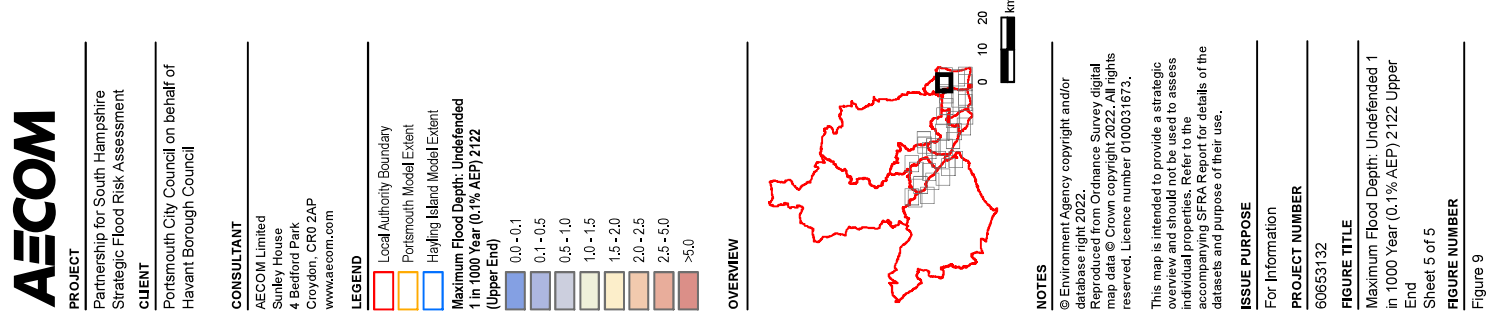




- Selected metals suite [arsenic, boron, beryllium, cadmium, chromium (total, trivalent and hexavalent), copper, lead, mercury, nickel, selenium, vanadium and zinc];
- Speciated (16 US EPA) Polycyclic Aromatic Hydrocarbons (PAH);
- Phenols;
- Total Petroleum Hydrocarbon (TPH) with BTEX and MTBE;
- Volatiles (VOC/SVOCs);
- pH;
- Soluble sulphate;
- Hardness;
- Total organic carbon.

Laboratory test results are included in Appendix E.

6.0 GROUND CONDITIONS

6.1 Strata Encountered

The ground investigation has generally identified hardstanding at surface, underlain by predominantly granular Made Ground soils overlying predominantly granular River Terrace Deposits beneath. Localised Alluvium and Possible Alluvium have also been encountered beneath Made Ground. Solid strata of Undifferentiated Chalk was recorded at depth beneath the Superficial Deposits to the full depth of the investigation (17.29m bgl).

The previous investigations by Clancy did not identify Alluvium directly beneath the Made Ground soils. The very soft to soft organic clays comprising frequent flint gravels, indicative of Alluvium, were assigned as the upper extent of the Superficial River Terrace Deposits.

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

Stratum	Depth to Top of Strata (m bgl)	Thickness (m)	Comments
Hard Standing	GL	0.10 - 0.20	Asphalt was encountered at surface in all but one exploratory hole (DCS3A)
Made Ground - Subbase	0.10 - 0.20	0.20 -1.00	Encountered in the majority of exploratory holes underlying hardstanding
Made Ground	0.20 - 1.00	0.30 – 1.30	Encountered in all exploratory holes.
Alluvium & Possible Alluvium	1.0 - 2.2	0.2 - 1.30	Alluvium encountered in CP01 in the northwest of the site. Possible Alluvium encountered in DCS02 and DCS03A
River Terrace Deposits	0.80 – 3.50	0.60-2.30	Encountered in all exploratory holes where Made Ground/Alluvium was fully

Stratum	Depth to Top of Strata (m bgl)	Thickness (m)	Comments
			penetrated. Base not proven in soakaway Trial Pits
Undifferentiated Chalk	3.40 – 5.10	12.99+	Encountered in the deeper boreholes only. Proven to the full depth of the investigation (17.29m bgl)

6.2 Hard Standing and Made Ground

Asphalt hardstanding covered the majority of the car parking area across the site, and was proven to depths of between 0.10m and 0.20m bgl. The only exception was DCS3A which was located in the soft landscaped area in the northeast of the site, hence asphalt was absent. At this location Made Ground/Topsoil was encountered at surface to 0.20m depth described as soft brown slightly gravelly very sandy clay with frequent rootlets.

