

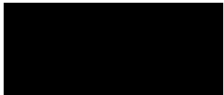
**REPORT ON
GROUND INVESTIGATION
AT
COLDHARBOUR ROAD
NORTHFLEET
GRAVESEND**



REPORT STATUS SHEET

Client:	Simply Develop (UK) Ltd
Report Title:	Report on Ground Investigation at Coldharbour Road, Northfleet, Gravesend.
Report Number:	AG3571-23-AR62
Report Status:	Validated Issue 1
Date:	February 2024



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1.0 INTRODUCTION

1.1 Objectives and Scope of Investigation

An area of land off Coldharbour Road, Gravesend (the Site) is being considered for redevelopment by Simply Develop (UK) Ltd (the Client). The proposals for the site comprise the construction of a 75-bed care home, with associated car parking, access road and areas of accessible soft landscaping.

Applied Geology has undertaken several phases of works on the site. An initial combined Phase I desk study and Phase II ground investigation was undertaken, on behalf of Frontier Estates Ltd, in August 2021 and reported in October 2021 (ref: AG3309-21-AN17).

Applied Geology was subsequently instructed by Frontier Estates Ltd to undertake supplementary soakaway testing in compliance with BRE Digest 365 methodology. The findings of this investigation were reported in October 2022 (ref. AG3309A-22-AP31).

In December 2023, Applied Geology was appointed by the Client to undertake a targeted investigation in order to supplement the previous information within the new proposed basement area. This current report details the findings of all three phases of intrusive works and includes conclusions and recommendations based on all data obtained. The terms of reference/brief for the works were mutually developed between the Client and Applied Geology and are outlined in our email proposal and estimate reference AG23-8656-01 dated 6th December 2023.

The scope of works undertaken by Applied Geology as part of this phase of works comprised the following:

- A supplementary ground investigation together with sampling, monitoring and a programme of laboratory testing in order to confirm and supplement the previous investigation, taking into account the specific proposed development proposal.
- Assessment and reporting of the Applied Geology desk study, conceptual site model and intrusive investigations undertaken to date (historic and recent).

As part of the most recent phase of works, service plans were obtained between the 12th of December 2023 and the 9th of January 2024. A topographic survey of the site by Survey Solutions (Drawing No. 18496SE-01 Rev -) dated October 2016, was provided by Frontier Estates Ltd.

1.2 Report Layout

This report presents a brief description of the site, the desk study data and the factual results of the intrusive investigations carried out. An interpretation of the ground conditions and a discussion/assessment of the findings is presented in the later report text sections. The main text of the report has been produced in a concise format, including the use of data tables to summarise key information where possible. The report should be read in conjunction with the general procedures detailed in Appendix F and General Notes given at the end of the main text, which provide details of investigation techniques, assessment methodology and standards, health & safety and limitations and exceptions of the report. Drawings and factual data including

exploratory hole records, laboratory testing results and desk study records are presented in the other Appendices.

2.0 SITE DESCRIPTION AND PROPOSALS

2.1 Site Description

The site is located at 8 Coldharbour Road, Gravesend, Kent, approximately 2km southwest of Gravesend town centre. The Ordnance Survey grid reference for the centre of the site is 563662, 172272 as shown on the Site Location Plan in Appendix A.

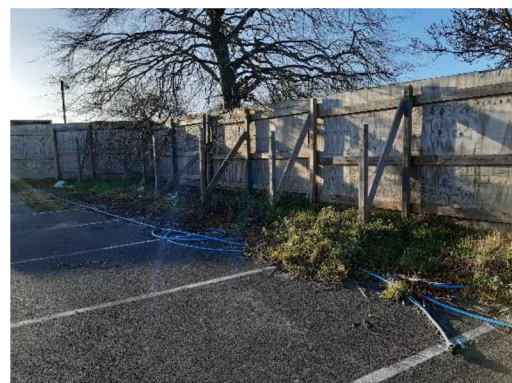
The site is approximately rectangular in plan shape with dimensions of approximately 70m by 50m (0.35Ha) and is relatively flat topographically at c. 40m to 41m AOD. The site then falls from an elevation of c. 40m to c. 38m AOD in the north of the site, suggesting there has been some cut to accommodate New House Lane to the north.

A site inspection/walkover was undertaken by Applied Geology as part of the initial investigation (reported in October 2021) and again during the supplementary works on the 27th of September 2022 and the 10th of January 2024. Access to the site was gained via a padlocked gate off Coldharbour Road, Gravesend. The site entrance was also secured with concrete bollards, which were moved and reinstated during the fieldwork. The perimeter of the site was secured with wooden fencing. At the time of inspection, the site comprised a disused parcel of land. The northern margin and eastern half of the site was surfaced with asphalt hardstanding whilst overgrown vegetation was present across the remainder of the site. Several piles of fly tipped material were noted, predominantly located in the margins of the site. These piles were not identified during the most recent site investigation/walkover and the overgrown vegetation was noted to have been cleared.

The site was bound to the north-west by New House Lane, to the south-west by Coldharbour road, to the south-east by Saint Clements Church and to the east by Shears Green Infant School and associated playing field. Beyond the boundaries of the site the surrounding area was predominantly residential. A number of semi-mature and mature trees were located along all boundaries to the site.



Concrete bollards and padlocked gate at the entrance to the site.



Photograph facing west at the wooden fencing securing the perimeter of the site.



Photograph looking east across the site.



Photo looking south-east across the site.

2.2 Site Proposals

The proposals for the site currently comprise the construction of a new 75-bed care home with a basement in the north-eastern corner, together with associated car parking and landscaping. The proposals are shown on Drawing 2271_00_005, Rev A, dated 30th October 2023 by Convery Prently Shields Architects as presented in Appendix A.

3.0 DESK STUDY INFORMATION

The desk study findings are summarised below with the full Groundsure Report and selected Historical Ordnance Survey Maps from the initial 2021 investigation included in Appendix B.

