SITE INVESTIGATION & BASEMENT IMPACT ASSESSMENT REPORT

4 Greenaway Gardens
London
NW3 7DJ

Client: Mr Verdi Israelian

Engineer: Richard Tant

J14381

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Geotechnical & Environmental Associates

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EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

BRIEF

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Richard Tant Associates, on behalf of Mr Verdi Israelian, with respect to the part demolition of the existing building and construction of a new single level basement structure around the side and rear of the principal building, with the two proposed ground floor extensions built and effectively structurally independent to the internal works of the main house. The basement will extend beyond the footprint of the existing house. The purpose of the investigation has been to determine the ground conditions, to provide information for the design of new foundations and retaining walls, to assess the impact that the basement will have on the hydrogeology of the surrounding area, and to to provide a preliminary assessment of the presence of contamination. The report also includes information required to comply with the London Borough of Camden (LBC) Planning Guidance CPG4, relating to the requirement for a Basement Impact Assessment (BIA).

SITE HISTORY

The earliest map studied, dated 1850, shows the site to be undeveloped open land with the nearest road being West End Lane located 100 m south of the site, later renamed Frognal Lane. A large house, later identified as Frognal Park, is shown 100 m northeast by 1871 and two ponds 60 m to the east of the site. Another pond was located 120 m to the northwest and some time between 1896 and 1915 it was backfilled along with one of the eastern ponds. The site was developed with the existing house between 1915 and 1935 and the remaining pond was backfilled. The site and the surrounding area have since remained essentially unchanged.

GROUND CONDITIONS

The investigation has generally confirmed the expected ground conditions in that, below a moderate thickness of made ground, the Claygate Member was encountered over by the London Clay, which extended to the maximum depth of the investigation, of 15.00 m. The made ground extended to depths of between 0.20 m and 0.30 m and generally comprised clayey sand and concrete gravel or slightly sandy gravelly clay with rare cobbles. The Claygate Member comprised brown mottled orange and grey silty clay and clayey silt, with occasional pockets of fine sand. The strength of the material was generally initially soft up to 0.7 m, becoming firm to 3.0 m to 4.0 m, and then stiff and extended to depths of between 5.9 m and 6.4m. At the front of the property the boundary was encountered at approximately 86.30 m to 87.15 m OD. The London Clay generally comprised firm becoming stiff fissured grey silty clay with occasional fine sand partings and shell fragments. Groundwater was initially encountered at depths of between 4.00 m (88.37 m OD) and 6.00 m (85.60 m OD) below which inflows of groundwater were sporadically encountered to the full depth of the investigation, of 15.00 m. Groundwater has subsequently been measured at depths of between 0.93 m (91.44 m OD) and 2.65 m (89.90 m OD) within the standpipes installed in a selection of the boreholes.

RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements. Based on the groundwater observations to date, groundwater is likely to be encountered within the 4.2 m deep basement excavation, although significant inflows are not anticipated due to the relatively low permeability of the silts and clays. It should be possible to adopt contiguous piles if trial excavations indicate that groundwater can be adequately controlled. However the designer has elected to use the more favourable secant bored pile wall in order to mitigate these groundwater risks. Spread foundations excavated from basement level to bear within the Claygate Member may be designed to provide an allowable bearing pressure of 150 kN/m^2, provided that groundwater inflows can be sufficiently controlled, or alternatively piles could be used for the support of the structural loads.

BASEMENT IMPACT ASSESSMENT

It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice. Groundwater is expected to be present at shallow depth beneath the site although inflows from within the Claygate Member would be expected to occur at a relatively slow rate such that they could be suitably controlled by sump pumping. The proposed works are not considered likely to have any detrimental effect on the local groundwater regime.

Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 INTRODUCTION

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Richard Tant Associates, on behalf of Mr Verdi Israelian, to carry out a desk study and ground investigation at 4 Greenaway Gardens, London, NW3 7DJ. This report includes a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC) in support of a planning application.

1.1 Proposed Development

It is understood that consideration is being given to the partial demolition of the existing building, and construction of a new single level basement extending to about 4.2m below the house and gardens. The basement foundation level will be at approximately 87.0 m OD.

This report is specific to the proposed development and the advice herein should be reviewed once the development proposals are finalised.

1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to check the history of the site and surrounding areas with respect to previous contaminative uses;
- to determine the ground conditions and their engineering properties;
- to provide advice and information with respect to the design of suitable foundations and retaining walls;
- to assess the impact of the proposed basement on the local hydrogeology;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, a desk study was carried out followed by a ground investigation. The desk study comprised:

- a review of available historical Ordinance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- a review of readily available geological and hydrogeological maps;
- a walkover survey of the site carried out in conjunction with the fieldwork.

In the light of this desk study an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- two boreholes advanced to a depth of 15.00 m by cable percussive methods;
- two boreholes advanced to a maximum depth of 8.00 m by means of an open-drive percussive sampler;
- installation of three groundwater monitoring standpipes within the boreholes, to a depth of 6.00 m;
- a series of hand excavated trial pits to depths between 0.66 m to 2.10 m investigate the configuration of the foundations of the existing house and neighbouring houses;
- standard penetration tests (SPTs), carried out at regular intervals in the boreholes, to provide additional quantitative data on the strength of the soils;
- laboratory testing of selected soil samples for contamination and geotechnical purposes; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

The report includes a contaminated land assessment which has been undertaken in accordance with the methodology presented in Contaminated Land Report (CLR) 11[1] and involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. The risk assessment is thus divided into three stages comprising Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Site-Specific Risk Assessment.

1.3.1 Basement Impact Assessment

The work carried out also includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup (the “Arup report”). The aim of the work is to provide information on surface water, land stability and groundwater and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years’ specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than

1 *Model Procedures for the Management of Land Contamination* issued jointly by the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) Sept 2004

2 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*

3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

ten years consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM.

The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a chartered geologist (CGeol) and Fellow of the Geological Society (FGS) with 25 years' experience in geotechnical engineering and engineering geology.

All assessors meet the qualification requirements of the Council guidance.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted and the number of locations where the ground was sampled. No liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located in a residential area in the London Borough of Camden, approximately 570m southwest of Hampstead London Underground Station, and 800m northeast of West Hampstead Thameslink Railway Station. The site fronts onto Greenaway Gardens to the northeast and is bounded by houses with associated garden areas to the southeast and northwest and to the southwest by the garden of a similar property fronting onto Bracknell Gardens. The site may be additionally located by National Grid Reference 525814, 185518 and is shown on the map extract overleaf.

A walkover of the site was carried out by a geotechnical engineer from GEA at the time of the fieldwork. The site located on a hill which slopes down towards the south, and is essentially rectangular in shape, measuring approximately 55 m by 26 m, a total of approximately 1,372m^2. The site is occupied by a detached three-storey house with associated areas of soft landscaping and hardstanding. The house also has a 1.2 m deep crawl space beneath the front (eastern) half of the house, and this extends for approximately three quarters of the width of the house. In addition, the garage that adjoins the southern side of the house is cut into the slope, such that the floor of the garage is at the same level as the floor of the crawl space below the house.

The front garden comprises an area of hardstanding forming the driveway which slopes down towards the south, with a series of small raised ponds running parallel to Greenaway Gardens. The rear garden includes a patio adjacent to the house with a central area of lawn with planted beds to the north and south and a pond towards the western boundary. A number of small raised planted beds are also present in areas of the patio.

A topographical survey of the site provided by the consulting engineer (drawing ref 227704A/1, dated November 2014) shows that the driveway at the front varies from approximately 92.8mOD in the north, to 91.4m OD in the south. In the garden to the rear, the raised patio area varies from 92.7m OD in the north, to 92.4m OD in the south. The rear garden slopes down to the west: the level of the garden at the base of the patio steps is approximately 91.6m OD, whilst toward the western boundary fence the level is approximately 90.2m OD.

2.2 Site History

The site history has been researched by reference to internet sources and historical Ordnance Survey (OS) maps obtained from the Envirocheck database.

The earliest map studied, dated 1850, shows the site to be undeveloped open land with the nearest road being West End Lane, approximately 100 m to the south of the site, later renamed Frognal Lane.

A large detached house, later identified as Frognal Park, is shown 100m northeast by 1871 and two ponds 60m to the east of the site. A third pond was located 120mnorthwest of the site at that time and a stream extended westwards from the pond which may have been a tributary of the River Westbourne.

At some time between 1896 and 1915 the pond to the northwest was backfilled, as was the southernmost pond to the east.

The site was developed with the existing house between 1915 and 1935 and the remaining pond backfilled. The site and surrounding area have since remained essentially unchanged.

2.3 Other Information

A search of public registers and databases has been made via the Envirocheck database and relevant extracts from the search are appended. Full results of the search can be provided if required.

The Envirocheck report has indicated no landfill sites, waste management or waste transfer sites located within 500m of the site. However, within 1 km, there is one landfill site, three registered waste transfer sites and one registered waste treatment or disposal times. The historical landfill is approximately 720m south of the site, under the name of Canfield Place. There is no information on the type of waste it received.

No pollution incidents to controlled waters have been recorded within 1km of the site.

The site is not within an area shown by the Environment Agency (EA) to be at risk from flooding from rivers or the sea and does not lie within any known areas of sensitive land use, such as Areas of Outstanding Natural Beauty, Environmentally Sensitive Areas, Special Areas of Conservation and Special Protection Areas. Further information can be found within the Landmark Envirocheck Report for the site. The site is not indicated to lie within a Source protection Zone as defined by the EA. According to the Arup report, the site is also outside the 1975 and 2003 road flooding areas.

Reference to records compiled by the Health Protection Agency (formerly the National Radiological Protection Board) indicates that the site falls within an area where less than 1% of homes are affected by radon emissions and therefore radon protective measures will not be necessary.

There is one listed fuel station within 500m of the site. It is located 473 m to the southwest, under the name of Cavendish Motors and is indicated to be obsolete.

2.4 Geology

The British Geological Survey (BGS) map of the area indicates that the site is underlain by the Claygate Member which is underlain by the London Clay Formation. The Claygate Member forms the youngest part of the London Clay Formation. The boundary between the Claygate Member and underlying London Clay is indicated to subcrop approximately 50 m to 125 m of the site to the northwest, west, south and southeast of the site.

According to the British Geological Society memoir, the Claygate Member comprises alternating beds of clayey silt, very silty clay, sandy silt and glauconitic silty fine sand. The lower part of the Claygate Member is generally more bioturbated. A bed of calcareous concretions is present near the base in many places. The London Clay Formation is described as homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine grained sand.

The Arup report indicates the site is located on a slope of less than 7 degrees and outside the zones at risk of slope instability.

A ground investigation was conducted by GEA on the neighbouring site to the south in 2011. This comprised a single cable percussion borehole to a depth of 25.0 m (66.1 m OD) supplemented by four window sampler boreholes to a maximum depth of 6.0 m. This investigation recorded topsoil to depths between 0.1 m and 0.2 m, overlying made ground to between 0.4 m (90.75 m OD) and 0.9 m (89.3 m OD) comprising brown or grey clayey silty sand with occasional ash and brick. The Claygate Member was found to underlie the made ground and comprised: initially soft becoming firm orangishbrown mottled pale brown and grey silty clay with rootlets and pockets of fine sand. The clay typically became very sandy below approximately 2.5m and was noted to be stiff below 3.5m. Stiff grey silty very sandy clay extended from approximately 5.0m to 8.1m (82.91m OD). The clay was indicated to be of medium plasticity.