Underlying the asphalt, a layer of Subbase material was encountered ('Made Ground-Subbase' on the logs) generally comprising grey slightly clayey slightly sandy gravel of coarse angular limestone. The subbase varied in thickness across the site, and generally between 0.07m and 0.30m thick but was recorded up to 0.85m thick in CP01 and 0.45m thick on CP02.

Other Made Ground was encountered in all exploratory holes beneath the hardstanding and subbase materials, between 0.5m (DCS02) and 1.3m thick (CP03) and was recorded to depths between 0.8m (SA01) and 2.2m bgl (CP01) where proven. The Made Ground strata was variable and had both cohesive and granular horizons, although was dominantly granular. The main Made Ground strata encountered are described as follows:

- Soft to firm brown slightly to sandy gravelly clay. Gravel is fine to coarse subangular to rounded flints, locally with brick and concrete fragments and rare ash;
- Medium dense brown very clayey sandy gravel of fine to coarse subangular to rounded flints, locally with subangular brick fragments.

The previous Clancy investigations at the Phase 2 site encountered Made Ground proven to depths of between 0.40m (WS11) and 2.60m bgl (BH1A) which accords with the findings of the current investigation.

Five in-situ SPTs were carried out in the Made Ground and recorded uncorrected 'N' values of N=14 and N=26.

6.3 Alluvium and Possible Alluvium

Strata considered to represent Alluvium were encountered in CP01 only between 2.2m and 3.5m bgl (1.3m thick). The Alluvium was described as firm light grey slightly gravelly sandy silt/clay with gravel of medium to coarse subangular to rounded flint.

The results of two Atterberg Limit tests undertaken on the cohesive horizons of Alluvium have indicated plasticity indices of 11% and 17% (corrected to 4.1% and

18.2%), indicating these soils to be of low shrinkability as defined by NHBC Standards. Uncorrected liquid limits of 26% and 36%, plastic limits of 15% and 19%, and moisture contents of 15.6% and 24.3% were also recorded. The results indicate the clays to be of low to medium plasticity.

Only one SPT was carried out in these soils, recording an 'N' value of N=18 at 3.00-3.45m bgl.

It should be noted that the previous investigation by Applied Geology on the land adjacent to the west encountered site wide Alluvium to depths between 0.90m and 1.90m bgl. The previous Clancy investigations did not identify Alluvium at the site.

Soils considered to be Possible Alluvium were encountered in two boreholes only, namely DCS02 in the west of the Phase 2 site and DCS03A in the northeast of the Phase 2 site. The Possible Alluvium was encountered beneath the Made Ground at 1.20m to 1.45m bgl in DCS02 and between 1.10m and 1.30m bgl in DCS03A. The soils were described as soft or firm dark brown/ dark brownish grey slightly sandy slightly gravelly silt/ sandy clay with fine to medium gravel of subrounded chalk and flint. These potentially represent a buried topsoil but, given the absence of significant decayed roots etc, has been termed Possible Alluvium for the purpose of this report.

6.4 River Terrace Deposits

Strata considered to represent River Terrace Deposits were encountered in all exploratory holes across the Phase 2 site, underlying the Made Ground or Alluvium and Possible Alluvium where these strata were fully penetrated. This stratum was encountered from depths of between 0.80m (SA01) and 3.50m bgl (CP01) and the base was encountered at depths of between 3.40m and 5.1m bgl (0.6m to 3.3m thick) where proven.

The strata were generally recorded as medium dense light brown and brown slightly sandy clayey gravel of fine to coarse subangular to rounded flint and occasional chalk. Occasional cobbles of subrounded flint were noted.

The previous Clancy investigations noted the River Terrace Deposits to comprise a variable sequence of interbedded clayey sandy gravel and gravelly sandy clays. The gravel was generally described as fine to coarse subrounded flint, whilst frequent wood fragments and rare amorphous peat were also recorded in the cohesive horizons. The base of the River Terrace Deposits was not encountered in six out of eight of the Clancy boreholes undertaken across the Phase 2 site due to shallow refusals/hard drilling.

Particle Size Distribution (PSD) tests were undertaken on samples of the River Terrace Deposits. The results of this testing and the resultant classifications are given in the table below.