Site History	• 1865 – The site and surrounding area are predominantly agricultural fields with New House Lane aligning the northern boundary of the site and an unnamed road (later known as Old Perry Street and then Coldharbour Lane) aligning the western boundary. The site is labelled as Shears Green, and a Guidepost is mapped in the north-western corner. Coldharbour Farm and several associated outbuildings and pond are mapped c.150m to the north, whilst Durndale Farm, outbuildings and pond are mapped c.300m to the south-west. Gravesend town centre is mapped c.750m to the north-east. • 1895 to 1898 – There are no further significant changes noted on site. A garden Nursey is mapped to the immediate east/ south-east and a second Nursery is mapped c. 250m to the north-east, off New House Lane. The buildings/ outbuildings associated with Coldharbour Farm no longer appear on mapping and have likely been demolished, only the pond remains. An unspecified Shaft is mapped c.600m to the north-west and an 'Old Chalk Pit' is mapped c.500m to the south-east. • 1907 to 1909 – There are at least two unspecified structures mapped within the central regions of the site, one rectangular and one 'L' shaped. The Nursery to the north-east (off New House Lane) has extended up to Old Perry Street to the west. The pond c.150m to the north (formerly in the grounds of Coldharbour Farm) and the Old Chalk Pit c.500m to the south-east, no longer appear on mapping. • 1931 to 1932 – There are no further significant changes noted on site. Old Perry Street to the adjacent west of the site is renamed Coldharbour Road. The Nursery to the north and north-east is renamed as Coldharbour Nurseries and an allotment is mapped c.450m to the east. There has been significant expansion to the west and south of Gravesend, primarily with terraced style residential dwellings. Mid Kent Golf Course is mapped c.700m east of the site. • 1938 - There are no further significant changes noted on site. The Nursery to the adjacent east and Coldharbour Nurseries to the north are no longer
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	present on mapping. The site of the allotment c.500m to the east has been redeveloped to comprise a school. • 1952 to 1953- The two onsite structures appear to be separate businesses, with the western most (rectangular structure) labelled as Shears Green House and the eastern most (L shaped structure) labelled as the Battle of Britain Public House. A rectangular extension has been added to the frontage of the Public House. An embankment (slope) aligns the northern boundary of the site, which continues along New House Lane, with further embanking noted to the immediate south-east. The settlement of Gravesend has undergone significant expansion, with residential housing mapped to the adjacent north (beyond New House Road) and c.150m to the south and c.250m to the east. The Old Shaft c.600m to the north-west no longer appears on mapping. • 1960 to 1962 – The two onsite structures are now adjoining and labelled as the Battle of Britain Public House. Shears Green County Primary School and associated playing fields are mapped c.100m south-east of the site. Further residential dwellings are mapped c. 100m to the north-west. • 1968 to 1971 – The extension fronting onto the L shaped section of the Public House no longer appears on mapping and has likely been demolished. A Fire Station and Ambulance Station are mapped c. 50m and c.100m south of the site respectively. Further residential dwellings have been constructed c.500m to the south-west and c.750m to the west. • 1973 to 1978 – There are no further significant changes noted on site. A rectangular structure labelled as Coldharbour Catholic Hall is mapped to the adjacent south/ south-east of the site. The outbuildings and farm associated with Durndale Farm c.300m to the south-west no longer appear on mapping. The construction of the residential estates to the south-east and south-west/west is largely complete. • 1983 to 1987 - There are no further significant changes noted on site. The undeveloped land to the adjacent east is labelled Coldharbour Ward, with recently constructed residential dwellings mapped immediately beyond. • 2001 to 2003 - There are no further significant changes noted on site. The Catholic Hall to the adjacent south/ south-east of the site has been replaced by a series of semi-detached residential dwellings and St Clements Church is mapped to the adjacent south. A playground and playing field are mapped to the adjacent south-west of the site, beyond Coldharbour Road. • 2010 – There are no further significant changes noted on site or within the immediate area. • 2021- The Battle of Britain Public House is no longer mapped on site and has likely been demolished. The Mid Kent Golf Course is no longer labelled. Aerial Imagery • 1999 – The Public House is mapped within the central and north-western regions of the site. Hardstanding and/or car parking is noted along the northern and western boundaries, with soft landscaping mapped in the south-west. The surrounding area is similar to that of the present day, with residential housing mapped in the north and west (beyond New House Lane and Coldharbour Road), a Primary School mapped to the south-east and residential housing a fire station and ambulance station to the south. • 2009 to 2015 – The Public House is still mapped on site, however there are several large vehicles and temporary structures, which would suggest the Public House is no longer operational. • 2021 – The Public House is no longer mapped on site. It is understood that the Public House was demolished without formal permission. Demolition ceased part way through and then subsequently fully demolished due to structural safety concerns. Hardstanding remains along the northern and western boundaries, whilst overgrown, soft landscaping is mapped across the remaining areas of the site. • 2024 – There are no further significant changes onsite or within the surrounding area
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Anticipated Geology and Ground Conditions	• The Published BGS Map indicates the site to be underlain by Solid Geology of the Cretaceous Thanet Sand Formation over the Cretaceous Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation, herein referred to as Undifferentiated Chalk. Superficial Deposits are not shown on site, however, Head Deposits and River Terrace Deposits are shown nearby. • There are no records of ground works or Made Ground within the boundaries of the site, however, due to the previous phases of development and subsequent demolition, a variable thickness of Made Ground is anticipated. • A search of BGS records indicates that there are four available archived boreholes located c.0.7km and 0.8km to the north-west of the site, either positioned within the grounds of Cygnet Leisure Centre or along Hall Road. The boreholes were advanced by a Cable Percussion rig between May 1984 and July 1998 and typically encountered either a nominal covering of hardstanding or Topsoil over silty sands associated with the Thanet Sand Formation. Undifferentiated Chalk strata was encountered in the grounds of the Leisure Centre at depths of 13.35m and 14.60m bgl and was proven to the full depth of the investigation (17.20m bgl). Groundwater was not encountered. • The site is not in a radon affected area, with <1% of homes above the Action Level. No radon protection measures are, therefore, considered necessary for new properties. • The Groundsure Report indicates that the Undifferentiated Chalk is soluble, however, the hazard rating of ground dissolution is indicated to be 'negligible'. The risk from running sands within the Thanet Sand Formation is also assessed as being low risk.
Mining/Quarrying	• The site is not indicated to be within an area of underground coal mining activities. • There are no recorded surface ground workings within 250m of the site. • The Groundsure report indicates that a BritPit (British Pit) was formerly located c.447m south-east of the site and operated primarily for chalk commodities (Durndale Chalk Pit). Reference to the available historical mapping suggests that the site of the BritPit was recently redeveloped (2021) to comprise residential housing estate. • There are also records for an unspecified shaft located c.576m west of the site, which appeared on the available historical mapping between 1895 and 1931, after which it was denoted as 'Old Shaft'. By 1971 the area was redeveloped to comprise residential dwellings. • Whilst there are no records of underground chalk mining within the boundaries of the site, the Groundsure Report acknowledges that sporadic, undocumented chalk mining may have previously occurred. • There are no recorded naturally occurring or man-made dissolution features/ cavities within the boundaries of the site. However, reference to the Groundsure Report (which contains information from the updated Stantec UK Ltd database of known natural and man-made chalk solution features) indicates that there are records for six solution pipe features (naturally occurring cavity), all of which are located c.408m south-west of the site. There are also records for three mining cavities/ crown holes, located c.231m to the north-east, 531m to the west and 670m to the south-west. These are present in areas where the Thanet Sand is either not anticipated or anticipated thinner than on site.
Hydrology	• There are no surface water features within 0.5km of the site. • The site is outside of River and Coastal Flood Zones 2 and 3. The risk of flooding from rivers and sea is rated 'very low, with less than 1 in 1000 chance of flooding per year from either source. • There are no Licensed Discharge consents within 0.5km of the site. • There are no surface water abstraction licenses within 2km of the site. • The associated risk from surface water flooding is noted to be negligible.
Hydrogeology	• The Thanet Sand Formation is classified as a Secondary A Aquifer, whilst the underlying Undifferentiated Chalk strata is classified as a Principal Aquifer. • The site lies in a Total Catchment Zone 2 Source Protection Zone.