The London Clay was encountered within the cable percussion borehole at a depth of 8.1m (82.91m OD). It comprised stiff grey fissured silty clay with occasional partings of pale grey sand and extended beyond the base of the exploratory hole of 25.0m. The clay was noted to be very stiff below a depth of 11.0m and was less silty below 21.0m.

2.5 Hydrology and Hydrogeology

The Claygate Member is classified as a Secondary A Aquifer, which refers to permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers, as defined by the Environment Agency (EA). The London Clay is classified as an Unproductive Stratum, which refers to rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Existing and historical spring lines are present at the interface of the Claygate Member and the underlying essentially impermeable London Clay. These springs have been the source of a number of London’s “lost” rivers, notably the Fleet, Westbourne and Tyburn, which generally rose on Hampstead Heath, to the north of the current site, although mostly at the interface between the Bagshot Formation and Claygate Member.

Any water infiltrating the Claygate Member will generally tend to flow vertically downwards at a slow rate toward the chalk aquifer and laterally along tiny fissures within the clay. Due to the predominantly cohesive nature of the soils, the groundwater flow rate is anticipated to be very slow and published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1×10^{-10} m/s and 1×10^{-8} m/s, with an even lower vertical permeability. Although the Claygate Member is more sandy in composition and permeability could be expected to be marginally higher.

The site is not within a designated Source Protection Zone (SPZ). There are no EA registered water abstraction points within 1km of the site.

During the aforementioned GEA (2011) site investigation, groundwater was encountered during drilling within the Claygate Member at depths of between 3.00 m and 3.80 m within the window sampler boreholes and 5.66 and 7.55 within the cable percussion borehole. Groundwater was also recorded within the London Clay at 9.40m within a parting of sand. Groundwater levels from monitoring undertaken one week later measured groundwater at a depth of depth between 2.61m (88.16m OD) and 2.98m (87.78m OD).

The nearest surface water feature to the site is located 989m to the north which appears to be associated with the Leg of Mutton Pond with West Heath. The site is not within an area at risk from flooding as defined by the EA.

Historically[4], two tributaries of the Westbourne, one of London's "lost" rivers, were located in close proximity of the site. The first tributary originated approximately 200 m to the southeast of the site, and the second flowed past, approximately 270 m northwest, along what is now Heath Drive, these both met in Kilburn before flowing on through The Serpentine in Hyde Park, issuing into the River Thames over 8km to the southeast of the site, near Chelsea Bridge.

The site is not at risk of flooding from rivers or sea, as defined by the Environment Agency.

The site is largely covered by the existing building and hardstanding and therefore infiltration of rain water into the ground beneath the site is limited to the area of soft landscaping forming the rear and front gardens. The majority of surface runoff is likely to drain into combined sewers in the road.

2.6 Preliminary Risk Assessment

Part IIA of the Environmental Protection Act 1990, which was inserted into that Act by Section 57 of the Environment Act 1995, provides the main regulatory regime for the identification and remediation of contaminated land. The determination of contaminated sites is based on a "suitable for use" approach which involves managing the risks posed by contaminated land by making risk-based decisions. This risk assessment is carried out on the basis of a source-pathway-receptor approach.

2.6.1 Source

The desk study research and walkover have indicated that the site has been occupied by the existing residential property for its entire known developed history. The site and immediate surrounding areas are not considered to have had a contaminative history.

Three former ponds have been identified within 150m of the site, these were in-filled approximately 100 years ago and as such are unlikely to represent a source of contamination or soil gas risk.

2.6.2 Receptor

The site will continue to have a residential end use following the excavation of the basement and no new receptors will result. However, the residential end use is considered a high sensitivity end-use. Buried services are likely to come into contact with any contaminants present within the soils through which they pass and site workers are likely to come into direct contact with any contaminants present in the soil and through inhalation of vapours during basement excavation and construction.

The site is underlain by Secondary 'A' Aquifer and therefore groundwater and adjacent sites should be considered moderately sensitive receptors. The presence of an Unproductive Stratum beneath the secondary aquifers means that the chalk aquifer at depth represents a relatively low sensitivity receptor.

2.6.3 Pathway

End users will be largely isolated from direct contact with any contaminants present within the made ground by the presence of the buildings and the extent of the hardstanding. However, in proposed areas of soft landscaping potential direct contaminant exposure pathways exist with respect to end users.

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4 Nicholas Barton (2000) *London's Lost Rivers.* Historical Publications Ltd

The presence of the Claygate Member may allow the migration of contaminated groundwater to adjacent sites. The negligible permeability of the underlying London Clay Formation will limit the potential for groundwater percolation into the underlying chalk, and thus a pathway is not considered likely to exist to the principal aquifer.
Except for the pathway of direct contact for buried services and site workers, no new pathways will be created by the basement excavation.

There is thus considered to be low potential for a significant contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant beneath the new building and extent of any hardstanding and a moderate potential exists within any proposed soft landscaped or garden areas.

2.6.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a LOW risk of there being a significant contaminant linkage at this site which would result in a requirement for major remediation work. Furthermore, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site: there should thus be no need to consider landfill gas exclusion systems.

3.0 SCREENING

The London Borough of Camden guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full Basement Impact Assessment (BIA) required.

3.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E which includes a series of questions within a screening flowchart for three categories; groundwater flow; land stability; and surface water flow. Responses to the questions are tabulated on the following page.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for 4 Greenaway Gardens
1a. Is the site located directly above an aquifer?	*Yes the site is located above a Secondary 'A' Aquifer as designated by the EA.*
1b. Will the proposed basement extend beneath the water table surface?	*Yes. The proposed basement level is approximately 87.0m OD and from previous nearby investigations in the area it is possible that the basement will extend beneath the water table. However a persistent water table may not be present due to the hydraulic properties of the saturated clays.*
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	*No*
3. Is the site within the catchment of the pond chains on Hampstead Heath?	*No*
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*No*

Question	Response for 4 Greenaway Gardens
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	*Unlikely, given that the site is underlain by clay soils and is unlikely to be suitable for a soakaway or similar SUDS based system. However if there is an existing soakaway system this will be utilised, otherwise site drainage will be directed to public sewer.*
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	*No. There is an ornamental pond in the garden but it is considered not relevant to this question.*

The above assessment has identified the following potential issues that need to be assessed:

Q1a. The site is located above a Secondary ‘A’ Aquifer as designated by the EA.
Q1b. The proposed basement may extend beneath the water table surface.
Q2. The site is within 100m of a potential spring line.

The potential issues that need to be assessed, along with the possible effects of the basement construction on the local hydrology and hydrogeology and are discussed further in Part 2 of this report.

3.1.2 Stability Screening Assessment

Question	Response for 4 Greenaway Gardens
1. Does the existing site include slopes, natural or manmade, greater than 7°?	*No.*
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	*No. The site is not to be significantly re-profiled as part of the development.*
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	*No*
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	*No not according to the slope angle map (figure 16) produced by Arup.*
5. Is the London Clay the shallowest strata at the site?	*No*
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	*It is understood that no trees will be felled as part of the redevelopment of the site.*
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of shrinkable London Clay and abundant mature trees.*
8. Is the site within 100 m of a watercourse or potential spring line?	*No*
9. Is the site within an area of previously worked ground?	*No*
10a. Is the site within an aquifer?	*Yes the site is located above a Secondary ‘A’ Aquifer as designated by the EA*
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	*Yes. The proposed basement level is approximately 87 m OD and from previous nearby investigations in the area it is possible that the basement will extend beneath the water table*
11. Is the site within 50 m of Hampstead Heath ponds?	*No*
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes - the site fronts onto a public road to the east*

Question	Response for 4 Greenaway Gardens
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Not known. The extent of the foundations on adjacent sites is not known*
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	*No*

The above assessment has identified the following potential issues that need to be assessed:

- Q7. there is a history of seasonal shrink-swell
- Q10a. the site is located above a Secondary 'A' Aquifer as designated by the EA
- Q10b. the proposed basement may extend beneath the water table
- Q12. the site is within 5 m of a public highway.
- Q13. the development may increase the foundation depths relative to the neighbouring properties to a relatively significant extent.

The potential issues that need to be assessed, along with the possible effects of the basement construction on the local hydrology and hydrogeology and are discussed further in Part 2 of this report.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for 4 Greenaway Gardens
1. Is the site within the catchment of the pond chains on Hampstead Heath?	*No. Figure 14 of the Camden geological, hydrogeological and hydrological study – Guidance for subterranean development dated 2010, confirms that the site is not located within this catchment area.*
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	*No. There will be no surface expression of the basement development, so surface water flows and drainage will be unchanged.*
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*No. Any new paved surfaces above the basement will be constructed using SUDS permeable paving or similar.*
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	*No.* *There will be no surface expression of the basement development, so the surface water flow regime will be unchanged..*
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	*No.* *There will be no surface expression of the basement development, so the surface water flow regime will be unchanged.*
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	*Yes, possibly.* *The Camden Flood Risk Management Strategy dated 2013, Figures 3iv, 4e, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses.*

Question	Response for 4 Greenaway Gardens
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	*Greenway Gardens is not identified on Figure 3iv of the SFRA to have flooded in 1975 or 2002.* *However, the basement will be constructed to a depth of 4.2m bgl and therefore within the Claygate water table set at 4m bgl.* *The site is also located within the Critical Drainage Area number GROUP3-010 as identified in the Camden SWMP. Therefore, a flood risk assessment was commissioned. The report found a low risk of surface water flooding. The report is discussed further in Section 9.*

The above assessment has identified the following potential issues that need to be assessed further.

Q6. the site is at risk from flooding as the proposed basement is below the static ground water level.

Although the basement will be mainly located within the dwelling footprint, it is proposed that the basement will also extend below ground into the garden area somewhat. The ground surface above the extended basement footprint will change from a part vegetated/part paved surface to a completely paved surface. However, any new paved surfaces above the basement will be constructed using SUDS permeable paving or similar. This will ensure no increase in runoff rate or volume as a result of the proposed basement construction.

The basement will largely be beneath the footprint of the dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by the Camden geological, hydrogeological and hydrological study – Guidance for subterranean development dated 2010, does not apply across these areas.

However, as the basement will also extend into the garden area, there will be a small section which has 0.5m distance between the roof of the basement and ground surface. It is considered that the use of SUDS paving or similar will mitigate any impact by not meeting the 1m requirement.

There will not be an increase in impermeable area. Any new paved surfaces above the basement will be constructed using SUDS permeable paving or similar. This will ensure no increase in runoff rate or volume as a result of the proposed basement construction or changes to inflows/volumes.

4.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified potential impact factors.

The potential impacts of the proposed development on surface flow and flooding and subterranean flow will need to be dealt with in separate assessments, such that the following section focuses on the potential impacts that may have an impact on slope stability.

4.1 Potential Impacts

The following potential impacts have been identified.

