG and Campbell Reith locations. 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		Concrete pad for former factory building.	
WS3	3.00		Concrete hardstanding adjacent to Electricity Sub-station.	
WS4	2.45		Concrete pad for former factory building.	Residential housing and associated garden areas.
WS5	1.80			
WS6	2.45			Residential flats and associated car parking.
WS7	2.45			
WS8	2.45			Residential housing and associated garden areas.
WS9	2.45			
WS10	2.45			Residential flats and associated car parking.
WS11	2.00			
WS12	2.45			Residential housing and associated garden areas.
WS13	2.45			
WS14	2.00			Residential flats and associated car parking.
WS15	2.00			
WS16	2.45		Tarmac car parking area.	Residential housing and associated garden areas.
WS17	2.45			
WS18	2.45			
WS19	2.45			
WS20	2.45			

Methodology for Sampling Locations and Chemical Laboratory Testing (WYG/Campbell Reith)				
Trial Hole	Depth (m bgl)	Sampling Strategy	Site Use (Existing)	Site Use (Proposed)
BH1	4.00	Random sampling strategy (assumed)	Tarmac car parking area.	Residential housing and associated garden areas.
BH2	3.50		Concrete hardstanding area to north of factory building.	Residential flats and associated car parking.
BH3	4.00			
BH4	5.00		Soft landscaping area adjacent to car park.	Soft landscaping adjacent to commercial units.
BH5	2.70		Tarmac car parking area south of offices.	Commercial units and associated access roads/car parking.
BH6	1.80		Hardstanding area surrounding Electricity Sub-station, south of factory building.	Residential housing and associated garden areas.
BH7	4.00			
BH8	0.80		Tarmac car parking area.	Soft landscaping adjacent to residential housing.
BH9	3.00			
BH10	0.30		Soft landscaping west of factory building.	Soft landscaping adjacent to commercial units.
BH11	3.00			
BH12	3.00		Soft landscaping along eastern boundary of site, adjacent to offices and associated parking.	Commercial units and associated access roads/car parking.
BH13	1.50			
BH14	4.00		Concrete pad inside factory building.	Residential flats and associated car parking.
BH1-I	3.00			
BH2-I	4.00			
BH3-I	3.00			
BH201	17.50	Targeted sampling strategy	Tarmac car parking area.	Residential housing and associated garden areas.
BH202	0.30		Concrete pad for former factory building.	
BH202a	12.50			
WS201	0.50		Tarmac car parking area.	
WS202	2.90			
WS203	5.45		Concrete pad for former factory building.	Soft landscaping adjacent to residential housing.
WS204	4.00			
WS205	2.90		Soft landscaping west of former factory building.	Residential flats and associated car parking.
WS206	2.45			
WS207	0.50		Concrete hardstanding area to north of factory building.	Commercial units and associated access roads.
TP202	2.50			
TP204	3.10		Concrete pad for former factory building.	Residential housing and associated garden areas.
TP205	2.20			
TP206	3.00		Soft landscaping west of former factory building.	Soft landscaping adjacent to residential housing.
TP207	1.10			
TP208	2.70		Soft landscaping area adjacent to car park.	Soft landscaping adjacent to commercial units.
TP209	2.50			
TP210	1.90		Soft landscaping along eastern boundary of site, adjacent to offices and associated parking.	Commercial units and associated access roads.
TP211	2.00			
HP201	0.40			
HP202	0.60			
HP203	1.00			
HP204	0.80			

The area of the site totals ~31,100m² (3.10 Hectares) and with 20No. Ground and Water Limited sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 2,332.50m² and a radius of approximately 27.25m would be encountered (CLR 4, 1994).

Including the WYG and Campbell Reith data, a total of 60 sampling locations have been provided. Given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 777.50m² and a radius of approximately 15.73m would be encountered (CLR 4, 1994).

This overall sampling density was deemed to be suitable for this site.

Sampling depths were chosen to reflect the receptor of concern, human health and typically comprised a surface or near surface sample and at approximately 0.5m depth increments thereafter, extending into the underlying natural soils.

The human health receptors relevant to the sampling depths were as follows:

Near surface samples	Direct ingestion, dermal contact and dust inhalation. Protection of end-users and maintenance workers e.g. Landscape Gardeners. Protection of shallow rooted plants Perched Water/Surface Water Run-off
>0.5m below ground level	Protection of deep rooted plants Perched Water/Surface Water Run-off

3.3 Soil Conditions

All Phase 4 trial holes were logged by Emily Murray and Aubyn Shortland 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 trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A capping of Made Ground was noted to overlie soils of the superficial Head Deposits over the London Clay Formation.

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 WS6.

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.

For details of the composition of the Made Ground, Head Deposits or London Clay Formation at particular points, reference must be made to the individual trial hole logs within Appendix B.

3.4 Roots Encountered

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

3.5 Groundwater Conditions

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 overpage:

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

4.0 PHASE 4 CONTAMINATION RISK ASSESSMENT

4.1 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by DETS Limited, was undertaken on twenty-five soil samples recovered from the trial holes.

Twenty-five soil samples were sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies.

The samples tested and the reasons for testing can be seen tabulated below.

Methodology for Sampling Locations and Chemical Laboratory Testing		
Trial Hole	Depth (m bgl)	Sampling Strategy
WS1	0.30	Samples of Made Ground surrounding the contamination hotspot 'TP202'.
WS1	2.00	
WS2	0.50	
WS3	2.00	
WS4	1.50	Sample of Made Ground from concrete hardstanding area to the south of site.
WS5	1.50	Representative samples of Made Ground beneath concrete slab of former Factory/Warehouse building.
WS6	0.50	
WS7	0.50	
WS8	0.30	
WS9	0.50	
WS11	0.80	
WS13	0.50	
WS14	0.50	
WS15	1.00	
WS16	0.50	
WS16	0.80	
WS16	1.00	
WS17	0.30	Representative samples of Made Ground from beneath tarmac parking area to the north-west of site.
WS17	0.50	
WS18	0.30	
WS18	1.00	
WS19	0.30	
WS19	0.80	
WS19	1.00	
WS20	0.30	

The analysis suite for the Ground and Water Limited Phase of Investigation is presented below and overpage, and comprised:

- Semi Metals and Heavy Metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc (WS1/2.00m, WS3/2.00m, WS16/0.50m, WS16/0.80m, WS17/0.50m bgl);
- Lead (WS1/0.30m, WS1/2.00m, WS2/0.50m, WS3/2.00m, WS4/1.50m, WS5/1.50m, WS6/0.50m, WS7/0.50m, WS8/0.30m, WS9/0.50m, WS11/0.80m, WS13/0.50m, WS14/0.50m, WS15/1.00m, WS16/0.50m, WS16/0.80m, WS16/1.00m, WS17/0.30m, WS17/0.50m, WS18/0.30m, WS18/1.00m, WS19/0.30m, WS19/0.80m, WS19/1.00m, WS20/0.30m bgl);

- Asbestos Screen (WS1/0.30m, WS1/2.00m, WS2/0.50m, WS3/2.00m, WS4/1.50m, WS5/1.50m, WS6/0.50m, WS7/0.50m, WS8/0.30m, WS9/0.50m, WS11/0.80m, WS13/0.50m, WS14/0.50m, WS15/1.00m, WS16/0.50m, WS16/0.80m, WS16/1.00m, WS17/0.30m, WS17/0.50m, WS18/0.30m, WS18/1.00m, WS19/0.30m, WS19/0.80m, WS19/1.00m, WS20/0.30m bgl);
- Polycyclic Aromatic Hydrocarbons (PAH's) incl. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene, Benzo(ghi)perylene (WS1/0.30m, WS1/2.00m, WS2/0.50m, WS4/1.50m, WS5/1.50m, WS6/0.50m, WS7/0.50m, WS8/0.30m, WS9/0.50m, WS11/0.80m, WS13/0.50m, WS14/0.50m, WS15/1.00m, WS16/1.00m, WS17/0.30m, WS17/0.50m, WS18/0.30m, WS18/1.00m, WS19/0.30m, WS19/0.80m, WS19/1.00m, WS20/0.30m bgl);
- Fuel Oils – Speciated TPH including full aliphatic/aromatic split (WS3/2.00m, WS16/0.50m, WS16/0.80m bgl);
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs) (WS3/2.00m, WS16/0.50m, WS16/0.80m bgl).

The chemical laboratory results are presented in Appendix C.

4.1.1 Soil Assessment Criteria

The derivation of Soil Assessment Criteria used within this report can be seen within Appendix D.

4.1.2 Determination of Representative Contamination Concentrations

At the time of reporting, November 2019, 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.

Therefore, the results of the chemical laboratory testing from Phase 4 of intrusive works were compared to the LQM/CIEH Suitable 4 Use Levels (S4UL) for a ***“Residential with home-grown produce”*** land-use scenario for the majority of site, with a ***“Commercial”*** land-use scenario for the eastern portion, as these were considered the most appropriate land-use scenarios for the proposed development.

It should be noted that the initial WYG and CampbellReith testing compared all samples to a ***“Residential with home-grown produce”*** land-use scenario. Some exceedances have therefore been omitted within this report, where locations were known to be within the commercial area of the proposed development and levels did not exceed that of a ***“Commercial”*** land-use scenario.

Where no LQM/CIEH S4UL/C4SL LLTC was available for a particular determinant then preliminary reference was made to the laboratory detection limit of the determinant. If a positive concentration was noted then further risk assessment was undertaken.

For Cyanide, where no LQM/CIEH S4UL/GAC/C4SL LLTC was available a Site Specific Assessment Criteria of 10mg/kg was adopted. This is based on ICRCL 59/83, TCL, ATRISK (SOIL) Screening Value and Dutch Intervention Value (ranging from 20 – 34mg/kg).

Therefore, a SSAC of ~10mg/kg is considered conservative.

Where a contaminant of concern's LQM/CIEH S4UL/GAC/C4SL LLTC varies according to the Soil's Organic Matter (SOM), the SOM recorded for each soil sample was used to derive the appropriate SGV/GAC. The SOM of the Phase 4 Made Ground samples ranged between 0.2 – 5.0%, therefore the sample at WS17/0.50m bgl was analysed against the 2.5% SOM category. All other samples were analysed against a 1.0% SOM category.

Double plot analysis of the speciated PAH's undertaken in Phase 4 of the investigation revealed all of the PAH's to be coal/coal ash and part of the urban background, with the exception of WS18/1.00m bgl which appeared to be coal tar/creosote-derived. As most PAH's were not coal tar derived, then the benzo(a)pyrene S4UL is suitable for use. For WS18/1.00m bgl, the benzo(a)pyrene results was compared to the Coal Tar S4UL. A copy of the LQM PAH Profiling Tool used can be seen in Appendix E.

In addition to PAH profiling of the soil samples tested, PAK marker spray testing was also conducted on areas of tarmac hardstanding across the site on the 21st October 2019. This revealed no evidence of PAHs over 150ppm in any of the tarmac tested. 4No. samples of tarmac were also taken and tested for speciated PAHs, TPHs and Monohydric Phenols in order to confirm their composition, and the results of this (DETS Report No. 19-15113) revealed no elevated determinands except C12 – C35 Aliphatic and Aromatic Hydrocarbons were present (although these were not beyond the threshold for a **'Residential with Home-grown Produce'** land-use scenario).

The results of the comparison of the representative contaminant concentrations for both rounds of chemical testing are presented in the table overpage.