	- The nearest recorded active groundwater abstraction license is located c.742m south-east of the site, held by Mid Kent Golf Club Ltd for spray irrigation purposes. Approximately 10,000m³ of water is abstracted per annum. - There are no potable abstraction licences within 1km of the site. - The associated risk from groundwater flooding is noted to be negligible.
Other Environmental data	- There are no records held for any historic/operational landfills and other waste sites within 250m of the site. - There are four waste exemption licenses within 0.5km of the site, the nearest is located c.322m north-east of the site and is for the sorting and de-naturing of controlled drugs for disposal. - There are no historic/operational petrol and fuel sites within 0.5km of the site. - There are records for two historical unspecified tanks, which were previously located c. 239m south-west and 476m north-east of the site. There are also records for two historical garages, which were located c. 382m and c.415m north of the site, respectively. - There are currently nine industrial land usages within 250m of the site. There is an unspecified mast c.25m south of the site, a Fire Station and Ambulance Station c.77m and 112m south-east of the site, and three electricity substations c.113m to the south-east, 173m to the north-east and 185m to the west. - There are no sites determined as Contaminated Land under Part 2a of the Environmental Protection Act 1990, within 500m of the site. - There are no EA pollution incidents within 0.5km of the site. - There are no listed buildings or cultural designations within 2km of the site.
Railways/Tunnels	There are no current or proposed railway or tunnels within 250m of the site.
Unexploded Ordnance Threat	The site has undergone a Detailed Unexploded Ordnance (UXO) Risk Assessment by specialist contractor 1st Line Defence who consider there to be a Low-Risk form UXO on the site. Therefore, a UXO presence during the intrusive investigation and the subsequent groundworks/construction activities is not considered necessary.
Planning Application Search	Upon review of the Local Authority Planning Portal (Gravesend Borough Council) there are several applications/ permissions applicable to the site, including approval to demolish the former Public House. The most recent and applicable permission is for the outline planning permission for the current redevelopment scheme under reference number (20221251). The application was granted on the 23rd of November 2023, subject to compliance of twenty-nine conditions. Planning Condition 7 relating to Contamination and Remediation, states that no development should take place until a site investigation with preliminary risk assessment has been undertaken, together with a remediation and verification plan (if required) being approved.

4.0 CONCEPTUAL SITE MODEL

In developing a Conceptual Model for the site, pollutant linkages are determined by identifying likely sources of contamination from previous and current site uses, possible targets such as site users, neighbouring site users and Controlled Waters and linkages between them. These are discussed below.

4.1 Sources

The site has been identified as being occupied, historically, by an assumed residential dwelling (later known as Shear Green House), which was gradually converted into a Public House between 1953 and 1962. The Public House was demolished between 2015 and 2021. The following potential sources of contamination have been identified.

- Made Ground soils on site associated with historical site development (e.g. metals, PAH compounds, hydrocarbons, asbestos);
- Contaminants within offsite Made Ground soils (Inc. the adjacent south residential dwellings, adjacent south Fire station and ambulance station);
- Possible fuel leaks/ spillages associated with the former plant which worked on the demolition of the onsite structures and from vehicles which utilised the Public Houses car park;
- Onsite and offsite ground gases and volatile organic vapours associated with decomposition of organic material in Made Ground and hydrocarbon leaks/spillages;
- Sulphates in Made Ground or underlying natural strata.

The electricity sub-stations located c.113m south-east, 173m north-east and 185m west, have not been considered a viable source of contamination due to the fact that PCBs have low mobility and any form of contamination would be localised to the immediate area of the sub-station.

4.2 Pathways

- Human dermal contact (within areas of soft landscaping);
- Human ingestion (within areas of soft landscaping);
- Human inhalation of dust or volatile vapours (within areas of soft landscaping and within ground floor building spaces);
- Direct contact with buried concrete/water supply services;
- Leaching and/or migration through permeable soils (granular Made Ground and/or natural strata).

4.3 Receptors

- End user residents (Human Health);
- Thanet Sand Formation and Undifferentiated Chalk – Secondary A Aquifer and Principal Aquifer, respectively (Controlled Waters);
- Buried foundation/substructure concrete (Building Materials);
- Water supply services (Building Materials).

4.4 Source/Pathway/Receptor Linkage and Assessed Risk

Source-pathway-receptor (SPR) linkages are tabulated below together with the qualitatively assessed risk. The risk to ground workers and construction workers is not included here due to the short-term exposure times that they will be subject to and the assumption that good hygiene practices will be adopted on site and the appropriate use of relevant PPE/RPE will be adhered to when exposed to potentially contaminated soils. Comments regarding contamination issues with respect to ground workers and construction workers are included in the health and safety section of the Standard Procedures included as Appendix F.

Source	Pathway	Receptor	Risk*
Potential contamination within Made Ground (on site) associated with	Inhalation, ingestion, dermal contact within areas of soft landscaping	End users	Low to Medium

Source	Pathway	Receptor	Risk*
former site usage (e.g. Metals, PAH compounds, Hydrocarbons, solvents, Asbestos)	Vertical and lateral migration and leaching	Secondary A and Principal Aquifers (Controlled Waters)	Low to Medium
	Direct contact	Water supply pipes	Low
Potential contaminants within Made Ground associated with offsite industrial site usage (hydrocarbons and volatile organic compounds)	Vertical and lateral migration and leaching	Secondary A and Principal Aquifers (Controlled Waters)	Low to Medium
Hydrocarbon contaminants within soils associated with leaks/spillages	Inhalation, ingestion, dermal contact within areas of soft landscaping	End users	Low
	Vertical and lateral migration and leaching	Secondary A and Principal Aquifers (Controlled Waters)	Low to Medium
	Direct contact	Water supply pipes	Low to Medium
Soil gas from onsite Made Ground and offsite industrial usages (methane, carbon dioxide)	Migration into buildings, service ducts, etc (inhalation/explosion)	End users	Low to Medium
Elevated sulphates in Made Ground/natural soils (on site)	Direct contact	Buried concrete	Low to Medium

*** Definition of Risk Categories**

Negligible - Contaminants that might have unacceptable impact on key receptors, are unlikely to be present, or no pathway is envisaged.

Low Risk: Contaminants may be present but are unlikely to be at levels to have unacceptable impact on key receptors, or pathways are likely to be minimal.

Medium Risk: Contaminants are probably present and might have an unacceptable impact on key receptors. Pathways may also be present therefore remedial measures may be necessary to reduce the risks.

High Risk – Contaminants probably or certainly present and pathways are probably also present. Therefore, contaminants are likely to have an unacceptable impact on key receptors and remedial measures are likely to be necessary to reduce the risks to acceptable levels.

4.0 GROUND INVESTIGATION WORKS

4.1 Fieldwork (2021 & 2022 & 2024)

The fieldwork undertaken during the 2021 intrusive investigation was designed based on the proposed development layout at the time and is summarised in the following table:

Type	Number	Reference	Max depth (m bgl)	Rationale
Cable Percussion Borehole	2	BH1 – BH2	12.45	Within footprint of proposed structures for geotechnical purposes and installation of monitoring wells
Driven Continuous Samples	5	DCS1 – DCS5	4.45	Within footprint of proposed structures for geotechnical

Type	Number	Reference	Max depth (m bgl)	Rationale
				purposes and installation of monitoring wells
Trail Pits	7	TP1 – TP7	3.00	Located in areas of proposed car parking/ hardstanding and/or soft landscaping, to provide a general site coverage and to obtain samples for subsequent contamination analysis. Soakaway infiltration tests undertaken within TP6 and TP7
Trial Trenches	3	TT1 – TT3	2.50	Confirm or otherwise the presence of a former cellar and/or concrete obstructions, such as relict foundations
TRL DCP Tests	4	TRL1 – TRL4	0.98	Determine the in-situ CBR profile of the soils within areas of proposed hardstanding (access roads/ car parking)

Soakaway testing in general accordance with BRE Digest 365 methodology was undertaken as part of the supplementary 2022 intrusive investigation in two trial pits (SA1 and SA2). The trial pits were machine excavated to depths of 2.40m and 3.40m below ground level (bgl) to target the granular Thanet Sand Formation. Due to the nature of the predominantly granular Thanet Sand strata and the potential for sidewall collapse, the trial pit soakaway excavations were backfilled with a washed single sized (20mm) imported gravel, in order to maintain sidewall stability during each fill.