Potential Impact	Consequence
The site is located within a Secondary 'A' Aquifer. Works could impact the aquifer	The proposed basement level may be below the water table and this could increase flow paths and/or raise groundwater levels locally.
The proposed works may extend into the water table and impact on groundwater flow in surrounding area	
Seasonal shrink-swell can result in foundation movements	If a new basement is not dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties.
The site may require some dewatering to enable construction	Localised settlement caused by dewatering
Site within 5 m of a highway or pedestrian right of way.	Excavation of a basement may result in structural damage to the road or footway. However, the proposed basement will not extend to within 5.0 m of the public paths and highways to the southeast of the site. Therefore it is unlikely that any movement would be caused by the development.
Founding depths relative to neighbours.	If not designed and constructed appropriately, the excavation of a basement may result in structural damage to neighbouring buildings and structures.
The site is at risk from flooding as the proposed basement is below the static water level.	If not design and constructed appropriately the basement may be prone to flood from groundwater.

These potential impacts have been investigated through the site investigation, as detailed in Section 9.0.

4.2 Exploratory Work

The scope of the works was specified by the consulting engineers, with input from GEA. In order to meet the objectives described in Section 1.2, two boreholes were drilled by means of a cable percussion rig to a depth of 15 m. In addition, two boreholes were drilled using an opendrive sampling rig, to a maximum depth of 8 m.

During boring disturbed and undisturbed samples were obtained from the boreholes for subsequent laboratory examination and testing. Standard Penetration Tests (SPTs) were carried out at regular intervals to provide additional quantitative data on the strength of soils encountered.

Groundwater monitoring standpipes were installed in three boreholes to depths of 6 m and have been monitored on two occasions.

In addition nine hand excavated trial pits were undertaken to depths of between 0.66 m and 2.10 m to expose the existing foundations of the house and its neighboring properties.

A selection of the samples recovered from the boreholes was submitted to a soil mechanics laboratory for a programme of geotechnical testing and an analytical laboratory for a programme of contamination testing.

All of the above work was carried out under the supervision of a geotechnical engineer from GEA.

The borehole records and results of the laboratory testing are appended, together with a site plan indicating the exploratory positions. The Ordnance Datum (OD) levels indicated on the borehole and trial pit records and quoted within the report have been interpreted from spot heights shown on a topographical survey drawing provided by the consulting engineers[5].

4.3 Sampling Strategy

The boreholes were positioned on site by GEA, with due respect to the proposed development. The trial pits locations were specified by the structural engineers and positioned on site by GEA, in accessible locations, whilst avoiding areas of buried services.

Four samples of made ground were subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. For this investigation the analytical suite for the soil included a range of metals, speciation of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway. A further two samples were taken and tested to provide advice in respect of re-use or for waste disposal classification.

The contamination analyses were carried out at a MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

5.0 GROUND CONDITIONS

The investigation has generally confirmed the expected ground conditions in that, below a moderate thickness of made ground, the Claygate Member was encountered, and was underlain by the London Clay Formation which extended to the maximum depth of the investigation, of 15.00 m.

The precise location of the boundary between the Claygate Member and London Clay is often difficult to define due to its gradational contact, and the close similarities in composition and geotechnical properties of each stratum. The boundaries have therefore been placed on the attached borehole records as described below, but part of what is described as Claygate Member may in fact comprise Unit D of the London Clay, and vice versa.

5.1 Made Ground

The made ground extended to depths of between 0.20 m and 0.30 m within the boreholes. To the front of the house (east) the boreholes encountered paving slabs over reinforced concrete, with a layer of topsoil comprising sand and gravel of brick, flint and concrete. To the rear of the property the made ground was overlain by paving slabs or topsoil and comprised clayey sand and concrete gravel and slightly sandy slightly gravelly clay with rare sandstone cobbles.

The foundation trial pits encountered between 0.03 m to 0.95 m of made ground. Most of the trial pits comprised concrete or brick of between 0.09 m to 0.25 m overlying soils of made ground. These soils generally comprised of firm dark brown slightly sandy clay with occasional fine to coarse gravel of flint and brick.

5 SG Consulting Ltd on behalf of Mr Israelian, 2014, Land Survey Drawing No. 22770A/1

Apart from the presence of fragments of extraneous material noted above, no visual or olfactory evidence of contamination was observed during the fieldwork. Four samples were analysed for a range of contaminants as a precautionary measure and the results are summarised in Section 4.6.

5.2 Claygate Member

The Claygate Member comprised interbedded layers of brown mottled orange and grey silty clay and clayey silt. Some of these layers included pockets of fine sand and carbonaceous material. The strength of the material was generally initially soft up to 0.7 m, becoming firm until 3.0 m to 4.0 m, and then stiff and extended to depths of between 5.9 m and 6.4m. The exception to this was Borehole No 2 which encountered a soft layer from 2.0 m to 3.7 m, then becoming firm until the London Clay boundary.

To the rear of the property (west) the boundary between the Claygate Member and underlying London Clay was at approximately 85.97 m OD to 86.00m OD. At the front of the property the boundary was encountered between 86.30 m OD to 87.15 m OD.

The results of laboratory plasticity index tests indicate that the clay is of medium volume change potential.

The results from the laboratory undrained triaxial compression tests, which are plotted against depth on a graph in the appendix, indicate the clay to generally increase in strength with depth from low/medium to high strength with undrained shear strength increasing from 22 kN/m^2 at a depth of 2.0 m, to 77 kN/m^2 at a depth of 3.0 m. It should be noted that this is not a linear increase with depth and there variation within the various layers, possibly due to silt and water content.

Consolidation with swelling tests were undertaken on two Claygate Member samples, the results of which can be found in the Appendix.

No evidence of contamination was noted in these soils.

5.3 London Clay Formation

The London Clay generally comprised firm becoming stiff fissured grey silty clay with occasional fine sand partings and shell fragments and proved to the maximum depth investigated of 15.00 m. Borehole No 2 encountered a soft dark grey silty clay layer, 0.3 m thick, at the interface with the Claygate Member at 5.4 m. The low strength of this layer is likely to be associated with the groundwater which was encountered at 5.5 m.

The results of laboratory plasticity index tests indicate that the clay is of medium volume change potential, with one result at 14 m indicating clay of high volume change potential.

The results from the laboratory undrained triaxial compression tests, which are plotted against depth on a graph in the appendix, indicate the clay to increase in strength with depth from medium to high strength with undrained shear strength increasing from 60 kN/m^2 at a depth of 7.5 m, to 148 kN/m^2 at a depth of 13.5 m.

Consolidation with swelling tests were undertaken on four London Clay samples, the results of which can be found in the Appendix.

No evidence of contamination was noted in these soils.

5.4 Groundwater

Groundwater was encountered within the Claygate Member at 4.0 m (88.37 m OD) at the silt / clay interface. Seepages were encountered at the interface between the Claygate Member and London Clay in Borehole 2 at 5.5m (87.05 m OD),which rose to 5.4 m (87.15 m OD) after 20 minutes, and in Borehole 4 at 6.0 m (85.60 m OD). Groundwater seepages were also encountered within the London Clay at 7.3 (84.3 m OD) rising to 7.1 m within Borehole No 1 and two strikes were encountered within Borehole No. 2 at 8.7 m (83.85 m OD) and 10.8m (81.75 m OD).

Three groundwater monitoring standpipes were installed and groundwater has subsequently been monitored on three occasions, approximately four weeks, seven weeks and thirteen weeks after installation, during which groundwater was measured at depths of between 0.93 m (91.44 m OD) and 2.65 m (89.90 m OD). The results of the groundwater monitoring indicate groundwater levels reflect the topography, falling away to the southwest.

The results of the monitoring visits carried out are shown in the table below.

Borehole No	Date:	13/01/2015		Date:	06/02/2015		Date:	20/03/2015	
	Depth of pipe (m bgl)	Ground water depth (m bgl)	Ground water level (m OD)	Depth of pipe (m bgl)	Ground water depth (mbgl)	Ground water level (m OD)	Depth of pipe (m bgl)	Ground water depth (m bgl)	Ground water level (m OD)
1	6.37	1.36	90.24	4.96	2.15	89.45	6.33	2.57	89.03
2	5.77	1.68	90.87	5.78	2.45	90.1	5.75	2.65	89.90
3	5.78	0.93	91.44	5.81	1.90	90.47	5.78	2.34	90.03

Water was encountered within several trial pits which were left open overnight.

5.5 Soil Contamination

The table below sets out the values measured within four samples of made ground analysed; all concentrations are in mg/kg unless otherwise stated.

Determinant	BH3 0.2	BH4 0.2	TH2 0.2	TH8 0.21
Arsenic	12	20	32	18
Cadmium	<0.1	0.43	0.15	0.3
Chromium	40	56	29	29
Copper	13	46	48	45
Lead	67	**260**	**500**	**890**
Mercury	0.15	0.53	0.1	0.44
Nickel	15	21	35	20
Selenium	<0.2	<0.2	<0.2	<0.2
Zinc	48	130	79	340
Total Cyanide	<0.5	<0.5	2	0.5

Determinant	BH3 0.2	BH4 0.2	TH2 0.2	TH8 0.21
Phenols	<0.3	<0.3	<0.3	<0.3
TPH	<10.0	33	150	52
Total PAH	<2.0	6.5	82	46
Benzo(a)pyrene	<0.1	0.42	5.9	4
Naphthalene	<0.1	<0.1	0.43	0.27
Total organic carbon %	0.31	4.5	3.8	2.6
Total Sulphate (g/l)	0.24	0.075	**0.83**	0.2
Sulphide	1.9	1.4	3.9	3.6
pH	8.9	7.4	10.4	9.8

Note: Figure in **bold** indicates concentration in excess of risk-based soil guideline values, as discussed in Part 2 of this report.

The results of the chemical analyses have indicated elevated concentrations of lead in three of the four samples and a single elevated concentration of water soluble Sulphate.

Waste Acceptance Criteria tests have also been carried out on two samples of soil and the results are discussed in Section 8.8.

5.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. To this end contaminants of concern are those that have values in excess of a generic human health risk based guideline values which are either that of the CLEA[6] Soil Guideline Value where available, or is a Generic Guideline Value calculated using the CLEA UK Version 1.06 software assuming a residential with plant uptake end use. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be young female children aged zero to six years old;
- that the exposure duration will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, skin contact with soils and indoor dust, and inhalation of indoor and outdoor dust and vapours; and
- that the building type equates to a two-storey small terraced house.

It is considered that these assumptions are acceptable for this generic assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

6 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include;

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

The concentrations of the contaminants of concern highlighted by a comparison of the measured concentrations against the generic screening values are tabulated below. This assessment is based upon the potential for risk to human health, which at this site that is underlain by a non-aquifer is considered to be the critical risk receptor.

Contaminant of Concern	Maximum concentration recorded (mg/kg)	Location(s) of elevated concentration(s) [depth m]	Generic Risk-Based Screening Value
Lead	**890**	BH4 [0.20 m], TH2 [0.20 m], TH8 [0.21 m]	200
Total Sulphate (g/l)	**0.83**	TH2 [0.20 m]	0.5

**Threshold values marked thus are for compounds with a limited human toxicity hence the threshold values adopted are not derived on a risk based methodology. Justification for all of the values quoted is provided in the appended table of Generic Risk Based Threshold Soil Guideline Values*

The significance of these results is considered further in Part 2 of the report.