Location	Depth (m bgl)	Fines % (Clay + Silt <0.063mm)	Sand %	Gravel %	Cobbles %	Classification
CP01	3.60	20	17	63	0	Sandy silty GRAVEL
CP02	2.50	4	13	83	0	Slightly clayey sandy GRAVEL
CP03	4.00	5	15	80	0	Slightly clayey sandy GRAVEL
DCS01	1.40	11	7	82	0	Sandy clayey GRAVEL
DCS02	2.20	13	15	72	0	Sandy clayey GRAVEL
DCS03A	1.30	26	33	41	0	Very clayey very sandy GRAVEL
DCS03A	2.20	11	15	74	0	Sandy clayey GRAVEL

The test results are generally in line with the field descriptions.

As part of the initial Clancy investigation, one particle size distribution test was undertaken on a bulk sample of granular River Terrace strata and the results typically accord with the proportions discussed above.

Clancy also undertook one CBR test on a bulk sample of granular River Terrace strata at 0.70m bgl, which recorded a minimum CBR value of 2.7%.

Twelve in-situ SPTs were carried out in the granular River Terrace Deposits and recorded uncorrected 'N' values of between N=14 and N=31 but with one result of >50 was recorded (extrapolated to N=61). The SPT vs depth plot shows a slight increase in strength with depth. SPT 'N' values of between N=1 and N=>50, were recorded during the previous Clancy investigations, indicating the River Terrace Deposits to be more variable.

6.5 Undifferentiated Chalk

Strata considered to represent Undifferentiated Chalk were encountered directly beneath the Superficial River Terrace Deposits (where base was proven). The Undifferentiated Chalk was encountered at depths of 3.40m to 5.10m bgl and was proven to the full depth of the investigation (17.29m bgl).

The cable percussion drilling and driven sampling methods severely disturb any structure present in chalk strata, leading to the recovery of highly disturbed samples. As such, full engineering descriptions and the assignment of chalk grades was generally not possible.

Findings of the previous investigations undertaken by Clancy typically accord with those of the current Applied Geology investigation, although previously the chalk strata were encountered at greater depths of between 5.4m and 5.8m bgl in the area of the Phase 2 site.

Thirty-five in-situ SPT tests were carried out within the Undifferentiated Chalk strata, recording general 'N' values of between N=14 and N=50. Consistent 'refusals' with extrapolated N values of between N=52 and N=61, were generally recorded from depths of 15m onwards which is in-line with AG's previous investigation to the north. The SPT N value vs depth plot shows a consistent increase with depth from c.15 at 5m bgl to c.60 at 17m bgl.

Lower SPT 'N' values of between N=6 and N=21, were typically recorded at depths of between 6m and c.15m bgl, during the previous Clancy investigations, increasing to SPT 'N' values of between N=15 and N=26 at depths of between 15m and 18m bgl.

Five saturation Moisture Content (SMC) tests were undertaken on bulk samples of Chalk and recorded dry density values of between 1.59Mg/m³ and 1.66Mg/m³ (mean 1.63Mg/m³), indicating low to medium density chalk. The tests also recorded saturated moisture contents of between 23% and 26% (mean 24%). The results recorded are in line with the previous AG investigation adjacent. In addition, nine SMC tests were undertaken as part of the initial Clancy investigation, recording dry density values of between 1.56Mg/m³ and 1.72Mg/m³ (mean 1.64Mg/m³), similarly indicating low to medium density chalk strata. These tests also recorded moisture contents of between 20% and 27% (mean 23%) and SMCs of between 21% and 27% (mean 24%), which typically accord with the findings of the Applied Geology investigations.

Clancy also undertook one undrained triaxial test on a sample of silt chalk at a depth of 6m bgl, which recorded an undrained shear strength of 38kPa.

6.6 Groundwater and Soakaway Tests

Groundwater strikes were encountered during drilling within River Terrace Deposits as detailed in the table below.

Location	Stratum	Depth (m bgl)	Groundwater level after 20min (m bgl)
CP01	River Terrace Deposits	4.00	1.80
CP02	River Terrace Deposits	1.60	1.40
CP03	River Terrace Deposits	2.20	2.20
DCS01	River Terrace Deposits	2.10	2.10
DCS02	River Terrace Deposits	2.30	2.10
DCS03A	River Terrace Deposits	2.20	2.10
SA01	River Terrace Deposits	1.20	-
SA01B	River Terrace Deposits	1.30	-
SA01C	River Terrace Deposits	1.60	-
SA02	River Terrace Deposits	2.30	-

The previous investigations by Clancy, recorded groundwater at depths of between 2.0m and 5.80m bgl in the Phase 2 site, in both the River Terrace Deposits and underlying Undifferentiated Chalk strata.