As part of the recent phase of works, the following scope of fieldwork was undertaken on the 10th of January 2024:

- 4 No. Driven Continuous Sampling boreholes (DCS101 to DCS104) to depths of between 4.31 to 4.35m bgl targeting the proposed basement;
- 2 No. drive in steel piezometers (within DCS101 and DCS102) installed to depths of between 4.50m and 4.70m bgl for groundwater monitoring;
- 1 No. follow on dynamic probe test commenced at the base of DCS103 to a depth of 7.10m bgl.

All phases of fieldwork were carried out, where relevant, in accordance with BS5930 (2015) “Code of Practice for Site Investigations” and were supervised by an experienced Geoenvironmental Engineer.

The trial pit, borehole and follow-on dynamic probe records are presented in Appendix B and C, along with the Standard Penetration Test (SPT) calibration certificates and an SPT summary sheet. The soakaway and TRL DCP records are included in Appendix B.

Prior to the initial phase of works, a Detailed Unexploded Ordnance Risk Assessment (dated August 2021) for the site was undertaken by 1st Line Defence on behalf of Applied Geology. The assessment concluded that the potential risk for unexploded WWI and WWII ordnance was Low and, therefore, no further action was warranted. On site UXO supervision was, therefore, not provided during the ground investigation works.

The locations of the exploratory holes were selected by Applied Geology Limited. For both the initial and most recent phase of works, the positions were set out on site and cleared for the presence of underground services by specialist contractors Midland Survey Ltd and Safe Dig Surveys Ltd respectively. For the second phase of works, locations of the trial pit soakaways were set out on site by Applied Geology.

The positions of the 2021 and 2024 exploratory holes were surveyed to National Grid and levelled to Ordnance Datum by the respective specialist contractors. The 2022 trial pit soakaway were located approximately by reference to physical features present on site and set out by Applied Geology at the time of the investigation.

The locations of the exploratory holes are presented on the Exploratory Hole Location Plan (AG3571-23-02) included in Appendix A and the co-ordinates and levels, where obtained, are included on the exploratory hole records in Appendix B and C.

4.2 Instrumentation and Monitoring

On completion of boring, a combination of 50mm and 19mm diameter standpipes were installed in selected Driven Continuous Sampling boreholes as follows, with further details included in the relevant borehole logs in Appendix B and C:

Stratum	BH No.	Response Zone (m bgl)	Diameter (mm)	Rationale
Made Ground	DCS5	0.50-1.50	50	Gas and groundwater monitoring
Thanet Sand Formation	DCS1 DCS2 DCS3 DCS4	1.00-4.00 1.00-4.00 1.00-3.00 1.50-4.00	50	Gas and groundwater monitoring
	DCS101 DCS102	4.10-4.50 4.30-4.70	19	Groundwater monitoring

During each phase of work, washed silica gravel (2-6mm) was used as the filter medium. Each 19mm standpipe fitted with a galvanised end cap and each 50mm standpipe was fitted with a push-in bung and a single gas tap. All installed boreholes were finished with a flush metal cover concreted in place.

Ground gas and groundwater monitoring visits were previously undertaken on four occasions from the 16th of August 2021 to the 16th of September 2021. Each 50mm monitoring well was monitored for concentrations of carbon dioxide, methane, VOCs, oxygen, flow rate and differential pressure and groundwater levels.

As part of the recent phase of supplementary works, a further two ground gas and groundwater monitoring visits have been undertaken on the 16th and the 30th of January 2024.

Collectively, the results of the ground gas and groundwater monitoring undertaken at the site to date are presented in Appendix D.

4.3 Laboratory Testing

Geotechnical laboratory testing was initially undertaken by specialist laboratory Terra Tek Limited (UKAS lab no. 0126) as part of the 2021 investigation, with supplementary testing undertaken by Geotechnics (UKAS lab no. 1365) as part of the 2024 phase of works.

Collectively, the geotechnical testing comprised the following:

- 6 No natural moisture content tests;
- 6 No Atterberg limit tests;
- 4 No Particle Size Distribution tests (sieve);
- 3 No Particle Size Distribution tests (sieve and hydro);
- 10 No BRE SD1 natural ground suite tests (4 with pyrite);
- 2 No BRE SD1 Brownfield tests.

As part of the initial investigation, chemical testing was undertaken by specialist laboratory Chemtest (UKAS lab no. 2183). As part of the most recent investigation, chemical testing was undertaken by specialist laboratory i2 Analytical (UKAS lab no.4041). The scope of testing was based on the desk study, walkover and site observations made during the fieldwork.

Made Ground

Eight samples of Made ground were analysed for the following suite of contaminants;

- Selected metals suite [arsenic, boron, beryllium, cadmium, chromium (total, trivalent and hexavalent), copper, mercury, nickel, lead, zinc, selenium, vanadium];
- Chromium trivalent and hexavalent (5 samples);
- Speciated (16 US EPA) Polycyclic Aromatic Hydrocarbons (PAH);
- Phenols (total);
- pH;
- Water soluble sulphate;
- Asbestos Containing Materials (ACM) Screen (nine samples);
- Soil organic matter;
- Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG) (four samples);
- Total Petroleum Hydrocarbons 9 band (two samples);
- BTEX and MTBE (four samples).

Natural Soils

One sample of the Head Deposits and four samples of the Thanet Sand Formation were analysed for the following suite of contaminants;

- Selected metals suite [arsenic, cadmium, chromium (total), copper, mercury, nickel, lead, zinc, selenium, boron, beryllium, vanadium];
- Speciated (16 US EPA) Polycyclic Aromatic Hydrocarbons (PAH);
- pH;
- Water soluble sulphate;

- Soil organic matter;
- TPH CWG (three samples);
- TPH (9 band) (one samples);
- BTEX an MTBE (three samples);
- Asbestos Containing Materials (ACM) screen (two samples).

At the request of the Client, two samples of the Thanet Sand Formation were submitted for Inert WAC testing as part of the supplementary works.

Leachate

Leachate analysis was carried out on one sample of Made Ground and two samples of the Thanet Sand Formation, for the following suite of contaminants:

- Selected metals suite [arsenic, cadmium, chromium (total, trivalent and hexavalent), copper, mercury, nickel, lead, zinc, selenium, vanadium];
- Speciated (16 US EPA) Polycyclic Aromatic Hydrocarbons (PAH);
- pH.

Copies of the laboratory test results as part of the initial phase of intrusive works are presented in Appendix B, whilst the results of the most recent phase of intrusive works are presented in Appendix E.