5.6 Existing Foundations

The findings of the trial pits are summarised in the table below. Sketches and photographs of each pit are included in the Appendix.

Trial Pit No	Structure	Foundation detail	Bearing Stratum
1	Inside boiler room. Neighbouring property foundation. Neighbouring house is set lower than site	Concrete over brick strip. Foundation may extend deeper. Top of brick 0.79 m Base of brick 1.07m Lateral projection 200mm	Hard (desiccated?) light orangish brown very closely fissured slightly sandy silty CLAY.
2	Garage	Mass concrete Top of concrete 0.18 m Base of concrete 0.48 m Lateral projection 245mm	Very stiff light orangish brown mottled orange fissured slightly sandy silty CLAY with rare fine angular black gravel. Occasional very fine to fine roots.

Trial Pit No	Structure	Foundation detail	Bearing Stratum
3	Rear of house	Brick corbels over mass concrete strip Top of brick 0.87 m Top of concrete 1.02 m Base of concrete 1.25 m Lateral projection 200 mm	Firm orangish brown slightly sandy silty CLAY.
4	Front of house	Mass concrete strip. Unable to confirm base of foundation. Top of concrete 1.36 m Base of concrete 1.8 m Lateral projection 210 mm	Stiff light orangish brown mottled orange slightly sandy silty CLAY with occasional fine subangular to subrounded gravel of flint. Occasional very fine to fine roots.
5	Rear of house	Brick corbels over mass concrete strip Top of brick 0.37 m Top of concrete 0.52 m Base of concrete 0.81 m Lateral projection 190 mm	Firm orangish brown slightly sandy silty CLAY.
6	Rear of house	Brick corbels over mass concrete strip Top of brick 0.32 m Top of concrete 0.48 m Base of concrete 0.80 m Lateral projection 165 mm	Soft light orangish brown slightly sandy silty CLAY. Frequent fine roots. Trial pit was located under a leaking gutter,
7	Inside house	Brick corbels over mass concrete strip Top of brick 0.82 m Top of concrete 1.00 m Base of concrete 1.30 m Lateral projection 335 mm	Firm orangish brown mottled dark brown silty CLAY. Desiccated. Occasional fine subangular gravel. Occasional very fine roots.
8	Front of house	Brick corbels over mass concrete strip. Terminated early due to services. Top of brick 0.72 m Top of concrete 0.77 m Base of concrete – not proven Lateral projection – not proven	Stiff light orangish brown mottled orange slightly sandy silty CLAY with occasional fine subangular to subrounded gravel of flint. Frequent fine roots.
9	Shed Neighbouring property foundation	Brick corbels over mass concrete strip. Top of brick 0.30 m Top of concrete 0.47 m Base of concrete – 6.20 m Lateral projection – 230 mm	Firm orangish brown thinly laminated slightly micaceous silty CLAY with occasional fine roots.

The depth of the foundations varied considerably. This appears to reflect the relationship of the foundation location to the crawl space under the southeastern quarter of the house.

Groundwater was encountered in Trial Pit Nos 3, 6, 7 and 9, although it should be noted that these trial pits were left open overnight and therefore had more time for any groundwater to accumulate. Trial Pit No 6 may have had artificially high water as there was a leaking gutter in close proximity. Trial Pit No 6 was also left open overnight but this remained dry.

Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to the basement excavation and the potential impact on the hydrogeology.

6.0 INTRODUCTION

It is understood that the current proposal is to form a new single storey basement structure around the side and rear of the house with an excavation of approximately 4.2m below existing ground level. A single storey extension is proposed at the rear, built in traditional loadbearing masonry, supported off the new reinforced concrete slab that extends out to cover the basement and forms support for a new terrace. A new two-storey extension to the west elevation is also proposed to be built in traditional loadbearing masonry supported off the new reinforced concrete slab.

The new basement construction is to comprise a piled wall with an internal reinforced concrete retaining wall with an internal cavity drain system. Reinforced concrete underpinning to the existing foundations is proposed where the basement abuts the house with an internal cavity drain system. The proposed basement with the two proposed ground floor extensions built over will be effectively structurally independent from the internal works of the main house.

7.0 GROUND MODEL

The desk study has revealed that the site has not had a potentially contaminative historical use as it has been developed with the existing house for its entire developed history, and on the basis of the fieldwork, the ground conditions at this site can be characterised as follows.

- The investigation encountered a moderate thickness of made ground over the Claygate Member, overlying the London Clay Formation;
- the made ground extends to depths of between 0.20 m and 0.30 m and comprises paving slabs over reinforced concrete to the front of the property and paving slabs or topsoil comprising clayey sand and concrete gravel and slightly sandy slightly gravelly clay with rare sandstone cobbles to the rear;
- the Claygate Member comprises interbedded layers of brown mottled orange and grey silty clay and clayey silt with occasional pockets of fine sand. The strength of the material was generally initially soft up to 0.7 m, becoming firm until 3.0 m to 4.0 m, and then stiff to its remaining thickness, which extended to depths of between 5.9 and 6.4m;
- the exception to this was Borehole No. 2 which encountered a soft layer from 2.0 m to 3.7 m, then becoming firm until the London Clay boundary;
- to the rear of the property (west) the boundary between the Claygate Member and underlying London Clay was approximately 85.97 to 86.00 m OD. At the front of the property the boundary was encountered at approximately 86.30 m to 87.15 m OD;

- generally the clay increases in strength with depth from low/medium to high strength. This is not a linear increase with depth and there variation within the various layers, possibly due to silt and water content;

- the London Clay generally comprises firm becoming stiff fissured grey silty clay with occasional fine sand partings and shell fragments and was proved to the maximum depth investigated of 15.00 m;

- Borehole No. 2 encountered a soft dark grey silty clay layer, 0.3 m thick, at the interface with the Claygate Member at 5.4 m. The low strength of this layer is likely to be associated with the groundwater which was encountered at 5.5 m;

- generally the clay increases in strength with depth from medium to high strength;

- groundwater is present in the more silty clay of the Claygate Member and particularly at the interface with the London Clay as seepages and was encountered between 88.37 m OD and 85.60 m OD;

- groundwater was also encountered within the London Clay as seepages between 84.3 m OD and 81.75 m OD, and

- made ground had elevated concentrations of lead in three of the four samples and a single elevated concentration of water soluble Sulphate.

8.0 ADVICE AND RECOMMENDATIONS

Formation level for the proposed 4.20 m deep basement, which is assumed to be at approximately 87.3 m OD, is likely to be within the Claygate Member. The groundwater monitoring to date indicates that the excavation will extend approximately 2 to 3 m below monitored groundwater levels, although significant groundwater inflows are not anticipated into the basement excavation due to the relatively low permeability of the silts and clays. As such it should be possible to adopt the proposed use of traditional underpinning methods and loadbearing masonry from the concrete basement slab to support the new development, in addition to the proposed secant piles enabling more control of groundwater inflows across the majority of the excavation.

Excavations for the proposed basement structure will require temporary support to maintain stability of the excavation and surrounding structures at all times. The existing foundations will need to be underpinned prior to construction of the proposed new basement or will need to be supported by new retaining walls.

The loads of the development are light to moderate.

8.1 Basement Construction

Richard Tant Associates Consulting Civil & Structural Engineers provided a Structural Methodology Report[7] with associated temporary works drawings: 4138-BG01 Rev B, 4138-BG02 Rev A, 4138-IN01 Rev B and 4138-IN02 Rev A, and accompanying calculations. These have been considered within the following sections.

[7] Richard Tant Associates, (2015), *4 Greenaway Gardens Structural Methodology Report, RT/SMS/4138*

8.1.1 Basement Excavations

It is understood that it is proposed to form a single level basement, which will extend beneath the existing house and beneath the proposed new rear extension to a depth of approximately 4.20 m below existing ground level and formation level will be within the firm to stiff Claygate Member.

Groundwater was encountered within the Claygate Member at depths of 4.00 m (88.37 m OD) and at the Claygate Member/London Clay interface at depth of between 5.5 m (87.05 m OD) and 6.0 m (85.60 m OD). Subsequent monitoring has indicated groundwater at levels of between 89.03 m OD and 91.44 m OD. On this basis groundwater is likely to be encountered within the basement excavation and at variable depths. It would be prudent to carry out rising head tests within the standpipes to establish the rate of rise in groundwater and permeability of the Claygate Member.

Groundwater is likely to be present within the Claygate Member as pockets of water rather than in continuous layers. Each individual pocket may therefore be of relatively low volume and individual inflows may cease once the pocket is emptied. However, as the basement excavation will cover a much larger area than that covered by the investigation, it is possible that larger pockets or inter-connected layers of groundwater could be encountered. It would therefore be prudent, once access is available, to carry out a number of trial excavations, to depths as close to the full basement depth as possible, to provide an indication of the likely groundwater conditions. It is likely that the rate of inflow will be relatively slow within the Claygate Member, although it is recommended that the chosen contractor has a contingency plan in place to deal with more significant or prolonged inflows, whilst underpinning, as a precautionary measure if a watertight temporary retention scheme is not adopted.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and surrounding structures, namely the neighbouring houses to both the east and west, and to protect against groundwater inflows. As the basement will be located within the saturated zone, there is a risk of groundwater flooding and this has been considered within the permanent design of the structure.

A sheet piled wall could be used as a temporary measure, prior to the construction of a permanent retaining wall, although the noise and vibrations associated with the installation of sheet piles maybe unacceptable, unless a “silent” installation method is adopted. Consideration could be given to using pressing techniques, although pressing techniques that use water jetting should be treated with caution in view of the risk of causing heave or settlement of the surrounding structures.

The monitoring carried out to date would suggest that groundwater will be encountered within the excavation, although it may be possible to adopt a contiguous bored pile wall with the use of localised grouting and sump pumping if necessary in order to deal with any groundwater inflows. To confirm this, trial excavations would be needed to understand whether groundwater can be adequately controlled through localised grouting and sump pumping. To mitigate such risks the Structural Methodology Report gives consideration to the use of a secant bored pile wall, which has the advantage of being incorporated into the permanent works and will be able to provide support for structural loads. It will also maximise the usable space within the basement area and could overcome the requirement for any secondary groundwater protection in the permanent works.

Where the existing structure interfaces with the proposed extension and basement, it is understood that traditional underpinning of the existing foundations are proposed. It may be possible to do this using a traditional 'hit and miss' approach but subject to further monitoring/testing or trial excavations, in order to understand the permeability of the ground.

Careful workmanship will be required to ensure that movement of the surrounding structures does not arise during underpinning of the existing foundations, but this method will have the benefit of minimising the plant required and maximising usable space in the new basement. The contractor should have a contingency in place to deal with any groundwater inflows.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements.

An assessment of the ground movements associated with the basement excavation has been commissioned and will be reported separately.

As it is understood that part of the basement is to be constructed by conventional underpinning, the support system will need to be considered as a whole, particularly with regard to preventing groundwater ingress in the temporary condition.

8.1.2 Retaining Walls

The following parameters are suggested for the design of the permanent basement retaining walls.