Soil Guideline Values and General Acceptance Criteria Results		
Substance	Sample Location Where available LQM/CIEH S4UL/, CSL4 LLTC or GAC were exceeded for relevant land-use scenario	
	"Residential with Home-grown produce" Land-Use Scenario	"Commercial" Land-Use Scenario
Arsenic	None	None
Beryllium	None	None
Boron	None	None
Cadmium	None	None
Chromium (III)	None	None
Hexavalent Chromium (VI)	None	None
Copper	None	None
Lead	WS17/0.50m (859mg/kg), WS18/1.00m (274mg/kg), WS19/0.80m (403mg/kg), WS19/1.00m (444mg/kg)	None
Mercury (Elemental)	None	None
Nickel	None	None
Selenium	None	None
Vanadium	None	None
Zinc	None	None
Cyanide (Total)	None	None
Total Phenol	None	None
Naphthalene	BH11/0.30m (2.31mg/kg)	None
Acenaphthylene	None	None
Acenaphthene	None	None
Fluorene	None	None
Phenanthrene	BH201/0.25m (230mg/kg)	None
Anthracene	None	None
Fluoranthene	None	None
Pyrene	None	None
Benzo(a)anthracene	BH201/0.25m (130mg/kg), BH11/0.30m (14.64mg/kg)	None
Chrysene	BH201/0.25m (94mg/kg), BH11/0.30m (15.55mg/kg)	None
Benzo(b)fluoranthene	BH201/0.25m (110mg/kg), BH11/0.30m (38.65mg/kg), WS201/0.45m (4.3mg/kg)	WS1/0.30m (103mg/kg)
Benzo(k)fluoranthene	None	None
Benzo(a)pyrene	BH201/0.25m (84mg/kg), BH11/0.30m (16.19mg/kg), WS201/0.45m (3.5mg/kg)	WS1/0.30m (67.3mg/kg)
Indeno(1,2,3-cd)pyrene	BH201/0.25m (50mg/kg)	None
Dibenz(a,h)anthracene	BH201/0.25m (17mg/kg), BH11/0.30m (2.25mg/kg), WS201/0.45m (0.33mg/kg)	WS1/0.30m (8.54mg/kg)
Benzo(ghi)perylene	None	None
TPH C5 – C6 (aliphatic)	None	None
TPH C6 – C8 (aliphatic)	None	None
TPH C8 – C10 (aliphatic)	WS16/0.50m (26mg/kg), WS16/0.80m (66mg/kg)	None
TPH C10 – C12 (aliphatic)	WS16/0.50m (437mg/kg), WS16/0.80m (367mg/kg)	None
TPH C12 – C16 (aliphatic)	WS16/0.50m (3547mg/kg), WS16/0.80m (1246mg/kg)	None
TPH C16 – C21 (aliphatic)	None	None
TPH C21 – C34 (aliphatic)	None	None
TPH C5 – C7 (aromatic)	None	None
TPH C7 – C8 (aromatic)	None	None
TPH C8 – C10 (aromatic)	None	None
TPH C10 – C12 (aromatic)	WS16/0.50m (356mg/kg), WS16/0.80m (299mg/kg)	None
TPH C12 – C16 (aromatic)	WS16/0.50m (382mg/kg), WS16/0.80m (297mg/kg), BH201/0.25m (240mg/kg)	None
TPH C16 – C21 (aromatic)	BH201/0.25m (1600mg/kg)	None
TPH C21 – C35 (aromatic)	BH201/0.25m (2600mg/kg)	None
Benzene	None	None
Toluene	None	None
Ethylbenzene	None	None
Xylene (o, m & p)	None	None
MTBE	None	None
Asbestos Screen	BH2/0.60m (Amosite: 0.002%)	BH14/0.30m (Chrysotile: 0.012%), HP201/0.50m (Chrysotile: <0.001%)

Chemical laboratory testing of the trial holes excavated by Ground and Water revealed elevated levels of Lead, aliphatic TPHs from C8 – C16 and aromatic TPHs from C10 – C16 within five samples tested (WS16/0.50m, WS17/0.50m, WS18/1.00m, WS19/0.80m and WS19/1.00m bgl) in excess of the ***“Residential with Home-grown Produce”*** land-use scenario, and elevated levels of Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenzo(a,h)anthracene within one sample (WS1/0.30m bgl) in excess of the ***“Commercial”*** land-use scenario.

The chemical laboratory testing undertaken for the WYG/CampbellReith samples revealed elevated levels of Naphthalene, Phenanthrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene and aromatic TPHs from C12 – C35 within three samples tested (BH201/0.25m, BH11/0.30m and WS201/0.45m bgl) in excess of the ***“Residential with Home-grown Produce”*** land-use scenario. All other previously reported elevated determinands were found to be within the eastern portion of site and not above the threshold for a ***“Commercial”*** land-use scenario, so have therefore been discounted.

In addition, positive asbestos identifications were noted within 4 of the 77 samples tested across all phases of the investigation; Amosite asbestos within BH2/0.60m bgl, and Chrysotile asbestos within BH14/0.30m, CP3/0.35m (this location could not be found on trial hole location plans, so it was assumed this was BH3), and HP201/0.50m bgl. Asbestos quantifications revealed concentrations of between <0.001% and 0.012% for Chrysotile, and 0.002% for Amosite.

Fragments of Chrysotile asbestos in the form of cement and bitumen were also noted in three samples tested; HP203/0.15m, HP201/0.20m and TP206/0.30m bgl.

The Ground and Water intrusive investigation revealed olfactory evidence to suggest hydrocarbon-type contamination within WS1 from 0.20 – 0.30m and 1.50 – 2.00m bgl, WS3 from 0.80 – 2.00m bgl and WS16 from 0.40 – 1.00m bgl. The chemical laboratory results verified that elevated concentrations of aliphatic/aromatic hydrocarbons (C₈-C₃₅) were present within WS16 from 0.50 – 0.80m bgl, and elevated aromatic hydrocarbons (C₁₀-C₃₅) were present within the WYG/CampbellReith sample BH201/0.25m bgl, above the threshold values for a ***“Residential with Home-grown Produce”*** land-use scenario.

4.1.3 CLAIRE Statistics

The results of CLAIRE statistical analysis of the distribution of elevated levels of Lead and PAHs within the Made Ground can be seen tabulated overpage.

The Made Ground found across the site, generally described as 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), was determined to be from a similar source. Both the WYG and CampbellReith investigations described Made Ground capping all areas of the site, and therefore this was also deemed to be from a similar source. Therefore, the use of CLAIRE statistics across all phases of investigation was deemed appropriate.

The results of the analysis can be seen in Appendix F. A précis of the results is tabulated overpage.

Soil Guideline Values and General Acceptance Criteria Results				
Substance	Outliers Present	Upper Confidence Limit of Sample Population (mg/kg)	Does the Upper Confidence Limit of the Sample Population Exceed the C4SL LLTC	
			Residential with Home Grown Produce	Commercial
Lead (with outliers)	Yes	191.89	No	No
Naphthalene (with outliers)	Yes	1.91	No	No
Phenanthrene (with outliers)	Yes	30.56	No	No
Benzo(a)anthracene (with outliers)	Yes	15.70	Yes	No
Benzo(a)anthracene (outliers removed: BH201/0.25m & WS1/0.30m)	Yes	2.62	No	No
Chrysene (with outliers)	Yes	12.93	No	No
Benzo(b)fluoranthene (with outliers)	Yes	15.35	Yes	No
Benzo(b)fluoranthene (outliers removed: BH201/0.25m, WS1/0.30m, BH11/0.30m & BH4/0.50m)	Yes	2.08	No	No
Benzo(a)pyrene (with outliers)	Yes	10.94	Yes	No
Benzo(a)pyrene (outliers removed: BH201/0.25m, WS1/0.30m & BH11/0.30m)	Yes	1.76	No	No
Indeno(1,2,3-cd)pyrene (with outliers)	Yes	7.05	No	No
Dibenz(a,h)anthracene (with outliers)	Yes	1.92	Yes	No
Dibenz(a,h)anthracene (outliers removed: BH201/0.25m, WS1/0.30m, BH11/0.30m, BH4/0.50m & WS2/0.50m)	Yes	0.16	No	No

The table above shows that the distribution of Lead and PAHs within the Made Ground was non-normal. Outliers were noted within all phases of works, however the Upper Confidence Limit only exceeded the threshold for a **'Residential with Home-grown Produce'** land use scenario for Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenz(ah)anthracene. The outliers that had to be removed in order to bring the Upper Confidence Limit below the threshold comprised the samples BH201/0.25m, WS1/0.30m, BH11/0.30m, BH4/0.50m and WS2/0.50m.

As WS1, WS2 and BH4 were all located within the area of site with a **'Commercial'** land-use scenario, and only WS1 was noted to exceed the threshold for this land-use, it was considered that no remediation was necessary for WS2 or BH4.

As the remaining two outliers noted during initial CLAIRE statistical analysis (covering the entire site) and samples found to individually exceed the threshold for a '**Residential with Home-Grown Produce**' land-use scenario were all located within the north-western portion of site (a car parking area), then it was considered that a second CLAIRE statistical analysis over this area of site would help determine a more realistic remediation strategy for the proposed development. The results of this CLAIRE statistical analysis for the distribution of elevated levels of Lead and PAHs within the Made Ground in the north-western residential area of site can be seen tabulated below.

Soil Guideline Values and General Acceptance Criteria Results			
Substance	Outliers Present	Upper Confidence Limit of Sample Population (mg/kg)	Does the Upper Confidence Limit of the Sample Population Exceed the C4SL LLTC
			Residential with Home Grown Produce
Lead (with outliers)	Yes	411.37	Yes
Lead (outlier removed: WS17/0.50m)	No	273.43	Yes
Naphthalene (with outliers)	Yes	0.84	No
Phenanthrene (with outliers)	Yes	79.49	No
Benzo(a)anthracene (with outliers)	Yes	44.72	Yes
Benzo(a)anthracene (outliers removed: BH201/0.25m)	Yes	5.67	No
Chrysene (with outliers)	Yes	32.84	Yes
Chrysene (outlier removed: BH201/0.25m)	Yes	6.03	No
Benzo(b)fluoranthene (with outliers)	Yes	39.19	Yes
Benzo(b)fluoranthene (outliers removed: BH201/0.25m & BH11/0.30m)	Yes	1.91	No
Benzo(a)pyrene (with outliers)	Yes	29.55	Yes
Benzo(a)pyrene (outliers removed: BH201/0.25m & BH11/0.30m)	Yes	1.48	No
Indeno(1,2,3-cd)pyrene (with outliers)	Yes	17.50	No
Dibenz(a,h)anthracene (with outliers)	Yes	5.89	Yes
Dibenz(a,h)anthracene (outliers removed: BH201/0.25m & BH11/0.30m)	Yes	0.18	No

This analysis confirmed that outliers were present within the north-western residential area samples at BH201/0.25m and BH11/0.30m. However, it also revealed that Lead was elevated across the site area, even with an outlier at WS17/0.50m bgl having been removed. Therefore, it was considered that remediation was necessary for the entire north-western car park area of site.

Remediation was also considered necessary for the elevated TPH values present within WS16. As this was the only trial hole where elevated determinands were noted outside of the north-western car park and '**Commercial**' area, hotspot removal in a ~15m radius surrounding WS16 was thought to be the most cost-effective solution.

4.1.4 Human Health – Asbestos contamination within the Made Ground

Fibres of Amosite asbestos was noted within BH2/0.60m bgl, and Chrysotile asbestos was noted within BH14/0.30m, CP3/0.35m (this location could not be found on trial hole location plans, so it was assumed this was BH3), and HP201/0.50m bgl. Asbestos quantifications revealed concentrations of between <0.001% and 0.012% for Chrysotile, and 0.002% for Amosite.

Given the presence of these fibres within the soils and the potential for these hotspots to coincide with publicly accessible areas on site, as well as workers during site redevelopment, it is considered likely that further risk assessment is necessary with respect to the asbestos detections noted.

The quantifications for BH2/0.60m and BH14/0.30m bgl were subject to risk assessment, as these were the highest noted for Amosite and Chrysotile respectively.

Based on a comparison of the results of the asbestos risk assessment in Appendix G with Tables 14.1 and 14.3 of CIRIA733, BH14 revealed an **insignificant** lifetime risk of mesothelioma or Lung Cancer. However, comparison of results of the asbestos risk assessment in Appendix G with Tables 14.1 and 14.3 of CIRIA733 revealed that the Amosite asbestos within BH2 had a lifetime risk of **2 per 100,000 people exposed (highest arguable 15)** for Mesothelioma, and an **insignificant** lifetime risk of Lung Cancer.

Therefore, remediation of BH2 was considered necessary in order to eliminate the risk from Amosite fibres to end-users. No remediation procedures were considered necessary where Chrysotile fibres were detected.

Fragments of Chrysotile asbestos in the form of cement and bitumen were also noted in three samples tested; TP206/0.30m bgl, around the eastern portion of the residential area of site, and HP203/0.15m and HP201/0.20m bgl around the north-eastern and south-eastern boundary of site. Through examination of the proposed development plans it was thought that these areas of soil are likely to comprise areas of soft landscaping, and although some soils may be excavated as part of redevelopment, there may still be a residual risk to end users. Therefore, remediation of these areas in the form of Made Ground removal and the use of a geo-textile membrane may be required.