5.0 GROUND CONDITIONS

5.1 Strata Encountered

Collectively, the Applied Geology ground investigations at the site have identified a variable and locally significant thickness of Made Ground, overlying predominantly granular soils of the Thanet Sand Formation. Locally in the north-western corner of the site, cohesive Head Deposits were noted above the Thanet Sand Formation.

Strata interpreted to represent the Undifferentiated Chalk were not identified by Applied Geology during the investigations, suggesting this stratum is at a depth in excess of 12m bgl.

Full details of the strata encountered are given on the borehole records presented in Appendix B and C. A generalised ground profile is presented below to summarise the information. An SPT 'N' value versus depth plot is presented in Appendix A.

Diagrammatic representations of the findings of the Trial Trenches are presented as Drawing AG3309-21-03 Sheets 1-3, in Appendix B.

Stratum	Depth to Top of Strata (m bgl)	Thickness (range) (m)	Comments
Hardstanding	GL	0.10 to 0.20	Encountered across the north-western, northern and eastern regions of the site.
Made Ground	GL	0.15 to 2.30	Encountered in all exploratory holes across the site. Greater thicknesses of Made Ground present within the

Stratum	Depth to Top of Strata (m bgl)	Thickness (range) (m)	Comments
			central regions of the site, in the footprint of the former Public House.
Head Deposits	0.50	2.00	Encountered in the north-western corner of the site in BH1 only.
Thanet Sand Formation	0.15 to 2.20	Proven to the full depth of the investigation (12.45m bgl)	Encountered in all exploratory holes across the site.

5.2 Hardstanding

Asphalt hardstanding was encountered from surface along the north-western, northern and eastern regions of the site and was proven to depths of between 0.10m and 0.20m bgl. Prior to advancement, the asphalt hardstanding was broken out using an excavator mounted hydraulic breaker.

5.3 Made Ground

Made Ground was encountered in all exploratory holes across the site, either from surface or beneath a covering of hardstanding. The thickness of the Made Ground varied significantly across the site, between depths of 0.15m (TP6) and 2.30m bgl (TT1), although the Made Ground was generally proven to shallow depths between of 0.15m and 0.60m bgl. The greater thicknesses of Made Ground (c.1.70m to 2.30m bgl) were generally encountered within the central regions of the site in the location of the former Public House and possibly indicative of the location of a former cellar. It should be acknowledged that as the site has been subject to previous phases of development and subsequent demolition, it is therefore probable that deeper Made Ground than that identified in the investigation, may be encountered locally.

The Made Ground generally comprised horizons of brown sandy slightly silty/clayey gravels and/ or brown slightly gravelly silty/clayey fine to medium sands, locally, horizons of soft brown slightly gravelly sandy clays were encountered. Collectively, the gravel content generally comprised fine to coarse subangular to subrounded quartzite, chalk, sandstone, asphalt, clinker, brick and concrete. The granular Made Ground in DCS4 had a notably higher organic content and a slightly natural organic odour.

A concrete obstruction was encountered across the full extent of TP3 (located in the north of the site) at a depth of between 0.30m to 0.50m bgl. The concrete was easily broken out by the onsite excavator (JCB 3CX) and the trial pit was progressed.

Due to the nominal thickness of the Made Ground, particularly within borehole positions, a single Standard Penetration Tests (SPTs) was undertaken. An SPT 'N' value of 19 (medium dense) was recorded in DCS5 at 1.2m bgl.

5.4 Head Deposits

During the initial investigation, strata considered to represent Superficial Head Deposits were encountered in a single exploratory hole (BH1) in the north-western corner of the site directly beneath the Made Ground from 0.50m bgl to 2.00m bgl. The Head Deposits comprised soft becoming firm brown mottled grey sandy clay, with fine to coarse subangular to subrounded quartzite gravel.

Due to the nominal thickness of the Head Deposits in BH1 and its absence elsewhere onsite, a single SPT was carried out in these soils, recording an 'N' value of N=16 (medium strength) at 1.20m bgl.

5.5 Thanet Sand Formation

Strata considered to represent the Thanet Sand Formation were recorded directly beneath the Made Ground and Head Deposits (where encountered) from depths of between 0.15m (TP6) and 2.20m bgl (TT1) and were proven to the full depth of the investigation (12.45m bgl).

The stratum generally comprised medium dense becoming dense (light) brown slightly clayey/silty, slightly gravelly fine to medium sand. Locally, nominal horizons of firm becoming stiff orangish brown slightly sandy, slightly gravelly clay/ silt were recorded. Collectively, the gravel content comprised fine to coarse subangular to subrounded flint gravel, whilst iron staining was also often recorded with depth.

The results of six Atterberg Limit tests undertaken on the cohesive Thanet Sand strata have indicated plasticity indices of between 27% and 33% (corrected to 7.6% and 33%) indicating these soils to be of low to medium shrinkability as defined by NHBC Standards. Uncorrected Liquid Limits of between 45% and 55%, plastic limits of between 15% and 22% and moisture contents of between 13.2% and 25.9% were also recorded. The results indicate the clays to be of medium to high plasticity. It should be noted that the sample obtained from DCS2 at 2.60m bgl was noted to be non-plastic.

Seven particle size distribution tests were undertaken on bulk samples of the Thanet Sand strata, six samples were taken from granular horizons and one sample was taken from cohesive silty strata (TP4 at 0.40m bgl). The results from the granular material indicated the following proportions: 0.0% cobble, 0.2% and 34.6% gravel, 41.7% and 93.5% sand, 5.2% and 18.6% fines, 12% and 17% silt, 6.7% and 12.1% clay. The sample obtained from a cohesive horizon of Thanet Sand strata indicated the following proportions: 0.0% cobble 22.8% gravel, 51.0% sand, 20.2% silt and 6.1% clay.

Fifty-one in-situ SPTs were carried out within the Thanet Sand strata, forty in the granular soils and eleven in the cohesive soils. Uncorrected 'N' values of between N=4 and N=24 (low to medium strength) were recorded at a depth of 1.20m bgl in the granular soils, increasing to 'N' values of N=17 and N=43 (medium to high strength) at 2.00m bgl. Uncorrected 'N' values of N=4 and N=43 (low to high strength) were recorded at depths of between 1.20m and 3.00m bgl in the cohesive soils. The SPT vs depth plot generally shows a prominent increase in strength with depth.

Following an SPT 'refusal' in DCS103, follow-on dynamic probing was undertaken. The dynamic probing recorded N100 values of between 2 and 34 (generally between 15 and 21) at depths of between 4.10m and 7.10m bgl.

Effective stress testing has not been undertaken on the Thanet Sands strata as part of these works, however, for preliminary design purposes peak internal friction angles (Φ') of between 30° and 35° may be assumed. These values are based on SPT N values using the angle of shear resistance and SPT relationship by Peck et al Tomlinson 7th Edition.

5.6 Groundwater and Soakaway Tests

During the 2022 and 2024 supplementary investigations, groundwater was not encountered during drilling or excavation. During the 2021 investigation, groundwater was recorded in the granular Thanet Sand Formation within the deeper cable percussion boreholes and within some DCS boreholes as detailed in the table below.