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (Φ' – degrees)
Made ground	1700	Zero	20
Claygate Member	1900	Zero	25
London Clay	1950	Zero	25

Groundwater is likely to be encountered within the excavation and at this stage, it is recommended that the basement is designed with a water level assumed to be 1.0 m below ground level. It may however be possible to review this requirement following additional investigation by means of trial excavations and further monitoring and the advice in BS8102:2009[8] should be followed in this respect.

8.1.3 Basement Heave

The proposed construction of the basement will result in an unloading of the Claygate Member at formation level. The excavations will result in an approximate unloading of around 80 kN/m^2, which will result in an elastic heave and long term swelling of the Claygate Member and London Clay. These movements will be mitigated to some extent by the applied structural loads, although it is likely that the basement floor slab will need to be designed to accommodate heave movements. It is recommended that a detailed heave analysis is undertaken once the proposed levels and loads are finalised.

8 BS8102 (2009) *Code of practice for protection of below ground structures against water from the ground*

8.2 Spread Foundations

The excavation of the basement will result in a formation level in the Claygate Member and it should be possible to adopt moderate width pad or strip foundations in the firm clay, designed to apply a net allowable bearing pressure of 150 kN/m^2 below the level of the proposed basement floor. The recommended bearing pressure provides an adequate factor of safety and should ensure that settlement remains within normal tolerable limits.

The depth of the basement excavation is expected to be such that foundations will be placed below the depth of actual or potential desiccation, but this should be checked once the proposals have been finalised. Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation. In this respect it would be prudent to have all foundation excavations inspected by a suitably experienced engineer. Due allowance should be made for future growth of existing / proposed trees. The requirement for compressible material alongside foundations should be determined by reference to the NHBC guidelines.

It is unlikely that it will be possible to attain the required depths without encountering groundwater inflows, and if inflows are such that spread foundations cannot be utilised, then recourse should be made to the use of a piled foundation solution.

8.3 Piled Foundations

For the ground conditions at this site, driven or bored piles could be adopted. Driven piles would have the advantage of minimising the spoil that is generated, but consideration would need to be given to the effects of noise and vibrations on neighbouring sites. Some form of bored pile may therefore be more appropriate. A conventional rotary augered pile could be considered, but temporary casing installed into the Claygate Member and London Clay would be required to protect against groundwater inflows and instability from within the made ground and Claygate Member. Therefore, to avoid the requirement for casing, bored piles installed using continuous flight auger (cfa) techniques may be more appropriate.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, for retaining walls and for any structural loads, based on the measured SPT / depth graph in the appendix. For the purposes of these parameters the formation level of the proposed new single level basement has been used 4.2m (87.3 m OD) and groundwater level has been assumed to be at a level of 0.93 (91.44 m OD).

Ultimate Skin Friction		***kN/m^2***
Basement Excavation	GL to 5.0 m	Ignore
London Clay	5.0 m to 15.00 m	Increasing linearly from 27 to 80
Ultimate End Bearing		***kN/m^2***
London Clay	12.00 m to 15.00 m	Increasing linearly from 1170 to 1440

In the absence of pile tests it is standard practice to apply a factor of safety of 2.6 to the above parameters in the computation of working loads of individual piles. On the basis of the above coefficients and applying a factor of safety of 2.6, it has been estimated that a 450 mm diameter pile extending to a depth of 12 m below proposed ground level should provide a safe working load of about 250 kN. Alternatively a similar diameter pile extending to a depth of 15 m below ground level should provide a safe working load of approximately 380 kN.

The above examples are not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of an appropriate piling scheme, and their attention should be drawn to the presence of groundwater within the Claygate Member.

8.4 Shallow Excavations

On the basis of the borehole and trial pit findings it is considered likely that it will be feasible to form relatively shallow excavations terminating within the made ground, and upper horizons of the Claygate Member without the requirement for lateral support, although localised instabilities may occur. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

Significant inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the made ground or from within more silty horizons within the Claygate Member, although such inflows should be suitably controlled by sump pumping, although this should be confirmed by additional investigations, ideally in the form of trial excavations to the full depth of the proposed basement.

However, if deeper excavations are considered or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

8.5 Basement Floor Slab

Following the excavation of the basement, it is likely that the floor slab for the proposed basement will need to be suspended over a void or layer of suitable compressible material to accommodate the anticipated heave unless the slab can be suitably reinforced to cope with these movements. Consideration may also need to be given to designing the basement to cope with water pressure below the slab. Further consideration will need to be given to these issues once the levels and magnitude of any slab loading are known.

8.6 Effect of Sulphates

Chemical analyses carried out on three samples; two samples of Claygate Member and a single sample of London Clay have revealed concentrations of soluble sulphate and near-neutral pH in accordance with Class DS-1. The measured pH value of the samples show that a ACEC class of AC-1 of Table C1 BRE Special Digest 1:SD Third Edition (2005) would be suitable. This assumes a mobile water condition at the site. The guidelines contained in the above digest should be followed in the design of foundation concrete.

8.7 Site Specific Risk Assessment

The desk study research has indicated that the site has not had a potentially contaminative historical use, having been occupied by the existing house throughout its developed history.

The chemical analyses of four samples of made ground have highlighted the presence of elevated concentrations of lead within three samples and a single elevated concentration of total sulphate. These concentrations could pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust.

The source of the lead contamination is not known but the made ground was noted to contain fragments of extraneous material throughout the site, and it is likely that fragments of such material, for example old paint fragments and ash, may have been present within the samples tested, accounting for the elevated concentrations. As a result it is not considered likely to be in a soluble form and as such do not present a risk to adjacent sites or to groundwater in the Secondary Aquifer. The underlying London Clay is classed as a non-aquifer and an Unproductive Stratum and therefore contamination to chalk aquifer at depth is not anticipated.

A risk to groundwater has not been identified.

Site workers will be protected from the contamination through adherence to normal high standards of site safety but there may be a requirement for protection of buried plastic services laid within the made ground.

8.7.1 End Users

8.7.1.1 Direct Contact

End users will be effectively isolated from direct contact with the identified contaminants by the building and areas of external hardstanding. The contamination is likely to be removed as part of the basement excavation and only in proposed garden areas could end users conceivably come into direct contact with the contaminated soils, although this pathway is already in existence.

As only a limited number of samples have been tested, it would be prudent to carry out contamination testing on additional samples of made ground / topsoil recovered from the areas of the site that are to remain as soft landscaped gardens, in order to ensure the absence of any significant contamination.

8.7.2 Site Workers

Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE and CIRIA[9] and the requirements of the Local Authority Environmental Health Officer.

9 CIRIA (1996) *A guide for safe working on contaminated sites* - Report 132, Construction Industry Research and Information Association

8.8 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[10], will need to be disposed of to a licensed tip. Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste going to landfill is subject to landfill tax at either the standard rate of £80 per tonne (about £145 per m^3) or at the lower rate of £2.50 per tonne (roughly £5 per m^3). However, the classification for tax purposes is not the same as that for disposal purposes. Currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring rocks and soils which are accurately described as such in terms of the 2011 Order[11] would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[12] it is considered likely that the made ground from this site, as represented by the four chemical analyses carried out, would be classified as a NON-HAZARDOUS waste under the waste code 17 05 04 (soils and stones not containing dangerous substances) and would be taxable at the standard rate. It is likely that the natural soils, if separated out, could be classified as an INERT waste also under the waste code 17 05 04. This material would be taxable at the lower rate, if accurately described as naturally occurring sand and gravel in terms of the 2011 Order on the waste transfer note. As this site has not had a contaminative history there should be no requirement for WAC leaching analyses to confirm that this material is suitable for landfilling, although this would require confirmation from the receiving site. WAC testing has been carried out in any case and revealed two samples of the Claygate Member to be suitable for disposal as Inert Waste and a copy of all lab results should be forwarded to the selected tips.

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[13] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.
The above opinion with regard to the classification of the excavated soils and its likely landfill taxable rate is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

It is recommended that once sufficient volumes of made ground are accumulated, such as during trial pit testing or surface strip, the material is sent for WAC testing.

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10 CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice* Version 2, March 2011
11 *Landfill Tax (Qualifying Material) Order 2011*
12 Environment Agency (2013) *Hazardous Waste: Interpretation of the definition and classification of hazardous waste. Technical Guidance* WM2 Third Edition, August 2013
13 Regulatory Position Statement (2007) *Treating non-hazardous waste for landfill - Enforcing the new requirement* Environment Agency 23 Oct 2007

9.0 BASEMENT IMPACT ASSESSMENT

The screening identified a number of potential impacts. The desk study and ground investigation information has been used to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

The site investigation indicates that the site is directly underlain by the Claygate Member, which is classified as Secondary 'A' Aquifer strata.

<table>
<tr><th>Potential Impact</th><th>Site Investigation Conclusions</th></tr>
<tr><td>The site is located directly above a Secondary 'A' Aquifer. The proposed basement development has the potential to reduce rainfall infiltration and subsequently recharge into the aquifer.</td><td>Groundwater was encountered within the Claygate Member and at the interface with the London Clay.
The Claygate Member is classified a Secondary Aquifer due to the presence of sand beds in some areas. However the site investigation established the Claygate Member beneath the site to comprise predominantly silty clay and therefore not capable of behaving as a Secondary Aquifer.</td></tr>
<tr><td>The proposed basement will extend beneath the water table. The proposed basement development has the potential to alter groundwater flow paths and increase groundwater levels locally.</td><td>Groundwater was encountered at 88.37 m OD and monitored at levels between 91.44 m OD and 89.45 m OD. The formation level is assumed to be 87.3 m OD. At the highest recorded groundwater level, the formation level is 4.14 m below the groundwater level; at the lowest recorded monitoring level the formation is 2.05 m below the groundwater level.
Some form of dewatering may be required. However, as the Claygate Member predominantly comprises silty clay strata, the potential for impacting on the local groundwater regime is negligible.</td></tr>
<tr><td>Shrink-swell could result in foundation movements</td><td>The Claygate Member can be prone to seasonal shrink-swell and can cause structural damage. Desiccation was noted during the fieldwork within the trial pits undertaken within the house, but desiccation may also be present within close proximity to existing trees elsewhere on site. The proposed basement will extend to a general depth of about 4.20 m, such that new foundations would be expected to bypass any desiccated soils present</td></tr>
<tr><td>Site within 5 m of a highway or pedestrian right of way.</td><td>The basement excavation will be in excess of 5m from the public highway and the investigation has not indicated any specific problems, such as weak or unstable ground, voids, that would make working within 5 m of public infrastructure particularly problematic at this site. In any case best practice in design and construction will ensure the stability of the highway.</td></tr>
<tr><td>Founding depths relative to neighbours.</td><td>The retention system will ensure the stability of the excavation and neighbouring properties at all times.</td></tr>
<tr><td>As part of the proposed site drainage, surface water flows (e.g. volume of rainfall and peak run-off) may be materially changed from the existing route</td><td rowspan="2">Groundwater was encountered within the Claygate Member and at the interface with the London Clay, as well as seepages recorded within the London Clay.