An **Asbestos Management Strategy** should be put in place to ensure that any more potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.

4.2 Groundwater Risk Assessment

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**.

Examination of the Defra records showed that the site was located within an **Inner Zone 1c (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.

During the Ground and Water investigation, 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. During the WYG investigation, groundwater strikes were encountered at depths ranging between 0.50 and 1.80m bgl and then between ground level and 2.79m bgl during return visits to monitor wells installed across the site. The CampbellReith investigation revealed groundwater strikes between 1.40 – 17.40m bgl, with slight seepage noted at depths of between 0.40 – 2.50m bgl.

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.

Given the olfactory evidence to suggest hydrocarbon-type contamination on-site, and corresponding exceedances of PAHs and lighter-end TPHs noted during the investigation, the Made Ground encountered onsite **was** considered to pose a possible risk to groundwater.

Although groundwater testing was beyond the scope of the Ground and Water investigation, groundwater sampling and leachate testing was undertaken during the WYG investigation. Details on this sampling and testing, as noted within the WYG Phase 1 Ground Investigation and Assessment Report (Ref: A090070-182, dated June 2017), is detailed below.

An initial visit was made to the site (10th February 2017) to complete well development. Subsequently, two monitoring trips were completed dated 20th and 27th February 2017. During these visits ground water sampling and groundwater level monitoring was undertaken. Groundwater was removed from the well as part of well development, using low flow method. All wells were purged dry due to slow flow rate.

Groundwater samples were collected using the low-flow technique, whereby the sample is extracted at the same rate that water flows into the well, i.e. the water level within the well remains constant throughout. As a precaution, due to the slow flow rate and low recharge, the wells were only purged until the water ran clear, which approximately removed 0.5 litres of groundwater.

The environmental chemistry of 13No. groundwater samples selected by WYG were analysed by Jones Environmental Laboratory. The analysis suite is presented below and overpage, and comprised:

- Metals Suite – Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium (III), Copper, Lead, Molybdenum, Mercury, Nickel, Selenium, Zinc;
- Calcium;

- Chloride;
- Polycyclic Aromatic Hydrocarbons (USEPA Standard 16) suite;
- Total Petroleum Hydrocarbons (TPH) Criteria Working group testing;
- Total Hardness;
- Phenols by HPLC;
- Standard inorganics including pH, sulphate, total cyanide;
- Nitrate and Nitrite;
- Dissolved Organic Carbon;
- Ammonical Nitrogen as NH_3 and NH_4 ;
- BTEX by GC-MS;
- Total Alkalinity as CaCO_3 ;
- Volatile Organic Compounds.

Of the 13 groundwater samples tested, exceedances with regard to annual average (AA) and maximum allowable concentration (MAC) Environmental Quality Standards were noted within 9 samples from BH1, BH4, BH5, BH11 and BH14. Where determinands were found to be under detection limits, no further risk assessment was considered necessary. Any above detection limits are tabulated below.

Tabulated Results For Groundwater Testing				
Determinant	Units	EQS Source	EQS Level	Samples where EQS Level was exceeded
Dissolved Nickel	$\mu\text{g/l}$	AA-EQS Freshwater	4	BH5/Round 1 (6.7 $\mu\text{g/l}$), Round 2 (7.0 $\mu\text{g/l}$) BH11/Round 1 (4.3 $\mu\text{g/l}$), Round 2 (4.4 $\mu\text{g/l}$)
Anthracene	$\mu\text{g/l}$	AA-EQS Freshwater	0.1	BH1/Round 1 (0.47 $\mu\text{g/l}$), Round 2 (0.14 $\mu\text{g/l}$) BH5/Round 2 (0.15 $\mu\text{g/l}$)
Fluoranthene	$\mu\text{g/l}$	AA-EQS Freshwater	0.0063	BH1/Round 1 (0.83 $\mu\text{g/l}$), Round 2 (0.27 $\mu\text{g/l}$) BH4/Round 1 (0.01 $\mu\text{g/l}$) BH5/Round 2 (2.45 $\mu\text{g/l}$) BH11/Round 1 (0.04 $\mu\text{g/l}$), Round 2 (0.11 $\mu\text{g/l}$) BH14/Round 1 (0.03 $\mu\text{g/l}$)
Benzo(a)pyrene	$\mu\text{g/l}$	AA-EQS Freshwater	0.00017	BH1/Round 1 (0.02 $\mu\text{g/l}$) BH5/Round 2 (0.35 $\mu\text{g/l}$)
Benzo(ghi)perylene	$\mu\text{g/l}$	MAC-EQS Freshwater	0.0082	BH1/Round 1 (0.01 $\mu\text{g/l}$) BH5/Round 2 (0.23 $\mu\text{g/l}$)
Benzo(k)fluoranthene	$\mu\text{g/l}$	MAC-EQS Freshwater	0.017	BH5/Round 2 (0.23 $\mu\text{g/l}$)
Benzo(b)fluoranthene	$\mu\text{g/l}$	MAC-EQS Freshwater	0.017	BH1/Round 1 (0.03 $\mu\text{g/l}$) BH5/Round 2 (0.53 $\mu\text{g/l}$)
Total Cyanide	$\mu\text{g/l}$	AA-EQS Freshwater	1	BH1/Round 1 (2 $\mu\text{g/l}$), Round 2 (4 $\mu\text{g/l}$) BH5/Round 1 (2 $\mu\text{g/l}$), Round 2 (3 $\mu\text{g/l}$) BH11/Round 1 (3 $\mu\text{g/l}$), Round 2 (4 $\mu\text{g/l}$)
Ammonia as Nitrogen	$\mu\text{g/l}$	EQS Freshwater	300	BH1/Round 1 (3,150 $\mu\text{g/l}$), Round 2 (870 $\mu\text{g/l}$) BH5/Round 1 (1,530 $\mu\text{g/l}$), Round 2 (1,470 $\mu\text{g/l}$) BH11/Round 1 (10,100 $\mu\text{g/l}$), Round 2 (4,070 $\mu\text{g/l}$) BH14/Round 1 (1,150 $\mu\text{g/l}$), Round 2 (1,140 $\mu\text{g/l}$)
Notes	EQS = Environmental Quality Standard for Protection of Aquatic Life (Freshwater or Saltwater) AA = Annual Average MAC = Maximum Allowable Concentration			

The results of the groundwater testing can be seen in Appendix C.

The testing revealed that a number of contaminants, in particular PAH compounds, metals, ammonia and cyanide exceeded the relevant EQS Freshwater standards. The exceedances for Nickel and Cyanide were noted to be marginal (within an order of magnitude of the threshold), however greater exceedances were noted for Ammonia within groundwater collected from BH1 and BH11 in the west of the site, and also in BH5 and BH14 in the south-east.

Relatively high concentrations of PAH compounds (fluoranthene, benzo(a)pyrene, benzo(ghi)perylene and benzo(b)fluoranthene) were also recorded within BH1 and BH5. It was noted during the WYG investigation that in BH1, superficial strata was not recorded and the shallow groundwater encountered was considered to be perched within the Made Ground overlying the London Clay Formation. BH1 was located in the north-west of the site ~250m from the nearest surface water feature to site (thought to be the River Lavant), and based on the inconsistent contaminant concentrations recorded within the groundwater, the absence of a confirmed continuous groundwater pathway and the travel distance to surface water features, it was considered **unlikely** that the groundwater contaminants recorded within BH1 would risk impacting watercourses surrounding the site (such as the River Lavant).

The exceedances of PAH compounds within BH5 were thought to be directly related to contaminants within the surrounding soils (such as those noted within WS1), as it was noted within the WYG report that minimal recovery of groundwater occurred following purging of the well and the groundwater sampled contained a high silt content. It was therefore considered likely that hotspot remediation of WS1 would eliminate the source of PAHs into groundwater in this area, and no further remediation would be necessary.

In addition to groundwater sampling, WYG also conducted leachate analysis on 3No. soil samples recovered during the investigation. The analysis suite is presented below and comprised:

- Metals Suite – Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium (III), Copper, Lead, Molybdenum, Mercury, Nickel, Selenium, Zinc;
- Polycyclic Aromatic Hydrocarbons (USEPA Standard 16) suite.

Of the 3 samples tested for leachates, exceedances with regard to annual average (AA) and maximum allowable concentration (MAC) Environmental Quality Standards were noted within 3 samples from BH1, BH5 and BH14. Where determinands were found to be under detection limits, no further risk assessment was considered necessary. Any above detection limits are tabulated below.

Tabulated Results For Groundwater Testing				
Determinant	Units	EQS Source	EQS Level	Samples where EQS Level was exceeded
Dissolved Nickel	µg/l	AA-EQS Freshwater	4	BH14/Round 1 (6.6µg/l)
Fluoranthene	µg/l	AA-EQS Freshwater	0.0063	BH1/1.50m (0.02µg/l) BH1/0.60m (0.70µg/l) BH14/0.30m (0.02µg/l)
Benzo(a)pyrene	µg/l	AA-EQS Freshwater	0.00017	BH5/0.60m (0.13µg/l)
Benzo(ghi)perylene	µg/l	MAC-EQS Freshwater	0.0082	BH5/0.60m (0.08µg/l)
Benzo(k)fluoranthene	µg/l	MAC-EQS Freshwater	0.017	BH5/0.60m (0.08µg/l)
Benzo(b)fluoranthene	µg/l	MAC-EQS Freshwater	0.017	BH5/0.60m (0.2µg/l)
Notes	EQS = Environmental Quality Standard for Protection of Aquatic Life (Freshwater or Saltwater) AA = Annual Average MAC = Maximum Allowable Concentration			

The exceedances noted within leachate samples correspond to those present within groundwater, with nickel and PAH exceedances noted in boreholes where groundwater contamination was also present. It was however noted within the WYG report that the method of leachate derivation can result in concentrations that exceed those present under natural conditions. It was therefore considered that the occurrences of contamination within groundwater provided a more meaningful assessment of the potential risks to controlled waters (such as the drain/River Lavant to the east of site).

With regard to the groundwater and leachate testing conducted during previous phases of investigation, it was confirmed that the thickness of the London Clay Formation underlying the site was considered sufficient to protect the underlying Principal Aquifer from perched groundwater contamination and there were not sufficient pathways for contamination to affect watercourses close to the site. Therefore, no specific remediation with regard to groundwater was considered necessary for the site.

4.3 Ground Gas Risk Assessment

Ground gas monitoring was undertaken across both the WYG and CampbellReith phases of the intrusive investigation. During the WYG phase of works, 2No. return monitoring visits were conducted over a 17-day period from 10/02/17 – 27/02/17 in 7No. installed wells (BH1, BH2, BH4, BH5, BH7, BH11 and BH14). This phase of monitoring detected carbon dioxide concentrations of between 0.1 – 2.5% and methane concentrations of between 0 – 0.9%. The maximum flow rate recorded was 0.4l/hr.

Further ground gas monitoring was undertaken during the CampbellReith phase of the investigation, on 4No. return monitoring visits over a 14-week period from 30/05/18 – 07/09/18 in 9No. installed wells (BH1, BH4, BH7, BH11, WS202, WS204, WS205, BH201, BH202). During this phase of monitoring, carbon dioxide concentrations of between 0 – 15.0% and methane concentrations of between 0 – 13.6% were detected. The maximum flow rate recorded was 0.3l/hr (higher peak flow rates were noted, however as these then dropped they were considered to be erroneous), and the highest carbon dioxide and methane concentrations detected were both within WS202.

Based on the documentation presented in “BS 8485:2007, Code of practice for the characterization and remediation from ground gas in affected developments”, the *hazardous gas flow rate* (Q_{hg}) should be calculated using:

$$Q_{hg} = C_{hg}/100 * q$$

Where:

C_{hg} is the measured hazardous gas concentration (in percentage volume-by-volume);

q is the flow rate (in litres per hour) of combined gases found by direct measurement. If gas borehole flow was not detectable, it should be assumed to be at the detection limit of the equipment used.