Location	Stratum	Depth of strike (m bgl)	Groundwater level after 20min	Comments
BH1	Thanet Sand Formation	4.30	4.30	Strike
BH2	Thanet Sand Formation	4.30	4.30	Strike
DCS1	Thanet Sand Formation	3.80	3.80	Strike
DCS4	Thanet Sand Formation	3.80	3.80	Seepage

During the 4No. monitoring visits following the 2021 investigation, groundwater was not encountered in any of the standpipes. As part of the subsequent 2024 monitoring programme, water was noted at the base of DCS2 and DCS4 at depths of 3.85m and 3.67m bgl respectively. It should however be noted that during the following visit, groundwater was not encountered.

The 2024 standpipes installed within the footprint of the proposed basement remained dry during both monitoring visits, at depths of 4.50m and 4.70m bgl, suggesting groundwater is at least 35.50m AOD at this location.

Groundwater levels may fluctuate for a number of reasons, including in the short term the prevailing weather conditions immediately before and during investigation and monitoring works and longer-term seasonal variations should be expected.

During the 2021 investigation, preliminary soakaway tests were carried out in two open trial pits located in the south (TP6) and central (TP7) regions of the site. The trial pits were terminated shallow at depths of 1.70m (TP6) and 2.00m bgl (TP7) within the Thanet Sand strata. The soakaway tests were carried out in general accordance with BRE Digest DG365 methodology, however, only one filling was undertaken.

Supplementary infiltration testing was undertaken in September 2022. The soakaway infiltration tests in SA1 and SA2 were carried out in accordance with BRE Digest DG365 methodology and three test fills were undertaken over the course of three days. The results of both the preliminary and supplementary tests are included in

Appendix B, including the calculations in accordance with BS5930 (BSI 1999) and are summarised in the table below:

Test ID	Stratum	Test results (m/s)
TP6	Thanet Sand Formation	1.10×10^{-5}
TP7		4.70×10^{-6}
SA1 (Fill 1)	Thanet Sand Formation	1.10×10^{-5}
SA1 (Fill 2)		5.70×10^{-6}
SA1 (Fill 3)		3.30×10^{-6}
SA2 (Fill 1)	Thanet Sand Formation	1.20×10^{-6}
SA2 (Fill 2)		1.00×10^{-6}
SA2 (Fill 3)		9.80×10^{-7}

The infiltration rates for fill one for both SA1 and SA2 are generally consistent to those determined as part of the initial investigation for TP6 and TP7.

As is normal and expected the infiltration rates generally reduced with successive fills of the test pits and it is recommended in BRE Digest DG365 that the results from the third fill is taken as being most representative for long term design purposes.

5.7 Ground Gas

Gas screening values have been calculated for each installation using highest concentrations and highest flow rates in accordance with CIRIA C665. The GSVs are as follows:

Stratum	BH	Response Zone (m bgl)	Ground water level (m bgl)	Max. Methane (%)	Max. Carbon Dioxide (%)	Max. Steady Flow (l/hr)	GSV Methane (l/hr)	GSV Carbon Dioxide (l/hr)
Thanet Sand Formation	DCS1	1.00-4.00	DRY	0.1	2.9	0.1	0.0001	0.0029
	DCS2	1.00-4.00	3.85	0.1	2.6	0.1	0.0001	0.0026
	DCS3	1.00-3.00	DRY	0.1	3.1	0.1	0.0001	0.0031
	DCS4	1.50-4.00	3.67	0.1	1.7	0.3	0.0003	0.0051
	DCS5	0.50-1.50	DRY	0.1	0.2	0.1	0.0001	0.0002

Green highlighted cells indicate CS-1 conditions.

Blue highlighted cells indicate a fully saturated response zone

Orange highlighted cells indicate consideration to be given to increasing CS classification

The results of the ground gas monitoring undertaken indicated methane concentrations below the limit of detection (<0.1%) together with carbon dioxide concentrations of between 0.2% and 3.1%. Oxygen concentrations were recorded between 16.9% and 21.6% and average flow rates were recorded between <0.1l/hr and 0.3l/hr.

All VOC concentrations were noted to be below the limit of detection (<0.1ppm) and therefore are of no significant concern.

5.8 Contamination

Aside from the gravel sized fragments of asphalt and clinker within the Made Ground soils, there was no obvious visual or olfactory evidence of any significant contamination observed in the boreholes, trial pits or the trial trenches.

6.0 GEOENVIRONMENTAL ASSESSMENT

6.1 Human Health Risk Assessment

The results of the chemical testing on soils have been assessed as described in Appendix E, with specific details as follows:

- Proposed end-use – Care Home with associated garden space;
- Screening criteria – Residential without Plant Uptake, based on 2.5% SOM;
- Assuming a single dataset based on the size of the site, current land-use and the proposed redevelopment.

There are no published generic screening criteria for a care home facility end use. It could be argued that the critical receptor is an adult worker present on site from the age of 16 to 65. Therefore, a commercial end use criteria would be considered appropriate. However, given the amount of landscaping present on the proposed development plan (Appendix A) and to reflect the end use as a care home, conservative residential without plant uptake criteria has been used to provide an initial screen.

The spreadsheets summarising the laboratory results and relevant screening values for each dataset are presented in Appendix E. A review of the chemical testing undertaken on the soil samples analysed has indicated all metals to be significantly below the screening criteria, whilst BTEX, MTBE and Phenol concentrations were below laboratory detection limits. TPH concentrations exceeded screening values in one carbon fraction in two samples as outlined below:

- Aromatic TPH – C21 to C35 exceedance in TP3 at 0.20m bgl (5000mg/kg against a screening value of 1900mg/kg);
- Aromatic TPH – C21 to C35 exceedance in TP4 at 0.15m bgl (3200mg/kg against a screening value of 1900mg/kg).

A number of PAH determinands were also noted to exceed screening values and together with the TPH exceedance, these were noted to be from samples predominantly within the upper granular Made Ground directly beneath the asphalt hardstanding and in exploratory positions located along the northern, north-western and north-eastern boundaries of the site, in areas of former car parking.

Subsequent chromatogram analysis was undertaken on the soil samples from DCS104 (0.20m bgl), TP3 (0.20m bgl) and TP4 (0.15m bgl), which indicated the potential source/origin of the elevated TPH to likely be PAH and/or heavy oil. It is considered plausible that these and the other elevated concentrations of hydrocarbons recorded are potentially from spills/leakages as these areas of the site were used as car parking for the former Public House, or associated with leaching from the overlying asphalt.

Laboratory screening for asbestos did not detect any Asbestos Containing Materials (ACM) within any of the samples tested.

6.2 Controlled Waters Risk Assessment

The Secondary A (Thanet Sand Formation) and Principal (Undifferentiated Chalk) aquifers beneath the site are considered to be the key Controlled Water receptors. The potential for complete pollutant linkages associated with leaching and vertical migration from impacted soils has, therefore, been semi-quantitatively assessed using the results of the soil leachate analysis detailed below:

As part of the 2021 investigation, three samples obtained from either the Made Ground or the natural strata marginally beneath the Made Ground were analysed for their metal and PAH leaching potential. The results were compared directly to the Controlled Water screening values based on the conservative UK Drinking Water Standards 2010 (UK DWS). In the absence of a relevant screening value, EQS and the laboratory limit of detection have been used as an initial screen. The results are tabulated and presented in Appendix B.