The Claygate Member is classified as a Secondary 'A' aquifer and the investigations carried out at the site have shown the strata to comprise layers of clay and silt material and therefore not capable of behaving as a Secondary Aquifer. As a result, the potential for impacting on the local groundwater regime is negligible.</td></tr>
<tr><td>The proposed basement development result in minor changes in the proportion of hard surfaced / paved areas</td></tr>
</table>

The results of the site investigation have been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

Groundwater

The site is underlain by the silty clays and clayey silts of the Claygate Member, which are designated as a Secondary 'A' Aquifer. However in the absence of any significant saturated permeable sand dominated horizons beneath the site the Claygate Member has the hydraulic characteristics of Non Productive strata. The proposed basement formation level is assumed to be 87.3 m OD and monitoring has established groundwater levels beneath the site to be between 91.44 m and 89.03 m OD. The proposed basement would therefore extend between approximately 1.73 m and 4.14 m beneath monitored groundwater levels within the saturated Claygate Member strata.

The proposed basement will be excavated into the Claygate Member and the strata will therefore abut the basement construction. The Claygate Member is also likely to extend 1.3m to 0.15 m from the underside of the basement slab to the top of the London Clay. Additionally, a distance of approximately 1 m of open ground is present between the house and the adjacent house to the north and a distance of approximately 1.5 m of "open" ground, where the boiler room and garage are located, is present between the house and the adjacent house to the south. Therefore groundwater, which is likely to flow toward the south, would be able to continue to flow around the proposed basement structure, maintaining the general groundwater flow regime across the site and to down gradient water features. Due to the clayey nature of the Claygate Member at the site, it is expected that permeability will be very low and that groundwater movement as a result will be very slow and of small volumes. Groundwater inflows in the basement excavation are likely to be similarly slow and it is likely that these could be controlled by sump pumping.

Seasonal Shrink-Swell

The proposed basement will extend to a depth of about 4.20 m, such that new foundations will be expected to bypass any desiccated soils.

Subject to inspection of foundation excavations in the normal way to ensure that there is not significant unexpectedly deep root growth, it is not considered that the occurrence of shrink-swell issues in the local area has any bearing on the proposed development.

Location of public highway

The basement excavation is located in excess of 5.0 m from the pathways and highways to the northeast. Therefore it is unlikely that the basement excavation would have an effect. The proposed development will include retaining walls that will be designed to maintain the stability of the surrounding ground, thus protecting the adjacent road and associated infrastructure beyond. There is nothing unusual or exceptional in the proposed development or the findings of the investigation that give rise to any concerns with regard to stability over and above any development of this nature.

The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties

It is assumed that the proposed basement will extend to a significant depth relative to the existing foundations of the neighbouring properties and will need to be designed to ensure the stability of the site and any potentially sensitive structures that are in close proximity to the site.

In order to comply with the requirements of CPG4 a ground movement assessment has been commissioned and will be reported separately. As a preliminary guide, on the basis that the proposed basement retaining wall will be at a minimum of 1 m laterally from the neighbours, based on previous experience, it is expected that the damage would not exceed the Burland "slight" category and therefore would be within normal tolerable limits. Details of the proposed sequence of construction has been prepared by Richard Tant Associates and a copy of the methodology is enclosed in the appendix, temporary works drawing: 4138-BG02 Rev A.

Risk from flooding

The proposed basement extends beneath the static groundwater table but appropriate design of the structure will minimise the risk of flooding from this. Previously mentioned published data indicates there is a low risk from surface flooding, as a result, a Flood Risk Assessment was carried out by Evans Rivers and Coastal Limited[14]. The report notes that the site is located within the Flood Zone 1 and all uses of land are appropriate within this zone. The report concludes that there will be a low risk of groundwater flooding across the site providing the basement is tanked. There is a low risk of flooding from other sources such as surface waters and sewers, but as a precaution to further mitigate this risk from sewer flooding, the use of a non-return valve is recommended. The report also recommends further groundwater monitoring and this shall be undertaken every three weeks.

9.1 BIA Conclusion

A Basement Impact Assessment has been carried out following the information and guidance published by the London Borough of Camden. Information from a Site Investigation has been used to assess potential impacts identified by the screening process.

It is concluded that the proposed development is unlikely to result in any specific land or slope stability issues, groundwater or surface water issues.

10.0 OUTSTANDING RISKS AND ISSUES

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of this investigation, or where issues have been identified by this investigation that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work is considered to be required.

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the ground

[14] Evans Rivers and Coastal Ltd, 2015, *Proposed basement at 4 Greenaway Gardens, London, NW3 7DJ, Flood Risk Assessment, Report Ref: 1412/RE/03-15/01*

conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

As discussed throughout the report, groundwater is likely to be encountered during the basement excavation. Groundwater monitoring shall continue in order to further assess equilibrium levels and trial excavations should be carried out to assess the extent of inflows to be expected and any instability within the more silty layers of the Claygate Member.

It is assumed that the basement will extend beneath the depth of any potential desiccation, but foundations should be inspected by a suitably qualified engineer.

A ground movement analysis has been commissioned in order to assess the potential movement of the soil as a result of the basement excavation and will be reported separately.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed. These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

As only a limited number of samples have been tested, it would be prudent to carry out contamination testing on additional samples of made ground / topsoil recovered from the areas of the site that are to remain as soft landscaped gardens, in order to ensure the absence of any significant contamination.

APPENDIX

Borehole Records

Trial Pit Records

Laboratory Geotechnical Test Results

Chemical Analyses (soil)

SPT & Cohesion / Depth Graph

Risk-based Generic Guideline Values

Envirocheck Extracts

Historical Maps

Flood Risk Assessment

Drawing: 4138-BG02 Rev A

Site Plan

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware,Herts
SG12 7QE

Site	4 Greenaway Gardens, London, NW3 7DJ			**Borehole Number**	BH1
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 7.50m	**Ground Level (mOD)** 91.60	**Client** Mr Verdi Israelian	**Job Number**	J14381
	Location	**Dates** 12/12/2014	**Engineer** Richard Tant Associates	**Sheet**	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water
					91.54	0.06	Paving slabs	
					91.40	(0.14) 0.20	Concrete with reinforcement	
0.40	D1						Firm medium strength orangish brown mottled pale grey silty CLAY.	
0.90	D2							
1.20	U1					(2.80)		
1.70	D3						At 1.7 m with abundant sand partings.	
1.90	D4							
2.00-2.45	SPT N60=8	1.50	DRY	1,1/1,2,2,2				
2.00	S1							
2.70	D5							
3.00	U2				88.60	3.00	Stiff fissured high strength grey mottled orange and brown silty CLAY with frequent sand partings	
3.50	D6							
3.80	D7							
4.00-4.45	SPT N60=17	1.50	DRY	2,2/3,3,4,4		(2.30)		
4.00	S2							
4.80	D8							
5.00	U3							
					86.30	5.30	Stiff fissured medium strength dark grey CLAY with occasional sand partings.	
5.50	D9							
6.00-6.45	SPT N60=15	1.50	DRY	2,2/3,3,3,4				
6.00	S3					(2.70)		
				Seepage(1) at 7.30m, rose to 7.10m in 20 mins.				▼1 ∇1
7.50	U4							
8.00	D10				83.60	8.00	Stiff thinly laminated fissured high strength dark grey silty CLAY with occasional shells and shell fragments.	
9.00-9.45	SPT N60=19	7.50	8.80	2,3/3,4,4,5				
9.00	S4							

Remarks
Standpipe installed in BH to 6.0m

Scale (approx)	**Logged By**
1:50	AB

Figure No. J14381.BH1

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware,Herts
SG12 7QE

Site	Borehole Number
4 Greenaway Gardens, London, NW3 7DJ	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 7.50m	91.60	Mr Verdi Israelian	J14381
	Location	**Dates** 12/12/2014	**Engineer** Richard Tant Associates	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50	U5								
11.00	D11								
						(6.50)			
12.00-12.45 12.00	SPT N60=26 S5	7.50	11.70	4,4/5,5,6,6					
13.50	U6								
14.00	D12								
14.50-14.95 14.50	SPT N60=31 S6	7.50	14.00	4,5/6,6,7,7	77.10	14.50 (0.50)	Very stiff laminated grey silty CLAY with occasional shell fragments and rare 3 mm burrow.		
					76.60	15.00	Complete at 15.00m		

Remarks	Scale (approx)	Logged By
Standpipe installed in BH to 6.0m	1:50	AB
	Figure No. J14381.BH1	

GEA Geotechnical & Environmental Associates Widbury Barn, Widbury Hill, Ware,Herts, SG12 7QE	**Site** 4 Greenaway Gardens, London, NW3 7DJ		**Borehole Number** **BH2**

Boring Method	**Casing Diameter**	**Ground Level (mOD)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 1.50m	92.55	Mr Verdi Israelian	J14381
	Location	**Dates** 15/12/2014	**Engineer** Richard Tant Associates	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					92.51	0.04 (0.16)	Paving slab		
0.30	U1				92.35	0.20 (0.25)	Concrete		
0.80	D2				92.10	0.45 (0.75)	Made ground: topsoil: dark brown and black fine to coarse sand and fine to coarse angular to subrounded gravel sized brick, flint and concrete. Soft thinly laminated fissured orangish brown slightly sandy silty CLAY with abundant fine sand partings.		
1.20-1.65 1.20	SPT N60=11 S1	1.20	DRY	1/2,2,2,3	91.35	1.20 (0.80)	Firm thinly laminated fissured orangish brown mottled pale grey silty CLAY with frequent sand partings.		
1.80	D3						At 1.8 m abundant fine sand partings.		
2.00	U1				90.55	2.00 (1.70)	Soft fissured low strength orangish brown mottled grey silty CLAY with occasional sand partings.		
2.50	D4								
2.80	D5								
3.00-3.45 3.00	SPT N60=12 S2	1.50	DRY	2,2/2,2,3,3			At 3.0 m rare sand partings.		
3.70	D6				88.85	3.70 (1.70)	Firm thinly laminated fissured medium strength orangish brown mottled grey silty CLAY with occasional sand partings.		
4.00	U2								
4.50	D7								
4.80	D8								
5.00-5.45 5.00	SPT N60=12 S3	1.50	DRY	2,2/2,2,3,3			At 5.0 m occasional very fine roots and fine to medium gravel sized black carbonaceous material.		
				SEEPAGE(1) at 5.50m, rose to 5.40m in 20 mins.	87.15	5.40 (0.30)	Soft dark grey silty CLAY.		1
5.70	D9				86.85	5.70 (6.80)	Firm fissured high strength dark grey silty CLAY with occasional fine sand partings and shell fragments.		
6.00	U3								
6.50	D10								
7.50-7.95 7.50	SPT N60=14 S4	1.50	7.40	2,2/2,3,3,4					
				SEEPAGE(2) at 8.70m.					2
9.00	U4								
9.50	D11								

Remarks	**Scale (approx)**	**Logged By**
Installation: standpipe to 6.0m. Chiselling from 0.00m to 1.20m for 1.25 hours.	1:50	AB
	Figure No. J14381.BH2	

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** 4 Greenaway Gardens, London, NW3 7DJ	**Borehole Number** **BH2**

Boring Method	**Casing Diameter**	**Ground Level (mOD)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 1.50m	92.55	Mr Verdi Israelian	J14381
	Location	**Dates** 15/12/2014	**Engineer** Richard Tant Associates	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50-10.95 10.50	SPT N60=22 S5	1.50	10.40	3,3/4,4,5,6 SEEPAGE(3) at 10.80m.					∇3
12.00	U5								
					80.05	12.50	Stiff very closely fissured high strength dark grey silty CLAY.		
12.50	D12								
13.50	U6								
						(2.50)			
14.00	D13								
14.50-14.95 14.50	SPT N60=31 S6	1.50	14.20	7,6/5,7,7,7					
					77.55	15.00	Complete at 15.00m		