Consequently, the Q_{hg} for carbon dioxide was calculated to be:

$$Q_{hg} \text{ (l/hr)} = 15.0 \text{ (highest carbon dioxide concentration noted)} / 100 * 0.4 \text{ (worst case possible flow rate)}$$

$$= 0.150 * 0.4$$

Q_{hg} for Carbon Dioxide = 0.06 l/hr

The Q_{hg} for methane was calculated to be:

Q_{hg} (l/hr) = 13.6 (highest methane concentration noted)/100 * 0.4 (worst case possible flow rate)

= 0.136 * 0.4

Q_{hg} for Methane = 0.0544 l/hr

This indicates the site falls within a Characteristic Situation 1 (CS2) based on BS8485 (2015). However, it is noted that where methane concentrations exceed 1% and carbon dioxide concentrations exceed 5% a CS2 for the site should be considered.

Therefore, based on the WYG and CampbellReith ground gas monitoring and risk assessment to date, given the elevated Methane and Carbon Dioxide values recorded, it is recommended that precautions up to a Characteristic Situation 2 in accordance with BS8485 (2015) are installed within the proposed buildings.

4.4 Re-Evaluated Conceptual Site Model

Following evaluation of the Site Investigation, the CSM developed within Section 2.7 of this report was re-evaluated and can be seen overleaf.

The plausible pollutant linkages remaining after risk assessment are shown and where risk assessment has indicated no unacceptable risk to sensitive receptors, the pollutant linkages have been crossed out.

Tabulated Conceptual Site Model – Plausible Pollutant Linkages Only		
Potential On-site Sources	Potential Absorption Pathways	Potential Receptors
Large former diesel AST (~10,000 gallons) situated south of the main factory building, & small double-skinned plastic AST (~1000 litres) for storage of 'fuel oil' situated on a plinth (not bunded) adjacent to the Fire Testing facility in the south of the site: • Total Petroleum Hydrocarbons (TPHs); • Poly-cyclic Aromatic Hydrocarbons (PAHs). Chemical testing revealed elevated TPHs and PAHs within soils in NW portion of site, and WS1 in SE Commercial area. Features of factory buildings, including oil-burning heaters and above-ground fuel pipes and the presence of an 'air pollution test facility': • Heavy Metals and Semi-Metals including: Arsenic, Cadmium, Chromium, Lead, Copper, Zinc, Beryllium, Mercury etc; • Poly-cyclic Aromatic Hydrocarbons (PAHs); • Total Petroleum Hydrocarbons (TPHs); • Asbestos (building materials). Chemical testing revealed elevated Lead, TPHs and PAHs within soils in NW portion of site, and WS1 in SE Commercial area. Amosite fibres presented risk to end-users in BH2, fragments requiring removal also noted to NE and SE boundaries. Electricity Sub-station present in south of site: • PCB Oils; No evidence of PCB oil contamination noted during chemical testing.	Leaching of onsite sources of contamination. Lateral and vertical migration of gases/vapours. Overland surface water runoff. Contaminant migration through preferential pathways (e.g. piles, underground service ducts, and drains). Contaminant transport through off site migration of groundwater. Groundwater testing revealed elevated Ammonia, Nickel, Cyanide and PAHs within wells. However, limited superficial soils and impermeable bedrock thought to protect underlying Principal Aquifer, and no sufficient pathways for contaminants to affect nearby watercourses. Atmospheric transport and inhalation of airborne dusts, vapours and fibres (indoors and outdoors). Direct contact (dermal contact and ingestion) with soil, dust and water. Inhalation of vapours arising from soil contamination.	Future site users (users/ occupants of future commercial/ residential premises). Construction workers during future development works. Groundwater (Head Deposits, Thanet Sand Formation, White Chalk, Aquifers, SPZ). Surface waters (River Lavant): Limited superficial soils and impermeable bedrock thought to protect underlying Principal Aquifer, and no sufficient pathways for contaminants to affect nearby watercourses. On-site buildings and services. Offsite workers and residents.
Ground gases associated with on-site contaminants noted during chemical testing. • Carbon dioxide; • Methane; • Hydrogen Sulphide; • Carbon Monoxide; • Trace Gases/VOC's Elevated CO2 and CH4 concentrations noted during monitoring within WS202; site classified CS2.	Migration through anthropogenic and natural pathways Inhalation Asphyxiation	Site occupiers. Buildings. Construction workers, service and maintenance operatives, especially in confined spaces.

4.5 Remediation Strategy

4.5.1 Human Health – Lead, PAH and TPH contamination within Made Ground

Based on the results of the intrusive works and chemical analyses undertaken to-date, the following remedial measures could be considered:

The use of CLAIRE statistical analysis revealed that of the elevated determinands noted, PAH hotspots within the residential area of site were present within BH11 and BH201. However, it was noted that Lead contamination present within the north-western car parking area of site remained elevated even following hotspot removal. **Therefore, it was considered necessary to remediate the entirety of the proposed soft landscaping within the north-western car parking area in order to remove all elevated levels of Lead and PAHs noted, and ensure residential garden areas present no residual risk to end users.**

For the remainder of the residential areas across the site, elevated TPH contamination was noted within WS16, and asbestos contamination was present within BH2 (in the form of Amosite fibres presenting a risk of mesothelioma to end users) and TP206 (in the form of fragments of cement-bound chrysotile). **Isolated hotspot removal of WS16 would eliminate the risk of TPH contamination to residential areas of site, and removal of BH2 would remove the highest risk from asbestos fibres.**

Asbestos in the form of cement-bound and bitumen fragments were noted within soils at HP203/0.15m, HP201/0.20m and TP206/0.30m bgl. The cement-bound fragment noted within TP206 was thought likely to be related to the overlying concrete slab present across the central portion of site, and as this slab and any associated sub-base was to be excavated it was considered that this source of asbestos contamination would be removed during development. It was also noted that the area of TP206 was proposed as an access road/parking area, and as no asbestos was noted within surrounding trial holes (such as WS7) it was considered that contamination was localised and the presence of hardstanding would sever any linkages between residual asbestos risk and end users. **Therefore, no further remediation was deemed to be necessary for this area.**

The area surrounding HP201 appeared to be proposed as communal soft landscaping, and therefore a risk to end users was considered to be present. **As positive asbestos identifications were noted within a number of locations along the north-eastern boundary of site (BH2, BH3 and HP201), a reduced dig of Made Ground and placement of a geotextile membrane with a clean capping layer across all soft landscaping in this area was considered the most effective way to remove all fragments of asbestos-containing material and eliminate risks to end-users.**

For the Commercial area of site in the south-east, elevated PAHs were noted within WS1 that exceeded a '**Commercial**' land-use scenario. Bitumen-containing chrysotile asbestos was also noted within HP203. **Isolated hotspot removal of WS1 would eliminate the risk of PAH contamination to the commercial area of site, and HP203 was thought close enough that this would also be removed and thus eliminate any asbestos risk in soft landscaping areas.**

Therefore, based on the above, the following remedial works are recommended:

- A reduced dig of the Made Ground with regard to site levels over the north-western car parking area of site, with placement of a geotextile membrane and 750mm clean capping across all residential garden areas.
- Excavation and removal/remediation of the Made Ground for a 16m radius around the WS16 hotspot in the residential area of site (which would also remove BH2), and the WS1 hotspot in the commercial area.
- A reduced dig of Made Ground with regard to site levels, placement of a geotextile membrane and 500mm clean capping across the proposed communal soft landscaping along the north-eastern boundary of site, and 300mm clean capping across public open spaces in the north-east and north-west.

Following isolated hotspot removal and reduced dig with geotextile membrane for the proposed residential garden areas in the north-western car parking area and soft landscaping across the north-eastern boundary, no remaining plausible pollutant linkages to end-users should remain.

Therefore, it is recommended that for all residential gardens and communal soft landscaping areas not within the north-western car park or north-eastern boundary a minimum 150mm capping of Topsoil is installed as a growing medium.

A remediation plan showing the location and extent of Made Ground removal can be seen within Figure 6.

4.5.2 PAH contamination within Groundwater

As the elevated levels of PAHs noted within groundwater/leachates appeared to be related to contaminant levels within soils, especially those noted within BH1, BH5, BH11 and BH14, it was thought that removal of Made Ground within the north-western car parking area and the hotspot at WS1 would also act as source removal for groundwater contamination noted. Given the variable depth of Head Deposits and thickness of underlying London Clay Formation, there was thought to be no risk to the underlying Principal Aquifer or watercourses surrounding the site. **No specific remediation of groundwater was therefore considered necessary.**

4.5.3 Ground-gas

Based on the WYG/CampbellReith ground-gas monitoring and risk assessment to date, given the elevated Carbon Dioxide and Methane values recorded, it is recommended that precautions up to a Characteristic Situation 2, in accordance with BS8485 (2015), are installed within the proposed buildings.

For Residential Houses (Building Type A) then this would be as follows:

Given privately managed residential properties are proposed, in accordance with BS8485 (2015), "3.5" gas protection points are required.

Protection systems providing such solutions scores could include the following, the options provided have taken into account the ground conditions encountered, for example a suspended slab is likely to be adopted given a traditional foundation scheme is likely to be used.

- Venting/Dilution;
- Passive sub-floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)

Good to Very good: 1.5 - 2.5 points.

In accordance with BS8485: The volume flow-through rate is governed by the size and number of side vents; for small to medium width buildings (up to 15 m wide - considered to be present onsite), the minimum area of side ventilation should be 1500 mm²/m run of wall on at least two opposite sides. Where there are multiple internal obstructions to air flow (caused by beams), there should be four or five times the area of the side vents provided in the internal obstructions.

This semi-quantitative risk assessment is deemed appropriate as it is based on the guidance provided in BS8485.

Gas resistant membrane meeting all of the following criteria (2 Points):

- Sufficiently impervious to the gases (carbon dioxide);
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc);
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas;
- Verified in accordance with CIRIA C735.

4.6 Remediation Method Statement

The measures outlined in the following sections are designed to ensure that the potential contamination does not endanger groundworkers or end-users of the proposed development and those end-users do not come into contact with potentially contaminated materials.

At the time of reporting, November 2019, 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 following remedial methodology should be undertaken based on the elevated levels of determinants noted:

- It is recommended that Made Ground is removed in circular areas, ~16m in diameter, and centred on the locations of WS1 and WS16 (also removing BH2). The depth of Made Ground in each of the hotspots was identified as 0.50m bgl in WS1, 0.80m bgl in BH2 and 0.35m bgl in WS16.
- It is also recommended that for all proposed residential garden areas across the north-western car parking area of the site, a reduced dig of Made Ground with regard to site levels is undertaken and a geo-textile membrane laid along the base of the void with 750mm clean capping.
- For the proposed soft landscaping along the north-east and north-west of site, it is recommended that a reduced dig of Made Ground is undertaken relative to site levels with a geo-textile membrane laid along the base of the void. 500mm of clean capping is then recommended within communal garden areas in the north-east, and 300mm within the commercial area and north-western car parking area public open spaces.
- Where deep Made Ground is encountered, excavation should cease at 1.00m below the proposed finish ground level and a 150mm coarse grained anti-capillarity barrier should be installed at the base of the void.
- It is recommended that all remedial works are supervised by a Ground and Water Limited Engineer. This will allow for supervision and segregation of the waste produced whilst remedial works are ongoing. This may reduce overall disposal costs.

- Following the reduced dig, the voids created must be visually inspected by an independent and suitably qualified person to verify the removal of the hotspots. Validation samples from the sides and, where applicable, the base of the excavations should be taken and analysed for the presence of asbestos and/or elevated levels of contaminants. Validation of any anti-capillarity barriers installed at the base of the voids will also be undertaken. Sampling of the soils at the base of the voids would not be required where an anti-capillarity barrier has been installed and the base is 1.00m or greater below the proposed finished floor level.
- Excavations may cease at shallower depth where natural soils are encountered.
- The voids created should be measured and photographed.
- Should validation sampling identify further contamination then remedial excavation should continue until validation sampling reveals all contaminants to have been removed. Repeat points above till sampling proves contaminants have been removed.
- The voids should be backfilled with certified clean Subsoil/Topsoil.
- Stockpiled contaminated Made Ground, destined for removal from site, must be placed on an impermeable liner with raised edge and must be covered at all times.
- Materials to be removed off-site must be classified by carrying out Waste Acceptance Produce (WAP) testing. A registered contractor must undertake the removal of waste. Full liaison must be made with the Environment Agency prior to the removal of any material and must be conducted to meet their full approval.