Following the initial screening, all determinands were at concentrations below screening values.

6.3 Disposal of Soil Arisings

General comments regarding the procedures for the assessment of waste soil for off-site disposal purposes is included in Appendix F. Under the Waste Framework Directive, naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development. The comments below only apply if surplus soil is sent off-site for disposal.

With regards to potential waste disposal of the Made Ground, the samples tested indicate contaminants at concentrations that would likely be classified as non-hazardous waste. However, where localised elevated hydrocarbon concentrations are present, as is the case for TP3 at 0.20m bgl (Total TPH of 7000mg/kg) and TP4 at 0.15m bgl (Total TPH of 6000mg/kg), hazardous WAC testing may be required if the material is to be disposed of at landfill. This would need to be discussed with the receiving landfill facility and the results of this investigation provided.

As requested, waste acceptance criteria (WAC) tests were undertaken on two samples of the Thanet Sand Formation. The results demonstrate compliance with the WAC limits for inert landfills.

Topsoil was not encountered at the site; therefore, it is assumed that a clean imported Subsoil/Topsoil which is suitable for use and complies with relevant British Standards and Landscape Architect requirements will be required for proposed gardens and other areas of soft landscaping.

7.0 GEOTECHNICAL ASSESSMENT

7.1 General

The proposals for the site currently comprise the construction of a new 75 bed care home with a semi-basement in the north-eastern corner, together with associated car parking and landscaping. No loading information was available at the time of writing.

The ground investigation undertaken at the site to date have identified a predominantly granular Made Ground from surface, proven to depths of between 0.15m and 2.20m bgl, although the Made Ground was generally proven to shallow depths of 0.15m and 0.60m bgl. Upon proving the base of the Made Ground, strata considered to represent the Thanet Sand Formation were generally encountered and proven to the full depth of the investigation (12.45m bgl). However, locally in BH1 strata interpreted as cohesive Head Deposits were encountered directly beneath the Made Ground and were proven to a base of 2.00m bgl.

Chalk was not encountered during the intrusive works, indicating this stratum is at a depth in excess of 12.45m bgl.

Groundwater strikes were recorded in the Cable Percussion and DCS boreholes at depths of 3.80m and 4.30m bgl during drilling, however the installed standpipes were generally dry during the return monitoring programme.

7.2 Foundation Design

It is considered that the granular strata of the Thanet Sand Formation encountered at the site are suitable to support conventional strip/trench fill or pad foundations. These must be placed below any Made Ground or disturbed ground and embedded within the in-situ medium dense or better sand strata beneath these materials.

Although a minimum founding depth of 0.9m bgl will apply to allow for seasonal effects, the borehole data suggests that founding depths of around 1.0m to 2.3m are likely to be required to ensure that the above deepening criteria are met. The boundaries of the site were lined with semi mature and mature trees and, therefore, localised deepening of foundations may be necessary within the zones of influence of these trees. Minimum foundation depths should initially be based on the depths given within published guidance, such as NHBC standards. Foundations would not need to be deepened beneath the depth where granular Thanet Sand is present.

Strip/trench fill (up to 1m wide) and pad foundations (up to 2m x 2m) competently designed to the above requirements may adopt safe net design bearing pressures up to 175kN/m². This is based on a typical N value of 10 over the influencing depth of foundations and using traditional methods of bearing capacity calculations e.g. as set out in Tomlinson 7th Edition and a factor of safety of 3 against bearing capacity failure. If required, a greater safe net design pressure of up to 250kN/m² is considered achievable for foundations deepened to 2.0m bgl (based on a typical N value of 20 at that depth).

Given the ground conditions encountered and the findings of the Phase I assessment, it is considered that there is a negligible risk of ground dissolution of soluble rocks. Further assessment is, therefore, not considered necessary. Should the ground

conditions differ locally during the groundworks to those encountered during this investigation, this assessment may need to be reviewed.

If conditions, significantly at variance to those described herein are encountered, specialist geotechnical advice should be sought to make appropriate assessment and recommendations.

7.3 Semi-Basement

It is anticipated that the single storey semi-basement level proposed in the north-east corner of the site will be up to 2.65m deep. Foundation excavations would be expected to be up to c.1m below this to a maximum depth of 36.625m AOD. The basement excavation will therefore likely be in a combination of generally shallow Made Ground and natural strata of the Thanet Sand Formation.

Based on groundwater level monitoring data to date and proposed basement depths, groundwater is unlikely to be encountered in foundation excavations or the permanent works.

7.4 Floor Slab and Gas Protection

It is an NHBC requirement that suspended ground floor slabs are adopted where Made Ground exceeds 600mm in thickness. Where Made Ground is less than 600mm thick ground bearing slabs may be adopted, subject to proof rolling, removal of soft spots and replacement with a suitable compacted granular material. Due to the depth and nature of the Made Ground encountered on this site and likelihood of some near surface disturbance following removal of old foundations etc, suspended ground floor slabs may be necessary locally. Elsewhere, ground bearing slabs would be feasible where the above criteria are satisfied.

Based on the calculated gas screening values the site can be characterised as Characteristic Situation 1 (CIRIA C665), for which no precautionary gas protection measures are required in line with BS8485:2015+A1:2019.

Radon protection measures are also not considered necessary.

7.5 Excavations

All trial pits and trial trenches advanced as part of this investigation remained stable during excavation. However, due to the predominant granular nature of the Made Ground and underlying Thanet Sands across the site, excavations may be prone to some instability. As such, excavations may need to be graded back to a stable angle or trench support should be provided. Trench support or angle of batter should be designed by an appropriately qualified engineer or competent person to suit the required depth and the ground and groundwater conditions. Any trenches requiring man access will require appropriate supports and assessments in line with current guidance and legislation.

Groundwater was encountered in the Thanet Sand Formation at depths of between 3.80m (DCS1 and DCS4) and 4.30m bgl (BH1 and BH2). Therefore, significant groundwater ingress is not expected in excavations, although it is recommended that some provision for sump pumping equipment is made available to control seepages or run-off in wet weather conditions.

As stated in Section 6.3, a shallow concrete obstruction was encountered in TP3 at a depth of 0.30m to 0.50m bgl. The obstruction was easily broken out using the onsite excavator, however it is envisaged that as part of the redevelopment, further relict obstructions, foundations, former utilities and other features may remain, which could pose a constraint with regards to the redevelopment and require breaking out.

7.6 Pavement Design

In-situ testing by TRL DCP has indicated approximate CBR values of between 4% and >100% in the Made Ground, 7% and 16% in the Head Deposits and 6% to 20% in the Thanet Sand Formation. The full results are presented in Appendix B. Collectively, the lower CBR values indicated should be considered as indicative short-term CBR values, with higher values probably influenced by the presence of gravel and cobble sized fragments.

Where Made Ground soils are encountered at formation, it is recommended that pavement design is based on a long-term equilibrium CBR design value of <2%, subject to proof rolling and the removal of soft/organic materials.

Equilibrium CBR values of 3% are recommended for the cohesive Thanet Sand Strata and the Head Deposits and a CBR value of 5% is recommended for the granular Thanet Sand strata.

Based on the visual description of the Made Ground during the intrusive investigation, this material is considered likely to be frost susceptible. Additionally, based on the laboratory analysis, the cohesive and granular Thanet Sand Formation strata are considered likely to be frost susceptible and, therefore, should not be present within the top 450mm of pavement construction.