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 subsequent monitoring programme standing groundwater levels within the standpipes were recorded and are summarised below:

Location	Response Zone (m bgl)	Stratum	Depth to groundwater (m bgl)
CP01	2.00 to 6.00	Alluvium, River Terrace Deposits and Undifferentiated Chalk	1.63 – 2.04 (2.60 – 3.01m AOD)
CP02	1.00 to 5.00	River Terrace Deposits and Undifferentiated Chalk	1.25 – 2.01 (2.32 – 3.08m AOD)
CP03	2.00 to 5.00	River Terrace Deposits	1.60 – 1.94 (2.72 – 3.06m AOD)
DCS01	1.00 to 2.00	Made Ground and River Terrace Deposits	1.67 – 1.85 (2.92 – 3.10m AOD)
DCS02	1.00 to 2.00	Possible Alluvium and River Terrace Deposits	1.54 – 1.93 (2.52 – 2.91m AOD)
DCS03A	1.00 to 2.00	Possible Alluvium and River Terrace Deposits	1.97 – 2.00 (2.99 – 3.01m AOD)

During the return monitoring programme, groundwater was recorded at depths of between 1.25m and 2.04m bgl (2.32m AOD to 3.10m AOD) with a slight drop between November 2023 and February 2024.

Based on the data collected, it is considered that the River Terrace Deposits and Chalk are likely to be in hydraulic continuity. The groundwater flow direction was unable to be determined as the levels are generally consistent across the site, however, it is likely to be towards the east towards the Lavant Stream.

Preliminary soakaway tests were carried out in two trial pit locations (SA01C and SA02). The soakaway tests were carried out in general accordance with BRE Digest DG365 methodology, with three fills undertaken. The results of the tests are summarised below and included in full in Appendix C.

Test ID	Stratum	Infiltration Rate (m/s)		
		Fill 1	Fill 2	Fill 3
SA01C	River Terrace Deposits 1.00-1.60m bgl	4.7 x10 ⁻⁴	4.8 x10 ⁻⁴	4.4 x10⁻⁴
SA02	River Terrace Deposits 1.05-2.30m bgl	4.1 x10 ⁻⁶	2.2 x10⁻⁶	9.3 x10 ⁻⁶

*Bold text indicate the lowest result recorded for each location

The soakaway testing has indicated a variable infiltration rate for the River Terrace Deposits depending on location. The results of each fill were generally consistent for SA01C but not for SA02. The River Terrace Deposit soils in both locations were dominantly granular but contained a variable portion of fines (Note: 4 to 26% fines content in this stratum based on laboratory tests) which would affect permeability. Standing groundwater was noted at the base of each pit prior to the test commencing which will have inhibited downward infiltration.

6.7 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)
ALL, RTD & CHK	CP01	2.0 to 6.0	1.63-2.04	0.3	4.3	1.2	0.0036	0.0516
RTD & CHK	CP02	1.0 to 5.0	1.25-2.01	0.3	1.8	<0.1	0.0003	0.0018
	CP03	2.0 to 5.0	1.60-1.94	0.3	2.7	<0.1	0.0003	0.0027
MG & RTD	DCS01	1.0 to 2.0	1.67-1.85	0.2	3.1	<0.1	0.0002	0.0031
PBT & RTD	DCS02	1.0 to 2.0	1.54-1.93	0.3	2.2	0.1	0.0003	0.0022
	DCS03 A	1.0 to 2.0	1.97-2.00	0.2	2.5	1.1	0.0022	0.0275

Key:

MG: Made Ground, PBT: Possible Alluvium, ALL: Alluvium, RTD: River Terrace Deposits, CHK: Chalk
Blue highlighted cells indicate fully flooded response zone.

Green highlighted cells indicate CS-1 conditions.

Gas monitoring recorded methane concentrations up to a maximum of 0.3% in the majority of installations. Carbon dioxide concentrations ranged from 0.1% v/v up to 3.1% v/v with the highest readings recorded in DCS01 located in the southeast of the site.