Post Construction:

- All voids from hotspot removal should be backfilled with a clean capping of Topsoil and/or Subsoil where private or communal soft landscaping is proposed.
- A minimum 150mm clean capping of material shall be required within all proposed areas of soft landscaping in both the residential and commercial areas of site as a growing medium, in accordance with NHBC.
- The pre-remediation formation level for the proposed soft landscaping should be levelled with respect to the proposed finished floor level. This should be compared to the desired clean capping requirements outlined above.
- If insufficient capping space is present then a reduce dig of the underlying Made Ground will be required in order to facilitate the required capping.
- The formation level following the reduced dig must be visually inspected by an independent and suitably qualified person to verify the removal of any Made Ground.
- Should natural soils of the Head Deposits/London Clay Formation be encountered at formation level or during the reduced dig then excavation may cease with samples of the formation taken to verify it is suitable for use. Should testing indicate contamination is present then further remedial works would be required.

- Where a satisfactory capping is present or has been formed then the voids created may be backfilled with certified clean Subsoil/Topsoil.
- Stockpiled contaminated Made Ground, destined for removal from site, must be placed on an impermeable liner with raised edge and must be covered at all times.
- Materials to be removed off-site must be classified by carrying out Waste Acceptance Produce (WAP) testing. A registered contractor must undertake the removal of waste. Full liaison must be made with the Environment Agency prior to the removal of any material and must be conducted to meet their full approval.

Additional verification of any imported soil will also need to occur onsite, once received, to validate the accompanying lab certificate. Any samples taken from a stockpile of imported soil or placed soil should be at a rate of one sample per 100m³ of material and be tested for semi-metals, heavy metals, speciated PAH's and speciated TPH.

4.7 Validation Strategy

Any remedial works undertaken on the site will need to be inspected and independently validated by a Ground and Water Limited Engineer. All remedial excavations will need to be inspected, documented and photographed.

4.8 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 WPA Ground Investigation Report and/or 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.

4.9 Waste Disposal

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM3) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Based on a risk phrase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, the Made Ground encountered during works undertaken by Ground and Water Limited on-site was **NON-HAZARDOUS** with the exception of WS16. The samples within WS16 was classed as **HAZARDOUS**, based on the high levels of TPH contamination noted. The results of the assessment are given within Appendix H. Any potential Hazardous waste would require pre-treatment prior to removal/recycling. This treatment may reduce the overall classification of the waste.

Full WAC Tests and batch leachates were conducted on five samples of Made Ground encountered on-site (WS4/0.50m, WS5/2.00m, WS9/0.30m, WS17/0.80m and WS19/0.50m bgl). All samples fell within the **INERT WASTE** category. The results of the WAC test can be seen in Appendix C.

Fibres of Amosite asbestos was noted within BH2/0.60m bgl, and Chrysotile asbestos was noted within BH14/0.30m, CP3/0.35m (this location could not be found on trial hole location plans, so it was assumed this was BH3), and HP201/0.50m bgl.

Fragments of Chrysotile asbestos in the form of cement and bitumen were also noted in three samples tested; TP206/0.30m bgl, around the eastern portion of the residential area of site, and HP203/0.15m and HP201/0.20m bgl around the north-eastern and south-eastern boundary of site.

Asbestos is the name given to a group of naturally occurring minerals which consist of flexible fibres. The most common types of asbestos are Chrysotile (white), Amosite (brown) and Crocidolite (blue). The properties of asbestos, in particular its strength, high thermal and electrical insulation, chemical resistance and fire resistance made it a very useful building material.

However, breathing in asbestos fibres can cause diseases of the respiratory system. Whilst its use has now been banned, there are still many buildings which have asbestos containing materials which were installed before the ban came into effect.

Asbestos is both carcinogenic and toxic. The threshold limit for carcinogenic materials (0.1%) is lower than the threshold for toxic materials (3%). In practice this means that any material containing more than 0.1% asbestos is classed as hazardous waste.

As the highest quantification of Chrysotile asbestos identified within the samples of the Made Ground was 0.012%, the soils are likely to be classified as **NON-HAZARDOUS**.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM3, therefore producing an initial classification in accordance with the guidance, landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

4.10 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. The compounds that are to be tested for are those given in the LQM S4UL's, which can be viewed in Appendix D of this report.

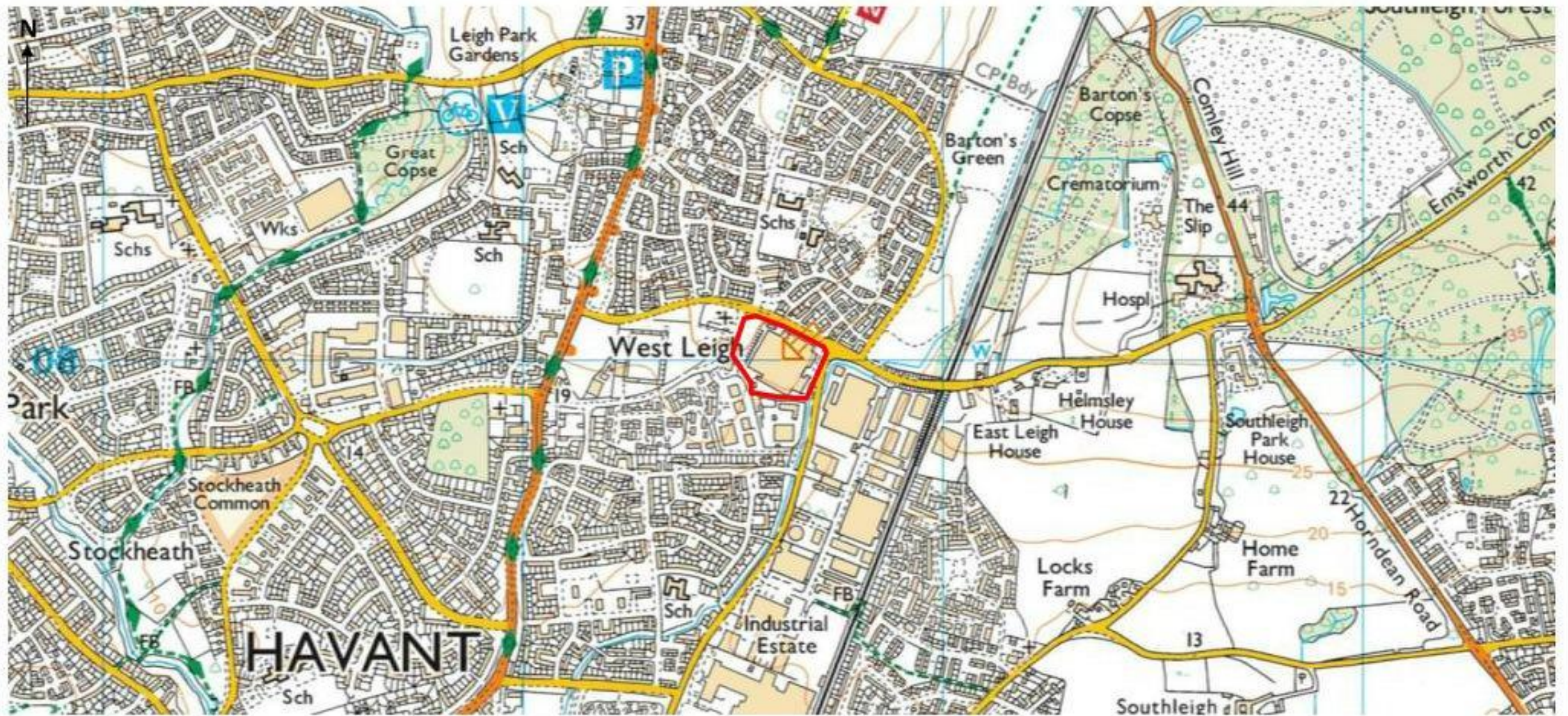
4.11 Duty of Care

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 were 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.

Where asbestos containing materials are present or suspected all works associated with construction/remediation will need to take into account the potential presence of asbestos cement and fibres. The Method Statements must ensure that not only site operative/workers are protected from any potential release of asbestos fibres but also that local residents are not affected.



NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

November 2019

Site Location Plan

Ref:

GWPR3192

Figure 1

ground&water



NOT TO SCALE

APPROXIMATE
SITE BOUNDARY

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

November 2019

Ref:

GWPR3192

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: November 2019
Aerial View of the Site		Ref: GWPR3192

Figure 3

ground&water



APPROX SITE BOUNDARY

Colt International,
New Lane, Havant
Residential option 13

27
revision B

Land use

- Employment (0.83 Hectares)
- Residential (1.93 Hectares)

Total no. of dwellings - 100

Quantum

1 bed	15 u%
2 bed (house)	12 u%
2 bed (apt)	42 u%
3 bed	21 u%
4 bed	10 u%
Total	100

Total employment space provided - 30,225 ft²

Total full-time employment provided - 120



AD90070-182(5T1)27 revision B

Scale 1:1250 @ A3

The AD90070-182(5T1)27(1) v1.dwg

NOT TO SCALE

Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

November 2019

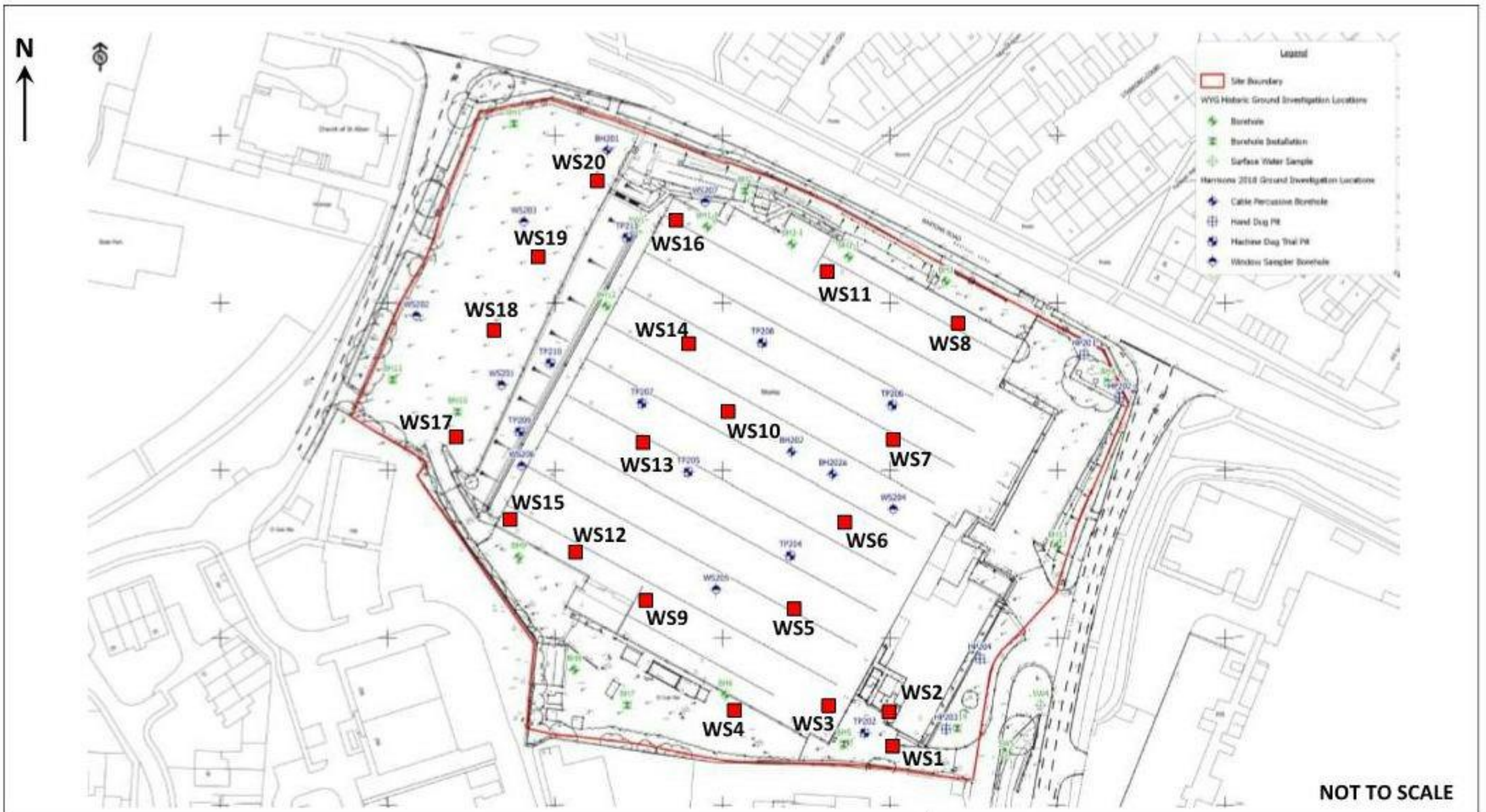
Proposed Development – Plan View

Ref:

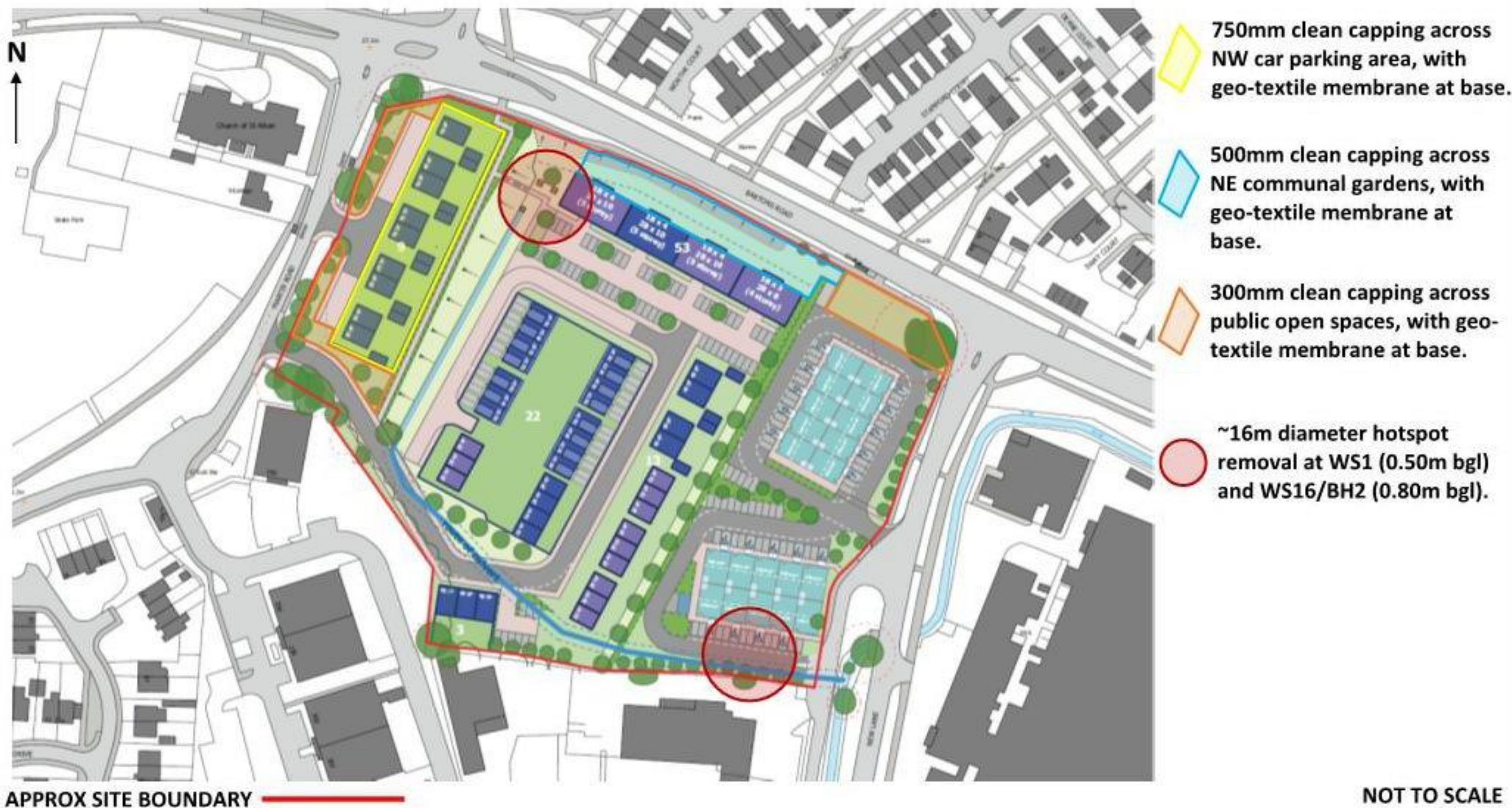
GWPR3192

Figure 4

ground&water



Project:		Former Colt International, New Lane, Havant PO9 2LZ		Figure 5
Client:	Drew Smith Group	Date:	November 2019	
Trial Hole Location Plan		Ref:	GWPR3192	



Project:

Former Colt International, New Lane, Havant PO9 2LZ

Client:

Drew Smith Group

Date:

November 2019

Remediation Plan

Ref:

GWPR3192

Figure 6

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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.

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: 02/09/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS1		Hole Type WLS		Level		Logged By AS		Scale 1:50		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							
					0.20			CONCRETE			
		0.30	D		0.50			MADE GROUND: Dark brown to black sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded flint (30%), brick (30%) and concrete (40%). Strong hydrocarbon/ creosote odour noted.	1 -		
		0.50	D								
		0.80	D								
		1.00	D								
		1.00	SPT	N=15 (2,1/2,4,5,4)				HEAD DEPOSITS: Grey-brown and dark brown to black mottled gravelly CLAY. Gravel is fine to coarse, sub-angular to sub-rounded flint and carbonaceous material. Hydrocarbon odour noted from ~1.50 - 2.00m bgl.	2 -		
		1.50	D								
		2.00	D								
		2.00	SPT	N=34 (4,5/4,5,10,15)				HEAD DEPOSITS: Mid to dark brown very gravelly CLAY. Gravel is fine to coarse, angular to sub-angular flint.			
					2.80				End of Borehole at 2.800m	3 -	
										4 -	
										5 -	
										6 -	
										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. Wet soils noted from 2.40 - 2.80m bgl. Strong hydrocarbon odour noted between 0.20 - 0.30m bgl, and a slight odour noted from 1.50 - 2.00m bgl.											

Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 02/09/2019	
Location: New Lane, Havant PO9 2LZ		Contractor: TK			
Project No. : GWPR3192		Crew Name:		Drilling Equipment:	
Borehole Number WS2	Hole Type WLS	Level	Logged By AS	Scale 1:50	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					
					0.20			CONCRETE	
		0.30	D		0.30			MADE GROUND: Tarmac and brick fragments.	
		0.50	D					MADE GROUND: Mid-brown clayey sandy gravel. Sand is fine to coarse grained, gravel is fine to coarse, sub-angular to angular flint (20%), brick (30%), concrete (20%) and tarmac fragments (30%).	
		0.80	D		0.80			MADE GROUND: Mid-brown slightly gravelly clay. Gravel is occasional, fine to medium flint (90%) and plastic waste (10%).	1
		1.00	D		1.00			HEAD DEPOSITS: Mid-brown slightly gravelly CLAY. Gravel is frequent, fine to coarse, angular to sub-angular flint.	
		1.00	SPT	N=14 (4,8/4,3,3,4)					
		1.50	D						
		2.00	D						2
		2.00	SPT	N=49 (5,6/7,13,13,16)					
					2.45			End of Borehole at 2.450m	
									3
									4
									5
									6
									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.
 Wet soils noted from 1.00 - 2.45m bgl.
 Mild chemical odour noted between 0.20 - 0.30m bgl.

Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 02/09/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS3		Hole Type WLS		Level		Logged By AS		Scale 1:50		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					
					0.20			CONCRETE	
		0.30	D					MADE GROUND: Pale yellow-brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded concrete fragments.	
		0.50	D						
		0.80	D						
		1.00	D					MADE GROUND: Yellow to reddish-brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-rounded flint (30%), brick (30%) and concrete (40%).	1
		1.00	SPT	N=3 (2,1/1,1,1,0)					
		1.50	D						
			2.00	D		2.00			MADE GROUND: Light to dark brown mottled slightly sandy gravelly clay. Sand is fine to coarse grained. Gravel is fine to coarse, sub-rounded to angular flint (20%), brick (25%), concrete (20%), tarmac (20%) and metal fragments (15%). Strong hydrocarbon/ creosote odour noted.
	2.00	SPT	N=20 (3,4/4,4,5,7)						
	2.50	D							
		3.00	D		3.00			MADE GROUND: Light to dark brown mottled very gravelly clay. Gravel is fine to coarse, sub-rounded to angular flint (20%), brick (25%), concrete (20%), tarmac (20%) and metal fragments (15%).	3
								End of Borehole at 3.000m	4
									5
									6
									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. No groundwater encountered. Strong hydrocarbon odour noted between 0.80 - 2.00m bgl.										

Percussion Drilling Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 02/09/2019			
Location: New Lane, Havant PO9 2LZ			Contractor: TK						
Project No. : GWPR3192			Crew Name:			Drilling Equipment:			
Borehole Number WS4		Hole Type WLS		Level		Logged By AS		Scale 1:50	Page Number Sheet 1 of 1

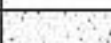
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20			CONCRETE	
		0.30	D					MADE GROUND: Pale yellow-brown sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to angular flint (30%), brick (30%) and concrete (40%).	
		0.50	D						
		0.80	D						
		1.00	D						
		1.00	SPT	N=32 (7,8/7,9,8,8)	1.00			MADE GROUND: Dark grey-brown sandy gravelly clay. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded flint (40%), brick (30%) and carbonaceous material (30%).	1
		1.50	D					HEAD DEPOSITS: Light to mid grey-brown slightly sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, sub-rounded to angular flint with occasional carbonaceous material.	
		2.00	D						
		2.00	SPT	N=18 (3,5/6,4,4,4)					
		2.45							2
							End of Borehole at 2.450m	3	
								4	
								5	
								6	
								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. No groundwater encountered.									



Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 02/09/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS5		Hole Type WLS		Level		Logged By EM		Scale 1:50		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							
					0.20			CONCRETE			
		0.30	D					MADE GROUND: Orange to reddish-brown slightly gravelly sandy clay. Sand is fine to coarse grained, gravel is occasional to frequent, fine to coarse, angular to sub-rounded brick (50%), chalk (35%) and flint (15%).	1 -		
		0.50	D								
		0.80	D		0.80						
		1.00	D		1.00			MADE GROUND: Chalk fill. Recovered as a structureless chalk composed of uncompacted, cream to off-white gravelly silt. Gravel is moderately weak, medium density, white and sub-angular. (Grade Dm in accordance with CIRIA574).	2 -		
		1.00	SPT	N=34 (3,7/9,9,8,8)							
		1.50	D		1.50			HEAD DEPOSITS: Brown slightly gravelly sandy CLAY. Sand is fine to coarse grained. Gravel is occasional to frequent, fine to coarse, sub-rounded to sub-angular flint.	3 -		
					1.80			HEAD DEPOSITS: Light brown to orange-brown slightly clayey gravelly SAND. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-rounded flint.	4 -		
									5 -		
									6 -		
									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. No groundwater encountered.											