7.7 Soakaways

Two preliminary trial pit soakaway tests were undertaken as part of the initial investigation targeting the predominantly granular Thanet Sands strata in TP6 (located in the south of the site) and TP7 (located in the central regions of the site). Both soakaway tests recorded a sufficient drop in water level to enable infiltration rates in the region of 10^{-5} and 10^{-6} to be determined. These results indicated relatively good infiltration potential and typically correlate with the upper limits of a silty/clayey sand. As such it is considered that the Thanet Sand strata encountered across the site could be suitable for the discharge of surface run-off water into conventional soakaways. Applied Geology was, therefore, instructed to undertake a supplementary investigation to ascertain the suitability for soakaway drainage at selected areas of the site.

As part of the 2022 supplementary investigation, soakaway infiltration tests were undertaken in SA1 (located in the southwest of the site) and SA2 (located in the east of the site). These were carried out in accordance with BRE Digest DG365 methodology and three test fills were undertaken over the course of three days. The results of the tests are included in Appendix B, including the calculations in accordance with BS5930 (BSI 1999). The results of the preliminary soakaway tests undertaken as part of the previous works are also included in Appendix B.

Test ID	Stratum	Test results (m/s)
SA1 (Fill 1)	Thanet Sand Formation	1.10×10^{-5}
SA1 (Fill 2)		5.70×10^{-6}
SA1 (Fill 3)		3.30×10^{-6}
SA2 (Fill 1)	Thanet Sand Formation	1.20×10^{-6}
SA2 (Fill 2)		1.00×10^{-6}
SA2 (Fill 3)		9.80×10^{-7}

The infiltration rates for fill one for both SA1 and SA2 are generally consistent to those determined as part of the initial investigation for TP6 and TP7.

As is normal and expected the infiltration rates generally reduced with successive fills of the test pits and it is recommended in BRE Digest DG365 that the results from the third fill is taken as being most representative for long term design purposes.

7.8 Buried Concrete and Services

As defined by BRE Special Digest 1, Concrete Aggressive Ground, 2005 the Design Sulphate Class and the Aggressive Chemical Environment for Concrete (ACEC) has been assessed for each of the strata encountered. Characteristic values for each stratum have been determined and are detailed in the table below:

Strata	No of samples tested	Soluble Sulphate (g/l)*1	Potentially Pyritic	pH	Design Sulphate Class	ACEC*2
Made Ground	7	0.5	None (0 of 7)	7.8	DS2	AC1s
Head Deposits	1	<0.1	None (0 of 1)	8.5	DS1	AC1s
Thanet Sands	13	0.2	None (0 of 13)	7.0	DS1	AC1s

Notes:

*1: Characteristic values are rounded to the nearest 0.1%.

*2: Assumes static groundwater.

In accordance with the guidance in BRE SD1, the characteristic values for each stratum have been determined based on the highest result (where less than 5 samples tested), the mean average of the highest 2no. results (where 5-9 samples tested) or the mean average of the highest 20% of results (where 10 or more samples tested).

The Design Sulphate Class for the Made Ground is DS-2 and AC-1s. All samples tested from the Head Deposits and Thanet Sand were found to be non-pyritic with a Design Sulphate Class of DS-1 and AC-1s.

Further reference should be made to BRE Special Digest 1 for requirements in respect of types of cement and aggregate to be used and variations in type of concrete construction.

The soil testing undertaken on the site wide Made Ground identified localised elevated concentrations of TPH in TP3 (total TPH of 7500mg/kg) and TP4 (total TPH of 6000mg/kg) that would exceed the UKWIR limit for the use of polyurethane (PE) water supply pipes. Therefore, the use of barrier pipes or an alternate pipe material (such as PVC, steel, copper etc.) may be required depending on the location of the routes. It should be noted, however, that the full suite of testing required by the UKWIR guidance has not been undertaken as part of this investigation and such testing may be required by the Water Authority once the pipeline routes are known. Further guidance on this subject is included within Appendix F.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Geo-environmental

Elevated concentrations of PAH and TPH have been identified within the upper granular Made Ground, beneath surface asphalt along the north-western, northern and north-eastern boundaries of the site.

Given the potential risk to site end users from elevated PAH and TPH contaminants in the shallow Made Ground in areas of existing hardstanding, consideration could be given to removing shallow Made Ground (incl asphalt) from areas currently beneath the asphalt hardstanding during the groundworks, hence removing the source of potential elevated contaminants. Appropriate validation to confirm removal of the source of contamination would be necessary if this approach is adopted. Given the potential uncertainties in fully removing the sources of contamination and the likely requirement for some placement of subsoil/topsoil in landscaping/garden areas to meet Landscape Architect requirements, placement of a cover layer may be more straightforward to implement on site.

If it is preferred to leave in situ or it cannot be ensured that full removal of impacted soils can be achieved and validated, it would be necessary to place a suitable inert cover layer (including appropriate thickness of subsoil/topsoil as specified by the Landscape Architect) in proposed garden spaces and within other areas of soft landscaping where hardstanding is currently present. The thickness of the cover layer should not be less than 450mm in thickness in garden/landscaping areas associated with individual resident rooms and not less than 300mm in communal or general landscaped areas, with a hard to dig separator layer or non-woven geotextile separator between existing Made Ground & imported clean cover. This should be documented in a Remediation Strategy and any imported material would need to be carried out in accordance with Gravesham Borough Council's validation criteria. It is also recommended that a Discovery Strategy and watching brief is implemented during the groundworks to confirm the absence of any unidentified contamination.

In areas not currently underlain by asphalt or hardstanding, no evidence of elevated concentrations of contaminants has been identified hence in these areas, no specific cover layers are considered necessary to mitigate risk to Human Health. It would however be necessary to ensure that Made Ground identified as impacted by contaminants elsewhere on site was not spread across other unaffected areas of the site during groundworks and in this regard, given that placement of subsoil/topsoil is likely to be required in garden/landscaping across the whole site to support growth and meet the Landscape Architects specification, consideration should be given to adopting the proposed cover layer strategy to all garden/landscaping areas of the site.

Given the limited extent of shallow exceedances, the site is not considered to pose a plausible significant risk to Controlled Waters.

8.2 Geotechnical

Conventional strip/trench fill or pad foundations bearing within the Thanet Sand strata and designed in accordance with the recommendations stated within Section 8.2, may adopt safe net design pressures up to 175kN/m². A greater safe net design pressure of up to 250kN/m² is considered achievable for foundations deepened to 2.0m bgl (placed within Thanet Sand).

In areas where Made Ground in excess of 0.6m is encountered, it is recommended that floor slabs are suspended. Where Made Ground is encountered to shallower depths, ground bearing floor slabs may be adopted. Gas protection measures are not considered necessary.

Based on groundwater level monitoring to date and proposed basement depths, groundwater is unlikely to be encountered during excavation, however, some form of sump pumping equipment maybe required to control seepages and run-off in wet weather conditions.

Special measures relating to buried concrete are not required for foundations placed within the natural strata, however, sulphate resisting concrete appropriate to DS-2, AC-1s will be required for the Made Ground.

It is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements with respect to water supply pipework and materials.

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