Oxygen concentrations between 8.5% (depleted) and 21.4% (atmospheric) by volume, with depleted levels mainly recorded in CP01 and did not correlate with boreholes with higher carbon dioxide values. VOC and carbon monoxide concentrations were recorded between <0.1ppm and 3.6ppm and are considered negligible. Flow readings taken over a three-minute average period recorded flow rates of between <0.1 l/hr and 1.2 l/hr with -3.1 l/hr recorded on one occasion in CP01.

6.8 Contamination

Ash was observed locally in the Made Ground in CP02 and the majority of exploratory hole locations recorded brick and concrete fragments. However, there was no visual or olfactory evidence of any gross contamination observed. No evidence of hydrocarbons was noted in the exploratory hole closest to the former substation.

7.0 GEOENVIRONMENTAL ASSESSMENT

7.1 Human Health Risk Assessment

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

- Proposed end-use – Commercial/industrial units;
- Screening criteria – Commercial/industrial, assuming 1% SOM;
- Assuming a single dataset based on the size of the site, the site's history, current land-use and/or the proposed redevelopment.

In respect of benzo(a)pyrene and other genotoxic PAHs, various PAH ratios have been plotted and compared against data from the Culp et al study and found to be within the same range, therefore use of the surrogate marker approach is justified.

The spreadsheets summarising the laboratory results and relevant screening values for each dataset are presented in Appendix E. All determinants have been found to be below the screening values. No elevated metals, phenols or BTEX have been detected in any of the samples tested.

There were no exceedances of TPH compounds recorded in the five samples tested, however, one sample recorded a concentration of Total TPH >1,000mg/kg - CP03 at 0.2m with a concentration of 5,000mg/kg. The TPH concentration is mainly made up of heavier-end Aliphatic and Aromatic fractions in the C21-C44 range. The TPH chromatogram from the laboratory indicates that the trace is complex and does not match any standard petroleum product profiles. No visual or olfactory evidence of contamination was noted in this borehole during fieldwork, however, as the sample was taken directly beneath the asphalt surfacing, it is likely that the sample may have contained fragments of asphalt which may have been a source for the TPH.

Four Semi-Volatile Organic Compounds (SVOCs) have been recorded above the limit of detection in one sample of Made Ground-Subbase taken from CP03 at 0.2m depth – the same sample as the highest TPH concentration. In addition, two of the SVOCs have also been detected in a second sample of Made Ground-Subbase taken from DCS02 at 0.2m bgl. Again it is considered likely that fragments of asphalt may have been in the samples of Made Ground sub-base which may be a source of the SVOCs. It should be noted that there are no published screening values for these SVOCs so the detection limit has been used as the screening value as a very conservative approach.

The existing asphalt will be removed during the development and it is understood that site levels will be raised by approximately 1.2m which will act as a cover layer to mitigate the risk to end users. Based on the proposed end use, the hydrocarbon impacted soils are considered to pose a low risk to end users, but may pose a risk to Controlled Waters based on the encountered ground conditions, discussed further in Section 7.2 below.

The Asbestos screening tests did not detect the presence of any Asbestos fibres.

Based on the lab testing undertaken and proposed development, there is considered to be a low risk to Human health receptors from identified contamination in soils.

7.2 Controlled Waters Risk Assessment

The soil testing has not recorded concentrations of any determinants above those values considered typical for Made Ground background concentrations, with the exception of localised elevated concentrations of TPH in shallow Made Ground in CP03. It should also be noted that the previous investigations by Clancy found elevated TPH in a groundwater sample from BH5 in the southwest of the site (282ug/l Total TPH).

In the context of Controlled Waters, the receptors to be considered are as follows:

- The Lavant Stream located 45m east;
- The Superficial Deposits underlying the site are classified as a Secondary A Aquifer, however, the underlying Undifferentiated Chalk is classified as a Principal Aquifer, although there are no potable water abstractions in proximity to the site.

The proposed development is noted to cover a large proportion of the site with hardstanding with only limited soft landscaping within the car park areas. This will therefore limit any leaching potential and migration of contaminants from the Made Ground into the underlying groundwater. It is also noted that historically the surrounding area has been utilised for numerous industrial uses which could potentially impact groundwater.