Percussion Drilling Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 02/09/2019			
Location: New Lane, Havant PO9 2LZ			Contractor: TK						
Project No. : GWPR3192			Crew Name:			Drilling Equipment:			
Borehole Number WS6		Hole Type WLS		Level		Logged By EM		Scale 1:50	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					
		0.30	D		0.20			CONCRETE	1
		0.50	D		0.40			MADE GROUND: Sub-base comprising light brown gravelly sand. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded flint rejects.	
		0.80	D					MADE GROUND: Reddish-brown mottled gravelly sandy clay. Sand is fine to medium grained. Gravel is fine to coarse, angular to sub-rounded brick (40%), chalk (40%) and flint (20%). Slight organic odour noted.	
		1.00	D						
		1.00	SPT	N=14 (2,1/2,3,4,5)	1.30				
		1.50	D					HEAD DEPOSITS: Orange-brown and grey-brown mottled slightly gravelly slightly sandy CLAY. Sand is fine grained. Gravel is fine to coarse, angular to rounded flint.	
		2.00	D		1.80				
		2.00	SPT	N=9 (2,1/2,2,3,2)				LONDON CLAY FORMATION: Mottled orange and grey-brown slightly sandy CLAY. Sand is fine grained.	
		2.45						End of Borehole at 2.450m	
								3	
								4	
								5	
								6	
								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 Roots noted to 1.00m bgl. No groundwater encountered.										
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Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 02/09/2019	
Location: New Lane, Havant PO9 2LZ		Contractor: TK			
Project No. : GWPR3192		Crew Name:		Drilling Equipment:	
Borehole Number WS7	Hole Type WLS	Level	Logged By AS	Scale 1:50	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					
					0.20			CONCRETE	
		0.30	D		0.30			MADE GROUND: Light yellow-brown gravelly sand. Sand is fine to coarse grained. Gravel is fine to coarse, sub-rounded to sub-angular flint (30%), brick (30%) and concrete (40%).	
		0.50	D						
		0.80	D		0.80				
		1.00	D					MADE GROUND: Light to dark grey-brown slightly gravelly sandy clay. Sand is fine to medium grained. Gravel is occasional to frequent, fine to coarse, sub-rounded to angular flint (40%), brick (30%) and concrete (30%). Rare (<5%) carbonaceous material and chalk fragments also noted.	1
		1.00	SPT	N=8 (2,1/2,1,2,3)					
		1.50	D						
		2.00	D					LONDON CLAY FORMATION: Grey-brown and orange-brown mottled CLAY.	2
		2.00	SPT	N=13 (1,1/2,3,4,4)					
					2.45			End of Borehole at 2.450m	
									3
									4
									5
									6
									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 Roots noted to 0.80m bgl. No groundwater encountered.										
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Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 02/09/2019	
Location: New Lane, Havant PO9 2LZ		Contractor: TK			
Project No. : GWPR3192		Crew Name:		Drilling Equipment:	
Borehole Number WS10	Hole Type WLS	Level	Logged By EM	Scale 1:50	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					
					0.18			CONCRETE	
		0.30	D					MADE GROUND: Orange to reddish-brown gravelly clayey sand. Sand is fine to medium grained. Gravel is fine to coarse, angular to sub-rounded flint (85%) and brick (15%). Rare (<5%) carbonaceous material also noted.	
		0.50	D		0.50				
		0.80	D						
		1.00	D		1.00			HEAD DEPOSITS: Grey and orange-brown slightly gravelly SAND. Sand is fine to medium grained. Gravel is occasional, fine to medium, sub-angular flint. Gravel becomes rarer from 0.80m bgl.	1
		1.00	SPT	N=20 (2,4/5,4,5,6)					
		1.50	D		1.60			HEAD DEPOSITS: Orange and reddish-brown mottled silty SAND. Sand is fine to medium grained.	
		2.00	D					HEAD DEPOSITS: Orange-brown slightly clayey SAND. Sand is fine grained.	2
		2.00	SPT	N=22 (4,5/5,5,6,6)					
					2.45			End of Borehole at 2.450m	
									3
									4
									5
									6
									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.
Water encountered between 0.80 - 1.10m bgl.

Percussion Drilling Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 30/08/2019			
Location: New Lane, Havant PO9 2LZ			Contractor: TK						
Project No. : GWPR3192			Crew Name:			Drilling Equipment:			
Borehole Number WS11		Hole Type WLS		Level		Logged By EM		Scale 1:50	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					
		0.30	D	N=14 (2,4/3,4,3,4)	0.30		CONCRETE	1 2 3 4 5 6 7 8 9 10	
		0.50	D		0.50		MADE GROUND: Pale yellow, grey and off-white slightly sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, angular to rounded flint rejects.		
		0.80	D		0.70		MADE GROUND: Orange-brown gravelly sand. Sand is fine to medium grained. Gravel is fine to coarse, sub-angular brick (50%) and flint (50%). MADE GROUND: Dark brown gravelly sandy clay. sand is fine to coarse grained. Gravel is fine to coarse, sub-angular brick (50%) and flint (50%). HEAD DEPOSITS: Orange-brown, grey and reddish-brown mottled, silty SAND. Sand is fine to medium grained.		
		1.00	D		0.80				
		1.00	SPT						
		1.50	D						
		2.00	D	2.00	End of Borehole at 2.000m				

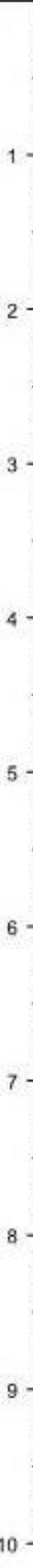
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks									
No roots noted. No groundwater encountered.									



Percussion Drilling Log

Project Name: Former Colt International		Client: Drew Smith Group		Date: 30/08/2019	
Location: New Lane, Havant PO9 2LZ		Contractor: TK			
Project No. : GWPR3192		Crew Name:		Drilling Equipment:	
Borehole Number WS12	Hole Type WLS	Level	Logged By EM	Scale 1:50	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					
		0.30	D	N=36 (5,7/7,8,11,10)	0.20			CONCRETE	
		0.50	D		0.40			MADE GROUND: Orange-brown slightly sandy gravel. Sand is fine to coarse grained. Gravel is fine to medium, sub-angular to rounded flint rejects.	
		0.80	D					HEAD DEPOSITS: Orange-brown and mid-brown SAND. Sand is fine to medium grained.	
		1.00	D						
		1.00	SPT						
		1.50	D	N=34 (6,9/9,9,8,8)					
		2.00	D						
		2.00	SPT		2.45				
								End of Borehole at 2.450m	

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: 30/08/2019	
Location: New Lane, Havant PO9 2LZ		Contractor: TK			
Project No. : GWPR3192		Crew Name:		Drilling Equipment:	
Borehole Number WS13	Hole Type WLS	Level	Logged By EM	Scale 1:50	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					
					0.20			CONCRETE	
		0.30	D		0.40			MADE GROUND: Pale orange to reddish-brown and off-white sandy gravel. Sand is fine to coarse grained. Gravel is fine to medium, angular to rounded flint rejects.	
		0.50	D					HEAD DEPOSITS: Orange-brown slightly gravelly SAND. Sand is fine grained. Gravel is occasional, fine, sub-angular to rounded flint.	1
		0.80	D		1.00			HEAD DEPOSITS: Mid-brown and orange-brown silty SAND. Sand is fine grained.	
		1.00	D						
		1.00	SPT	N=25 (3,4/4,5,6,10)					
		1.50	D						
		2.00	D						2
		2.00	SPT	N=26 (4,6/6,7,6,7)					
					2.45			End of Borehole at 2.450m	
									3
									4
									5
									6
									7
									8
									9
									10

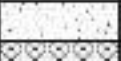
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No roots noted.
Wet soils noted at -1.50m bgl.

Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 30/08/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS14		Hole Type WLS		Level		Logged By EM		Scale 1:50		Page Number Sheet 1 of 1	

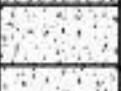
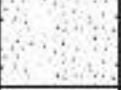
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20			CONCRETE	
		0.30	D		0.40			MADE GROUND: Fine to coarse flint gravel sub-base.	
		0.50	D					HEAD DEPOSITS: Orange to reddish-brown slightly gravelly SAND. Sand is fine grained. Gravel is rare to occasional, fine to coarse, sub-angular to rounded flint. Gravel becomes rarer from 0.80m bgl.	1
		0.80	D						
		1.00	D						
		1.00	SPT	N=26 (3,5/5,6,7,8)					
		1.50	D						
	2.00	D		2.00		End of Borehole at 2.000m	2		
								3	
								4	
								5	
								6	
								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.										
No groundwater encountered.										

Percussion Drilling Log

Project Name: Former Colt International			Client: Drew Smith Group			Date: 30/08/2019			
Location: New Lane, Havant PO9 2LZ			Contractor: TK						
Project No. : GWPR3192			Crew Name:			Drilling Equipment:			
Borehole Number WS15		Hole Type WLS		Level		Logged By EM		Scale 1:50	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					
					0.20		CONCRETE		
		0.30	D					MADE GROUND: Off-white sandy gravel. Sand is fine to medium grained. Gravel is fine to medium, angular to rounded flint.	
		0.50	D						
		0.80	D		0.70			HEAD DEPOSITS: Orange-brown gravelly SAND. Sand is fine to medium grained. Gravel is fine to medium, sub-angular to rounded flint.	
		1.00	D		1.00				
		1.00	SPT	N=25 (3,4/4,6,6,9)				HEAD DEPOSITS: Pale grey and orange sandy GRAVEL. Sand is fine to coarse grained. Gravel is fine to medium, sub-angular to rounded flint. Becomes sandier from 1.30m bgl.	
		1.50	D		1.40				
	2.00	D		2.00			HEAD DEPOSITS: Orange-brown SAND. Sand is fine to medium grained.		
							End of Borehole at 2.000m		

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.										
No groundwater encountered.										

Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 30/08/2019						
Location: New Lane, Havant PO9 2LZ				Contractor: TK										
Project No. : GWPR3192				Crew Name:				Drilling Equipment:						
Borehole Number WS16		Hole Type WLS		Level		Logged By EM		Scale 1:50		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										
		0.30	D	N=22 (2,5/4,6,6,6)	0.25			CONCRETE	1 -					
		0.50	D		0.35			MADE GROUND: Orange-brown, off-white and pale grey slightly sandy gravel. Sand is fine to coarse. Gravel is fine to medium, angular to sub-rounded flint rejects.						
		0.80	D		0.40			HEAD DEPOSITS: Orange-brown gravelly SAND. Sand is fine to coarse grained. Gravel is fine to medium, sub-angular flint.						
		1.00	D		1.00			HEAD DEPOSITS: Mottled brown, orange-brown grey and black silty SAND. Sand is fine grained. Strong hydrocarbon odour noted throughout, PID readings between 122.0 - 141.8ppm.						
		1.00	SPT	N=23 (4,4/5,5,7,6)	2.45						HEAD DEPOSITS: Orange and grey mottled silty SAND. Sand is fine grained. No odour noted, PID reading of 12.3ppm.	2 -		
		1.50	D								End of Borehole at 2.450m			
		2.00	D											
		2.00	SPT											
														3 -
														4 -
									5 -					
									6 -					
									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. Wet soils noted from 1.50 - 2.00m bgl. Strong hydrocarbon odour noted between 0.40 - 1.00m bgl, PID reading between 122.0 - 141.8ppm.														

Percussion Drilling Log

Project Name: Former Colt International						Client: Drew Smith Group						Date: 29/08/2019					
Location: New Lane, Havant PO9 2LZ						Contractor: TK											
Project No. : GWPR3192						Crew Name:						Drilling Equipment:					
Borehole Number WS17			Hole Type WLS			Level			Logged By EM			Scale 1:50			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													
					0.15			TARMAC									
		0.30	D	N=28 (2,2/3,5,8,12)	0.40			MADE GROUND: Chalk fill. Recovered as a structureless chalk composed of uncompacted, cream to off-white gravelly silt. Gravel is moderately weak, medium density, white and sub-angular. (Grade Dm in accordance with CIRIA574).	1 -								
		0.50	D														
		0.80	D														
		1.00	D														
		1.00	SPT					MADE GROUND: Dark grey-brown to black gravelly silty clay. Gravel is fine to medium, sub-angular flint (70%), brick (20%) and ceramic fragments (10%).	1 -								
		1.50	D		1.60			HEAD DEPOSITS: Light to mid-brown and grey mottled slightly sandy gravelly silty CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, angular to rounded flint.									
		2.00	D														
		2.00	SPT	50 (11,15/17,17,16,)				HEAD DEPOSITS: Orange-brown silty SAND. Sand is fine grained.	2 -								
					2.45				End of Borehole at 2.450m								
										3 -							
										4 -							
										5 -							
										6 -							
										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																	
Roots noted to 0.50m bgl. No groundwater encountered.																	