Remarks	**Scale (approx)**	**Logged By**
	1:50	AB
	Figure No. J14381.BH2	

Geotechnical & Environmental Associates	Widbury Barn, Widbury Hill, Ware, Herts, SG12 7QE	Site: 4 Greenaway Gardens, London, NW3 7DJ	Number: **BH3**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		92.37	Mr Verdi Israelian	J14381
	Location	**Dates**	**Engineer**	**Sheet**
	SW of kitchen	18/12/2014	Richard Tant Associates	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water
					(0.25)	MG Brown clayey sand and concrete fragments and gravel set.	
0.20	E1			92.12	0.25		
0.50	D1					Firm light brown mottled orange brown thinly laminated clayey SILT with occasional partings of fine sand. Rootlets from 0.7m to 1.0m. Pockets of fine sand from 2.5m.	
1.00-1.45	SPT N60=8		2,2/2,2,2,2				
1.50	D2						
					(3.15)		
2.00-2.45	SPT N60=10		2,1/2,3,2,3				
2.50	D3						
3.00-3.45	SPT N60=9		2,1/2,2,3,2				
				88.97	3.40	Firm light brown mottled orange brown and light grey clayey SILT with lenses of fine sand.	
3.50	D4				(0.60)		
4.00-4.45	SPT N60=12		Water strike(1) at 4.00m. 2,2/3,2,3,4	88.37	4.00	Stiff brown mottled grey silty CLAY with pockets of fine sand and carbonaceous material.	∇1
4.50	D5				(1.00)		
5.00-5.45	SPT N60=11		2,2/2,3,3,3	87.37	5.00	Stiff brown mottled orange brown and grey silty CLAY.	
5.60	D6				(1.40)		
6.00-6.45	SPT N60=10		2,2/2,3,2,3				
				85.97	6.40	Stiff grey silty CLAY.	
6.60	D7						
7.00-7.45	SPT N60=12		2,2/2,3,4,3		(1.60)		
7.80	D8					at 7.8mbgl to 7.9mbgl mottled brown at 7.9mbgl silt partings	
8.00-8.45	SPT N60=11		2,2/3,2,3,3	84.37	8.00		
						Complete at 8.00m	

Remarks
Installation: 6m standpipe (1m plain and 5m slotted with pea gravel surround)
On completion of borehole groundwater at 4.0m.

Scale (approx)	Logged By
1:50	AB

Figure No. J14381.BH3

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** 4 Greenaway Gardens, London, NW3 7DJ	**Number** **BH4**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Drive-in Window Sampler		91.60	Mr Verdi Israelian	J14381
	Location	**Dates**	**Engineer**	**Sheet**
	Bedding south of rear steps	18/12/2014	Richard Tant Associates	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records
0.20	E1		
0.50	D1		
0.80	D2		
1.00-1.45	SPT N60=9		2,1/2,2,2,3
1.70	D3		
2.00-2.45	SPT N60=8		1,1/2,2,2,2
			Water strike(1) at 2.50m.
2.60	D4		
3.00-3.45	SPT N60=8		1,1/2,2,2,2
3.60	D5		
4.00-4.45	SPT N60=10		1,1/1,2,3,4
4.60	D6		
5.00-5.45	SPT N60=11		2,2/2,3,3,3
5.60	D7		
5.90	D8		
6.00-6.45	SPT N60=13		2,2/3,3,3,4
6.60	D9		

Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
91.45	(0.15) 0.15	Topsoil. Plastic dark brown slightly sandy slightly gravelly CLAY with rare cobble of sandstone. Frequent rootlets		
91.30	(0.15) 0.30	Made ground. Dark soft greyish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is rounded to angular flint. Rare pottery fragment. Frequent rootlets.		
91.15	(0.15) 0.45	Soft light greyish orange mottled black silty CLAY. Micaceous.		
90.90	(0.25) 0.70	Soft light bluish grey mottled orange and black silty CLAY with occasional rootlets. Micaceous.		
88.60	(2.30) 3.00	Firm thinly laminated brownish orange mottled grey silty CLAY with rootlets. Occasional pockets of fine to medium sand. from 0.9 rootlets absent. from 2.5 frequent fine to medium sand partings.		∇1
87.60	(1.00) 4.00	Firm thinly laminated orangish grey mottled orange and reddish brown silty CLAY with frequent fine to mediium sand partings.		
86.60	(1.00) 5.00	Stiff orangish brown mottled reddish brown and grey clayey SILT with carbonaceous material and lenses of fine sand.		
85.70	(0.90) 5.90	Stiff light grey brown mottled orange silty CLAY with occasional pockets of fine sand.		
84.60	(1.10) 7.00	Stiff grey silty CLAY. Rare green staining,		
		Complete at 7.00m		

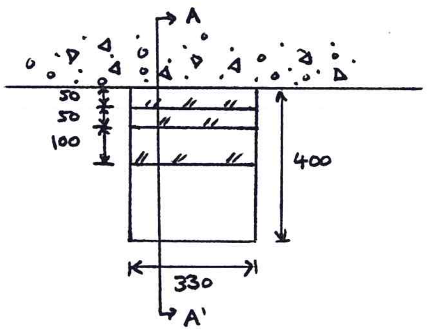
Remarks
Borehole backfilled with arisings.
On completion of borehole groundwater at 2.5m.

Scale (approx)	**Logged By**
1:50	AB

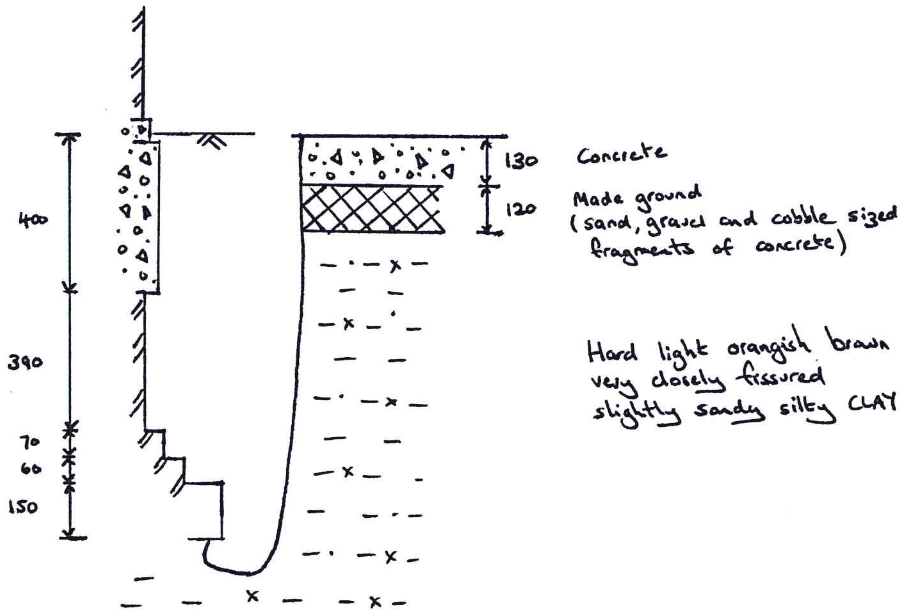
Figure No.
J14381.BH4

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG	Site 4 Greenaway Gardens, NW3 7DJ		Trial Pit Number 1
Excavation Method Manual	**Dimensions (mm)** 400 x 330 x 1160	**Ground Level (mOD)**	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN



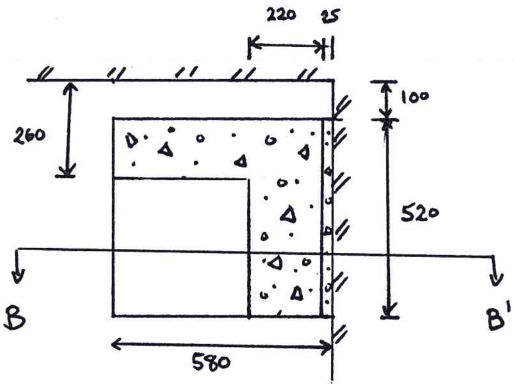
SECTION A - A'



Remarks: Restricted working room. Neighbouring building is situated at lower level and wall may continue deeper.	Scale: 1:20
All dimensions in millimetres	
Sides of trial pit remained stable during excavation	Logged by: AB
Groundwater: None encountered	

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG		Site 4 Greenaway Gardens, NW3 7DJ	Trial Pit Number 2
Excavation Method Manual	**Dimensions (mm)** 580 x 520 x 660	**Ground Level (mOD)**	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location INSIDE GARAGE	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN

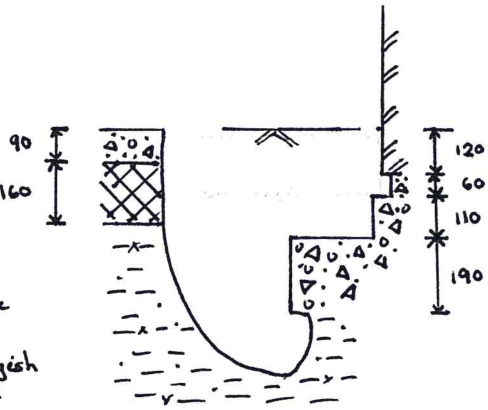


SECTION B - B'

Concrete

Made ground (fine to coarse sand and fine to medium subrounded to angular gravel of brick, clinker, ash and wood. Occasional cobble of clinker)

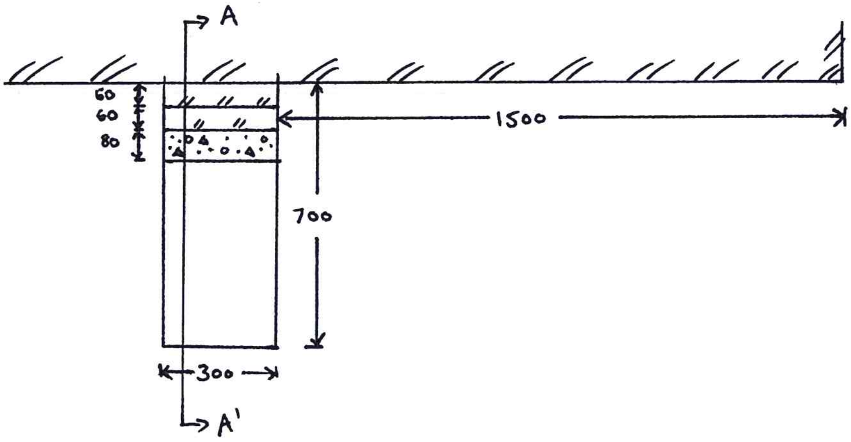
Very stiff light orangish brown, mottled orange fissured slightly sandy silty CLAY with rare fine angular black gravel. Occasional very fine to fine roots.