The results of the chemical testing on leachate and groundwater samples have been assessed as described in Appendix F, with the UK Drinking Water Standards (UK DWS) used as the screening criteria (or where unavailable, Water Framework Directive Environmental Standards (WFD ES) or detection limit) based on the presence of a Principal Aquifer underlying the site (Undifferentiated Chalk).

Groundwater Testing

The groundwater results and relevant screening values have been directly compared, with a summary comparison spreadsheets included in Appendix E of this report.

The summary spreadsheets do not identify any determinants exceeding the corresponding screening values, with the majority of the concentrations (including PAHs, TPH, BTEX, MTBE, VOC and SVOC) all having been recorded below the limit of laboratory detection.

Although localised TPH up to 5,000mg/kg has been found in shallow Made Ground – Subbase, there is no indication that this has had an impact on underlying groundwater. Therefore, based on the context of the site and the proposed redevelopment, there is considered to be a negligible to low risk to Controlled Waters.

7.3 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.

Made Ground soils at the site are unlikely to be acceptable at inert landfills and are likely to be generally categorised as non-hazardous. If Made Ground soils are to be disposed of at landfill, further testing will likely be required for the actual waste stream during construction.

If natural soils are to be disposed of from site, inert WAC testing will likely be required to classify the soils for disposal.

8.0 GEOTECHNICAL ASSESSMENT

8.1 General

Proposals for the site comprise the construction of three new commercial/industrial units (5, 6 & 7) at the Phase 2 site, together with associated yard/loading areas and car parking. Site levels beneath the proposed buildings will be raised in the order of 0.6-1.2m above existing ground level and two small retaining walls will be incorporated into the final design. It is understood that foundations for the proposed new portal frame structures will require to be founded in soils with up to 150kN/m² bearing pressures and the ground bearing floor slab should be assumed to have a uniformly distributed loading of 50kN/m².

In the area of Phase 2, the ground investigation has identified a covering of asphalt hardstanding from surface over predominantly granular Made Ground, proven to depths of between 0.8m and 2.2m bgl. Upon proving the base of the Made Ground, Superficial Deposits of granular River Terrace Deposits, were proven to a base depth of between 3.60m and 5.80m bgl, with Undifferentiated Chalk recorded directly beneath. Localised Alluvium and Possible Alluvium were also encountered.

In the area of Phase 2, groundwater strikes were recorded in the Superficial River Terrace Deposits at depths of between 1.20m and 2.30m bgl during formation. During the subsequent monitoring of standpipes, groundwater was recorded at depths of between 1.25m and 2.04m bgl (2.32m AOD to 3.10m AOD).

8.2 Foundation and Floor Slab Design

Based on the strata encountered, traditional pad foundations would potentially be suitable founded on firm clays or medium dense granular natural soils at between 1m and c.2.5m bgl across the site. However, as site levels are to be raised by 0.6-1.2m and groundwater was frequently encountered in close proximity and locally above likely foundation depths, it is considered that some form of ground improvement or a piled foundation solution will be required.

Excavation and re-engineering of the Made Ground prior to placement of further engineered fill to raise site levels could be considered. The re-engineering of existing soils and placement of new engineered fill would need to be undertaken to an agreed Earthworks Specification that was designed to provide an allowable bearing capacity for shallow foundation of 150kN/m² and the required floor slab design loading whilst meeting the required settlement criteria. Some soils are likely to be unsuitable for re-engineering. This would require careful and detailed assessment and would require further ground investigation works in order to obtain bulk samples for earthworks testing. Advantages of this method would include 'guaranteed' removal of any soft spots and/or hard spots/obstructions in the Made Ground under the buildings, no requirement for any required working platform and continuity with the likely required earthworks for external areas. Disadvantages would include having to deal with shallow groundwater in places and it is likely to be more costly than some ground improvement techniques.