Percussion Drilling Log

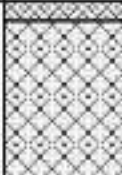
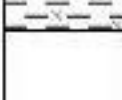
Project Name: Former Colt International				Client: Drew Smith Group				Date: 29/08/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS18		Hole Type WLS		Level		Logged By EM		Scale 1:50		Page Number Sheet 1 of 1	

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.30	D		0.20		TARMAC			
		0.50	D				MADE GROUND: Chalk fill. Recovered as a structureless chalk composed of uncompacted, cream to off-white gravelly silt. Gravel is moderately weak, medium density, white and sub-angular. (Grade Dm in accordance with CIRIA574).			
		0.80	D		0.70					
		1.00	D		1.00					
		1.00	SPT	N=6 (1,1/1,2,1,2)			MADE GROUND: Brown to black and off-white mottled sandy gravelly clay. Sand is fine to medium grained. Gravel is fine to medium, sub-angular to rounded flint (50%), chalk fragments (35%) and brick (15%). Rare (<5%) carbonaceous material also noted.		1	
		1.50	D				LONDON CLAY FORMATION: Orange-brown and blue-grey mottled silty CLAY. Claystone noted at ~2.00m bgl.		2	
		2.00	D							
		2.00	SPT	N=17 (1,1/2,2,4,9)						
					2.45			End of Borehole at 2.450m		3
										4
								5		
								6		
								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 Decayed roots noted at 2.00m bgl. No groundwater encountered.										

Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 29/08/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS19		Hole Type WLS		Level		Logged By EM		Scale 1:50		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							
					0.10		 TARMAC  MADE GROUND: Chalk fill. Recovered as a structureless chalk composed of uncompacted, cream to off-white gravelly silt. Gravel is moderately weak, medium density, white and sub-angular. (Grade Dm in accordance with CIRIA574).  MADE GROUND: Orange-brown gravelly sand. Sand is fine to coarse grained. Gravel is fine to medium, sub-angular to rounded flint rejects.  MADE GROUND: Reddish-brown to black gravelly sandy CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-rounded brick fragments. Soils become very wet ~1.50m bgl.  LONDON CLAY FORMATION: Orange-brown silty CLAY.				
		0.30	D		0.40						
		0.50	D		0.70						
		0.80	D								
		1.00	D								
		1.00	SPT	N=12 (1,1/2,1,2,7)							
		1.50	D		1.50						
		2.00	D								
		2.00	SPT	N=5 (1,1/1,1,1,2)							
		2.45									
End of Borehole at 2.450m											
										3 -	
										4 -	
										5 -	
										6 -	
										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 Roots noted to 2.00m bgl. Water encountered from 0.70 - 1.50m bgl.											

Percussion Drilling Log

Project Name: Former Colt International				Client: Drew Smith Group				Date: 29/08/2019			
Location: New Lane, Havant PO9 2LZ				Contractor: TK							
Project No. : GWPR3192				Crew Name:				Drilling Equipment:			
Borehole Number WS20		Hole Type WLS		Level		Logged By EM		Scale 1:50		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							
					0.20			TARMAC			
		0.30	D		0.50			MADE GROUND: Reddish-brown and off-white gravelly sandy clay. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-angular brick (50%) and flint (50%).	1		
		0.50	D		0.60						
		0.80	D								
		1.00	D		1.00			MADE GROUND: Off-white gravelly SAND. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular concrete fragments.			
		1.00	SPT	N=8 (1,1/1,2,2,3)				HEAD DEPOSITS: Orange-brown and greenish-grey mottled slightly gravelly sandy CLAY. Sand is fine to coarse grained. Gravel is occasional to abundant, fine to coarse, angular to sub-angular flint.			
		1.50	D					LONDON CLAY FORMATION: Orange, greenish-grey and brown mottled CLAY. Shell fragments noted at ~1.70m bgl, and claystone noted at ~2.00m bgl.	2		
		2.00	D								
		2.00	SPT	N=14 (1,2/3,3,4,4)							
					2.45				End of Borehole at 2.450m	3	
									4		
									5		
									6		
									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 Roots noted to 1.00m bgl. No groundwater encountered.											

APPENDIX C
Chemical Laboratory Test Results



James Dalziel
Ground & Water Ltd
2 The Long Barn
Norton Farm
Selborne Road
Alton
Hampshire
GU34 3NB

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 19-12935

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

Project / Job Ref: GWPR3192

Order No: None Supplied

Sample Receipt Date: 10/09/2019

Sample Scheduled Date: 10/09/2019

Report Issue Number: 1

Reporting Date: 17/09/2019

Authorised by:



Technical Manager

Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate

DETS Report No: 19-12935	Date Sampled	02/09/19	02/09/19	02/09/19	02/09/19	02/09/19
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Former Colt International, New Lane, Havant, PO9 2LZ	TP / BH No	WS1	WS1	WS2	WS3	WS4
Project / Job Ref: GWPR3192	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.30	2.00	0.50	2.00	1.50
Reporting Date: 17/09/2019	DETS Sample No	433622	433623	433624	433625	433627

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS		8.0		8.0	
Total Cyanide	mg/kg	< 2	NONE		< 2		< 2	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS		17		194	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS		0.02		0.19	
Organic Matter	%	< 0.1	MCERTS		0.2		0.8	
Total Organic Carbon (TOC)	%	< 0.1	MCERTS		0.1		0.5	
Arsenic (As)	mg/kg	< 2	MCERTS		< 2		8	
W/S Boron	mg/kg	< 1	NONE		< 1		< 1	
Cadmium (Cd)	mg/kg	< 0.2	MCERTS		< 0.2		< 0.2	
Chromium (Cr)	mg/kg	< 2	MCERTS		5		26	
Chromium (hexavalent)	mg/kg	< 2	NONE		< 2		< 2	
Copper (Cu)	mg/kg	< 4	MCERTS		< 4		42	
Lead (Pb)	mg/kg	< 3	MCERTS	167	7	321	53	10
Mercury (Hg)	mg/kg	< 1	NONE		< 1		< 1	
Nickel (Ni)	mg/kg	< 3	MCERTS		6		22	
Selenium (Se)	mg/kg	< 3	NONE		< 3		< 3	
Vanadium (V)	mg/kg	< 2	NONE		8		40	
Zinc (Zn)	mg/kg	< 3	MCERTS		11		286	
Total Phenols (monohydric)	mg/kg	< 2	NONE		< 2		< 2	

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

Subcontracted analysis (S)

(n) Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate

DETS Report No: 19-12935	Date Sampled	02/09/19	02/09/19	02/09/19	02/09/19	02/09/19
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Former Colt International, New Lane, Havant, PO9 2LZ	TP / BH No	WS5	WS6	WS7	WS8	WS9
Project / Job Ref: GWPR3192	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	1.50	0.50	0.50	0.30	0.50
Reporting Date: 17/09/2019	DETS Sample No	433629	433630	433631	433632	433634

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS					
Total Cyanide	mg/kg	< 2	NONE					
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS					
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS					
Organic Matter	%	< 0.1	MCERTS					
Total Organic Carbon (TOC)	%	< 0.1	MCERTS					
Arsenic (As)	mg/kg	< 2	MCERTS					
W/S Boron	mg/kg	< 1	NONE					
Cadmium (Cd)	mg/kg	< 0.2	MCERTS					
Chromium (Cr)	mg/kg	< 2	MCERTS					
Chromium (hexavalent)	mg/kg	< 2	NONE					
Copper (Cu)	mg/kg	< 4	MCERTS					
Lead (Pb)	mg/kg	< 3	MCERTS	55	17	89	9	5
Mercury (Hg)	mg/kg	< 1	NONE					
Nickel (Ni)	mg/kg	< 3	MCERTS					
Selenium (Se)	mg/kg	< 3	NONE					
Vanadium (V)	mg/kg	< 2	NONE					
Zinc (Zn)	mg/kg	< 3	MCERTS					
Total Phenols (monohydric)	mg/kg	< 2	NONE					

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

Subcontracted analysis (S)



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
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Soil Analysis Certificate						
DETS Report No: 19-12935	Date Sampled	02/09/19	02/09/19	02/09/19	02/09/19	02/09/19
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Former Colt International, New Lane, Havant, PO9 2LZ	TP / BH No	WS11	WS13	WS14	WS15	WS16
Project / Job Ref: GWPR3192	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.80	0.50	0.50	1.00	0.50
Reporting Date: 17/09/2019	DETS Sample No	433635	433636	433637	433638	433639

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS					7.9
Total Cyanide	mg/kg	< 2	NONE					< 2
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS					86
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS					0.09
Organic Matter	%	< 0.1	MCERTS					1.3
Total Organic Carbon (TOC)	%	< 0.1	MCERTS					0.8
Arsenic (As)	mg/kg	< 2	MCERTS					3
W/S Boron	mg/kg	< 1	NONE					< 1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS					< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS					14
Chromium (hexavalent)	mg/kg	< 2	NONE					< 2
Copper (Cu)	mg/kg	< 4	MCERTS					< 4
Lead (Pb)	mg/kg	< 3	MCERTS	17	< 3	9	< 3	< 3
Mercury (Hg)	mg/kg	< 1	NONE					< 1
Nickel (Ni)	mg/kg	< 3	MCERTS					7
Selenium (Se)	mg/kg	< 3	NONE					< 3
Vanadium (V)	mg/kg	< 2	NONE					18
Zinc (Zn)	mg/kg	< 3	MCERTS					26
Total Phenols (monohydric)	mg/kg	< 2	NONE					< 2

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



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate

DETS Report No: 19-12935	Date Sampled	02/09/19	02/09/19	02/09/19	02/09/19	02/09/19
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Former Colt International, New Lane, Havant, PO9 2LZ	TP / BH No	WS16	WS16	WS17	WS17	WS18
Project / Job Ref: GWPR3192	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.80	1.00	0.30	0.50	0.30
Reporting Date: 17/09/2019	DETS Sample No	433640	433641	433642	433643	433645

Determinand	Unit	RL	Accreditation	(n)		(n)	
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	6.4		7.7	
Total Cyanide	mg/kg	< 2	NONE	< 2		7	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	89		49	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.09		0.05	
Organic Matter	%	< 0.1	MCERTS	1		5	
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.6		2.9	
Arsenic (As)	mg/kg	< 2	MCERTS	4		16	
W/S Boron	mg/kg	< 1	NONE	< 1		1.9	
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2		0.3	
Chromium (Cr)	mg/kg	< 2	MCERTS	11		19	
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2		< 2	
Copper (Cu)	mg/kg	< 4	MCERTS	< 4		32	
Lead (Pb)	mg/kg	< 3	MCERTS	< 3	< 3	859	< 3
Mercury (Hg)	mg/kg	< 1	NONE	< 1		< 1	
Nickel (Ni)	mg/kg	< 3	MCERTS	10		12	
Selenium (Se)	mg/kg	< 3	NONE	< 3		< 3	
Vanadium (V)	mg/kg	< 2	NONE	14		44	
Zinc (Zn)	mg/kg	< 3	MCERTS	17		99	
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2		< 2	

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

Subcontracted analysis (S)



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate						
DETS Report No: 19-12935	Date Sampled	02/09/19	02/09/19	02/09/19	02/09/19	02/09/19
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Former Colt International, New Lane, Havant, PO9 2LZ	TP / BH No	WS18	WS19	WS19	WS19	WS20
Project / Job Ref: GWPR3192	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	1.00	0.30	0.80	1.00	0.30
Reporting Date: 17/09/2019	DETS Sample No	433646	433647	433649	433650	433651

Determinand	Unit	RL	Accreditation	(n)				
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS					
Total Cyanide	mg/kg	< 2	NONE					
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS					
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS					
Organic Matter	%	< 0.1	MCERTS					
Total Organic Carbon (TOC)	%	< 0.1	MCERTS					
Arsenic (As)	mg/kg	< 2	MCERTS					
W/S Boron	mg/kg	< 1	NONE					
Cadmium (Cd)	mg/kg	< 0.2	MCERTS					
Chromium (Cr)	mg/kg	< 2	MCERTS					
Chromium (hexavalent)	mg/kg	< 2	NONE					
Copper (Cu)	mg/kg	< 4	MCERTS					
Lead (Pb)	mg/kg	< 3	MCERTS	274	3	403	444	84
Mercury (Hg)	mg/kg	< 1	NONE					
Nickel (Ni)	mg/kg	< 3	MCERTS					
Selenium (Se)	mg/kg	< 3	NONE					
Vanadium (V)	mg/kg	< 2	NONE					
Zinc (Zn)	mg/kg	< 3	MCERTS					
Total Phenols (monohydric)	mg/kg	< 2	NONE					

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

Subcontracted analysis (S)