

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



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.

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.