Ground improvement by vibro-replacement or rigid inclusions could be considered and would allow the use of shallow pad foundations and ground bearing slabs and avoid the need for dealing with groundwater. Discussions should be held with specialist contractors to confirm that the required allowable bearing capacity of 150kN/m² is achievable in the ground conditions encountered. A working platform would be required for such ground improvement techniques; however, this could be incorporated into the required upfill to get to the required site levels, assuming the ground improvement would be undertaken post upfilling. For treatment of the full thickness by vibro-replacement, any upfill would need to be wholly granular and suitable for treatment by the vibro-replacement process. Typically, this requires a granular upfill to contain less than 5-10% clay and silt fines, with no particles greater than 100mm, though the specific requirements of ground improvement contractors would need to be established. Where such treatment was proposed, it is likely that treatment would extend through placed upfill, Alluvium/loose/soft River Terrace Deposits, terminating within competent granular River Terrace Deposits or Chalk. If vibro-replacement was proposed prior to upfilling, proposed upfill could comprise suitably engineered granular material, or potentially other suitably engineered fill (including possible modified or stabilised clay fills). The specification for the upfilling would need to be agreed in advance with the ground improvement contractor to avoid pre-boring requirements and to ensure the required bearing capacity and settlement tolerances are not compromised.

Taking into account the depth of the Made Ground, the localised presence of underlying low strength superficial deposits and the proposal to raise site levels by up to 1.2m, a piled solution for the foundations and floor slabs represents a low-risk solution which would address the various technical considerations. The piles would need to extend through any imported upfill, existing Made Ground, Superficial Deposits and gain support in skin friction and end bearing within the Undifferentiated Chalk, together with some contribution from the Superficial Deposits. The use of bored, CFA or driven piles is likely to prove suitable for the site, however it is recommended that the advice of a specialist piling contractor is sought with regard to detailed design, including suitable pile diameters, capacities and confirmation of suitable pile types. The nature and thickness of the upfill material will need to be taken in to account with regards to pile mat design.

Prior to placement of upfill, it is recommended that any hardstanding and known obstructions are removed as they would represent potential obstructions to ground improvement or piling.

Placement of upfill above the existing ground surface will result in induced settlements within the underlying Made Ground and natural strata as a result of the additional loading. The majority of settlements within the granular Made Ground and granular River Terrace Deposits would occur quickly, though induced settlements within the cohesive Alluvium/possible Alluvium would be ongoing for a longer period. Detailed assessment would be required to determine the likely magnitude of potential total/differential settlements. Settlement assessments will need to be undertaken once final site levels, sources of fill and loading are known.

As documented in Section 3.3 above, the STATs site investigation report (dated 2003) considered the site to be of a moderate low subsidence risk from potential chalk dissolution features/cavities. The report stated that the Edmund's database of known natural and man-made chalk features did not identify any such features within the boundaries of the wider Technology Park. Further assessment into the Chalk

dissolution hazard risk was outside the scope of the current investigation, although no evidence of potential solution features/cavities was noted in any of the cable percussion boreholes.

8.3 Retaining Walls

Due to the site levels being raised across the site, the development proposal includes two retaining walls including a section c.39m long and 0.7m high at the southern boundary and another 5m long and 0.45m high at the northwest boundary. It is anticipated that these will be retaining the Engineered Fill.

Given the low retained heights, it is envisaged that the retaining walls will be simple gravity walls such as gabions, crib lock or reinforced earth. It is understood that the retaining walls will be designed by specialist contractors. As well as the findings of this investigation, the design should also take into account the nature of the retained soils (engineered fill), which, at this stage, are not known. The wall designs should also take account of the likely settlements induced by placement of the upfill materials.

Both sections of proposed retaining wall are underlain by around 2m of Made Ground, which may not provide a suitable founding stratum for the walls. Some localised overdig and re-engineering or ground improvement is therefore anticipated in the location of the retaining walls.

8.4 Floor Slab Gas Protection

Based on the gas monitoring undertaken to date and the calculated GSVs the site is likely to be characterised as Characteristic Situation 1 (CIRIA C665). The site is also not in a Radon affected area. Therefore, gas protection measures are not considered necessary for the proposed development.

8.5 Excavations

No instability was recorded in shallow excavations undertaken for soakaway testing. However, trial pits undertaken as part of the previous AG investigation on the adjacent site were noted to be unstable with continual sidewall collapse recorded. Instability was generally encountered within the granular River Terrace Deposits, occasionally coinciding with the depths of water ingress.

In general, excavations will likely be prone to some instability particularly where advanced into the granular River Terrace Deposits and in particular once groundwater is encountered. As such, excavations into these soils may need to be graded back to a stable angle or trench support be provided. Trench support or the 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. Furthermore, due to the potential of groundwater ingress (at depths greater than 1.5m), it is recommended provision for groundwater control is made, particularly if any deeper excavations are proposed.

8.6 Pavement Design

In-situ testing by TRL DCP at the Phase 2 site has indicated approximate CBR values of between 2% and >100% principally within Made Ground. 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.

Based on the proposed development site levels will be raised by up to c.1.2m.–The CBR at formation level will therefore largely be dictated by the quality of engineered fill placed to raise site levels. The placement of fill may lead to additional settlement of underlying Made Ground/Alluvium so some assessment of this is required and soft spot removal may be needed prior to placement of the fill.

Based on a review of the classification testing, soil type and construction conditions, indicative long-term equilibrium CBR design values of 2-3% for the Alluvium and 5% for the River Terrace Deposits are recommended, should these soils be within influencing distance of pavement loadings.

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 Alluvium and River Terrace Deposits strata are likely considered to be frost susceptible, however, based on the proposed development, it is unlikely that these material will be present within 450mm of pavement surfaces.

8.7 Soakaways

The soakaway tests undertaken as part of this current investigation, predominantly within the granular River Terrace Deposits, recorded infiltration rates of c. 4×10^{-4} m/s (SA01C) to 2×10^{-6} m/s (SA02) and varied by location. The variability is likely due to different percentage of fines present in the strata locally affecting the infiltration. Values of around 1×10^{-4} indicate a relatively good permeability and typically comply with the lower end limits for a poorly graded gravel. As such, it is considered likely that the shallow granular River Terrace Deposits across the site may be locally suitable for the discharge of surface run-off water into conventional soakaways, subject to consideration of groundwater levels, which are quite shallow in places. Strata with higher fines content and infiltration rates of around 10^{-6} m/s will be less suitable for soakaway drainage.

The soakaway tests undertaken as part of previous investigations, predominantly within the granular River Terrace Deposits, recorded infiltration rates in the region of 10^{-3} to 10^{-5} m/s.

It should be noted that due to the relatively high groundwater level encountered at the site, this could limit the capacity for soakaway drainage and hence, this should be considered in the soakaway design. If infiltration drainage is considered further, additional testing may be required to further assess the suitability at specific locations.

8.8 Buried Concrete

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 the Made Ground, Superficial Deposits and underlying Undifferentiated Chalk strata. Characteristic values for each stratum have been determined and are detailed in the table below:

Strata	No of samples tested ^{*3}	Soluble Sulphate (g/l) ^{*1}	Total Potential Sulphate (%)	Potentially Pyritic	pH	Design Sulphate Class	ACEC ^{*2}
Made Ground	8	0.60	-	-	7.4	DS-1	AC-1
Alluvium & Possible Alluvium	6	0.07	0.27	No	7.7	DS-2	AC-2
River Terrace Deposits	5	0.02	-	-	8.2	DS-1	AC-1
Undifferentiated Chalk	3	0.01	-	-	8.6	DS-1	AC-1
Groundwater	3	0.03	-	-	7.3	DS-1	AC-1

*1: Characteristic values are rounded to the nearest 0.01g/l.

*2: Assumes mobile groundwater

*3: In a data set less than 5 samples, the highest sulphate value and lowest pH is taken as the characteristic value. In a data set of between 5 and 9 the mean of the highest two sulphate test results has been taken as the characteristic value. In a data set in excess of 10, the mean of the highest 20% has been taken as the characteristic value.

The Design Sulphate Class for each strata and groundwater is DS-1 and AC-1, except for the Alluvium/Possible Alluvium, which is DS-2 and AC-2 due to a total Potential Sulphate of 0.27% recorded. These results typically accord with the findings of the previous investigations, although Alluvium was assessed as DS-1.

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.

It is considered unlikely that barrier pipes will be required for the proposed development.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Geoenvironmental

The risk assessments in Section 7.0 have indicated a low risk to Human health and Controlled Waters receptors based on the proposed development. Therefore, no further action is considered warranted. However, should any suspected contamination be encountered during redevelopment appropriate advice should be sought.

9.2 Geotechnical

Ground improvement or piling is anticipated to be required for the proposed units and floor slabs. Discussions should be held with specialist ground improvement contractors to confirm that the required allowable bearing capacity of 150kN/m² is achievable in the ground conditions encountered.

The proposed upfill will influence the design of the ground improvement and piling and will also influence the design of the external areas, in terms of induced