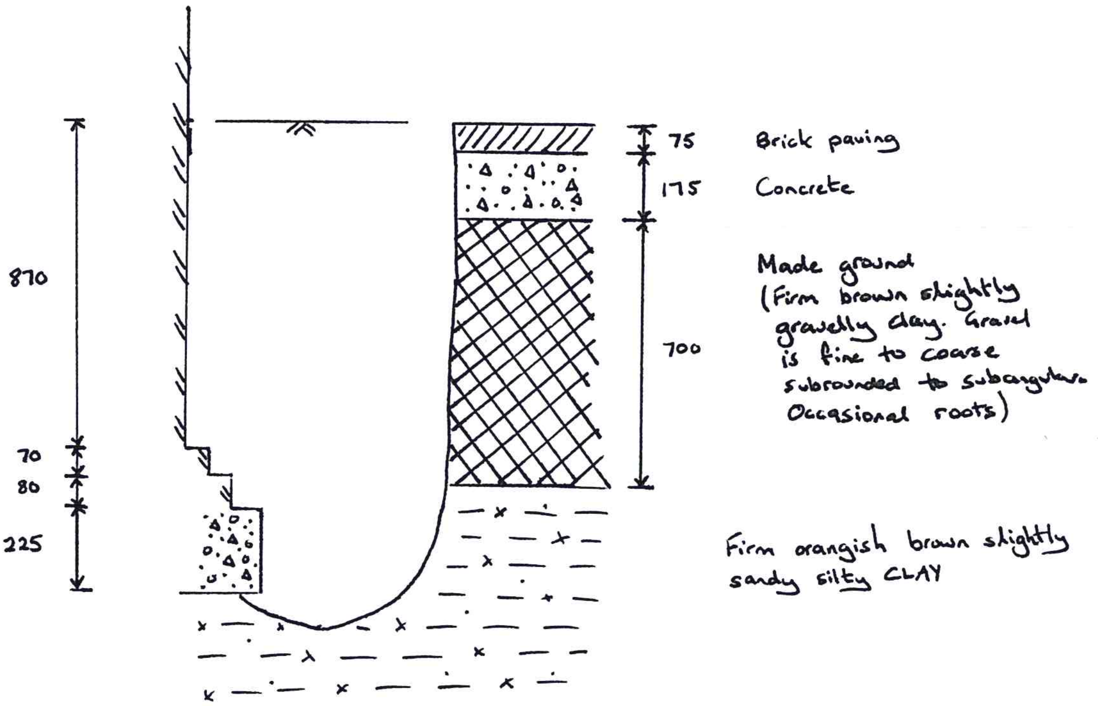
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: None encountered	AB

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG		Site 4 Greenaway Gardens, NW3 7DJ	Trial Pit Number 3
Excavation Method Manual	**Dimensions (mm)** 700 x 300 x 1330	**Ground Level (mOD)**	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN



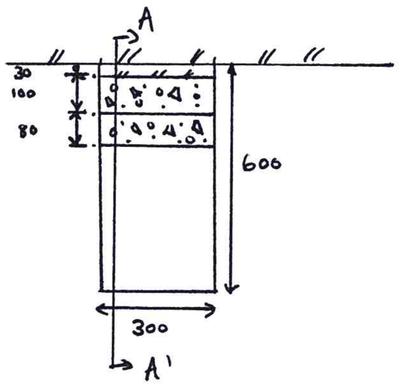
SECTION A - A'



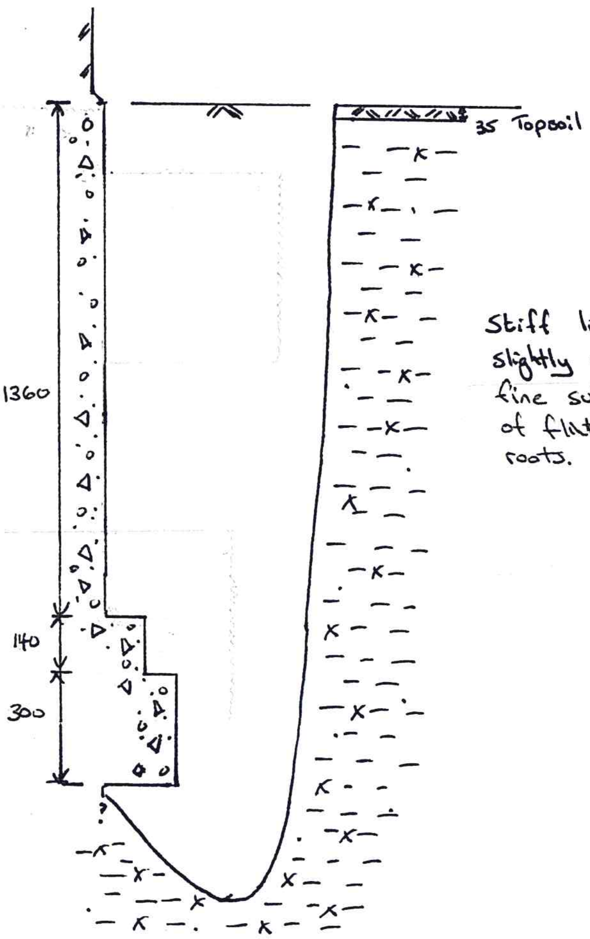
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: 1260mm	AB

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG	Site 4 Greenaway Gardens, NW3 7DJ	Trial Pit Number 4
Excavation Method Manual	**Dimensions (mm)** 600 x 300 x 2100	**Ground Level (mOD)**	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN



SECTION A - A'



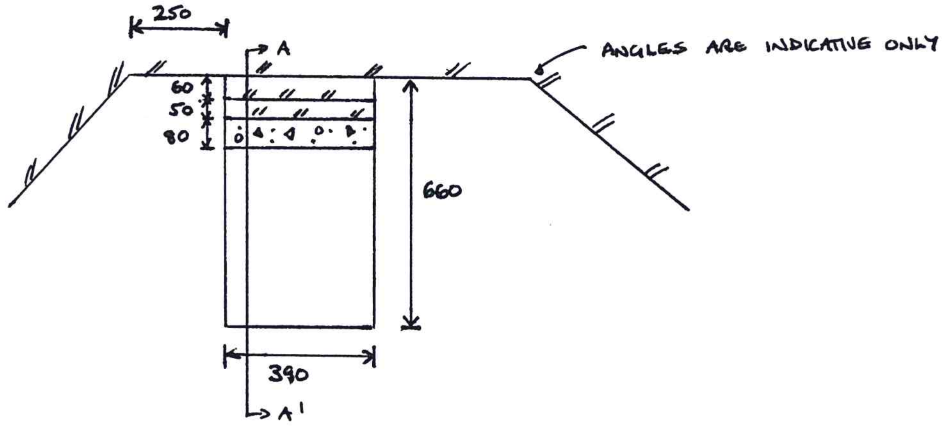
Stiff light orangish brown mottled orange slightly sandy silty CLAY with occasional fine subangular to subrounded gravel of flint. Occasional very fine to fine roots.

Remarks: Unable to confirm if foundation returns back to an underlying wall. Base of foundation not proven. All dimensions in millimetres	Scale: 1:20
Sides of trial pit remained stable during excavation Groundwater: None encountered	Logged by: AB

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG	Site 4 Greenaway Gardens, NW3 7DJ	Trial Pit Number 5

Excavation Method	Dimensions (mm)	Ground Level (mOD)	Client	Job Number
Manual	660 x 390 x 980		Mr Verdi Israelian	J14381
	Location	**Dates**	**Engineer**	**Sheet**
		13/01/2015	Richard Tant Associates	1 / 1

PLAN



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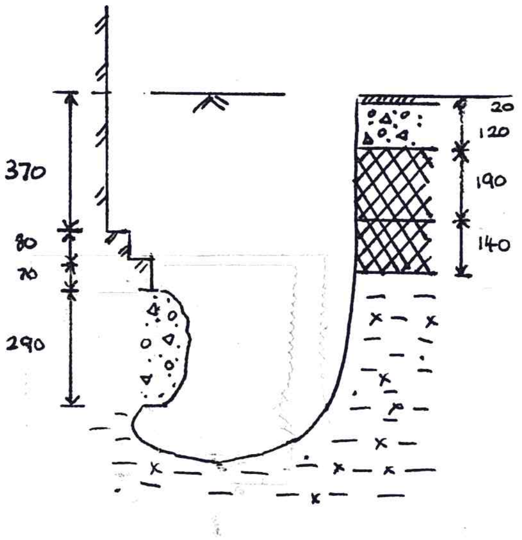


Tile

Concrete

Made ground
(Very stiff light orangish brown slightly sandy clayey silt. Slightly micaceous.)

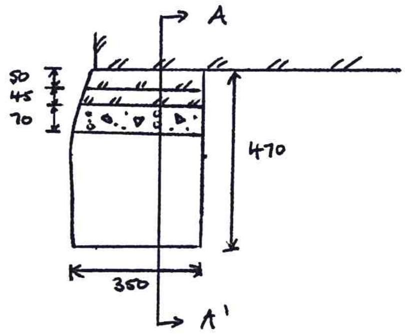
Made ground:
(Light brown and white slightly silty very gravelly sand. Gravel is fine to coarse angular to subrounded of sandstone, chalk and brick. Sand is fine to coarse. Occasional chalk and brick cobbles.)

Firm orangish brown slightly sandy silty CLAY.

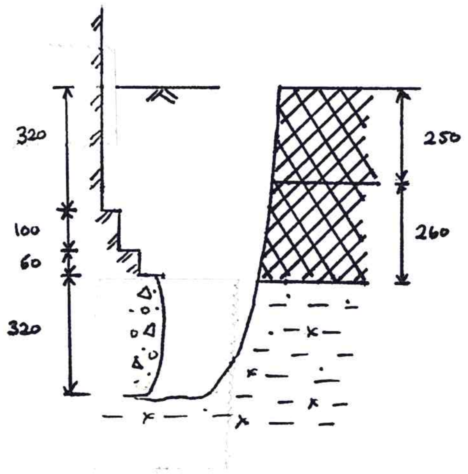
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: None encountered	AB

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG	Site 4 Greenaway Gardens, NW3 7DJ	Trial Pit Number 6
Excavation Method Manual	**Dimensions (mm)** 470 x 350 x 805	**Ground Level (mOD)**	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN



SECTION A -A'



Brick and concrete

Made ground
(Stiff dark brown and black sandy slightly gravelly clay. Sand is fine to coarse. Gravel is fine to medium angular to sub angular brick, ash and clinker. Frequent coarse roots)

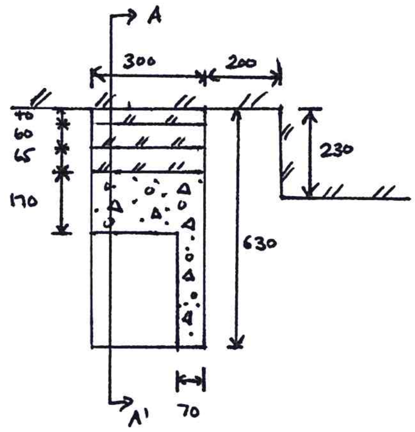
Soft light orangish brown slightly sandy silty CLAY. Frequent fine roots.

Remarks: Trial pit in close proximity to leaking gutter. Water level may be artifically high as a result. All dimensions in millimetres	Scale: 1:20
Sides of trial pit remained stable during excavation Groundwater: 590mm	Logged by: AB

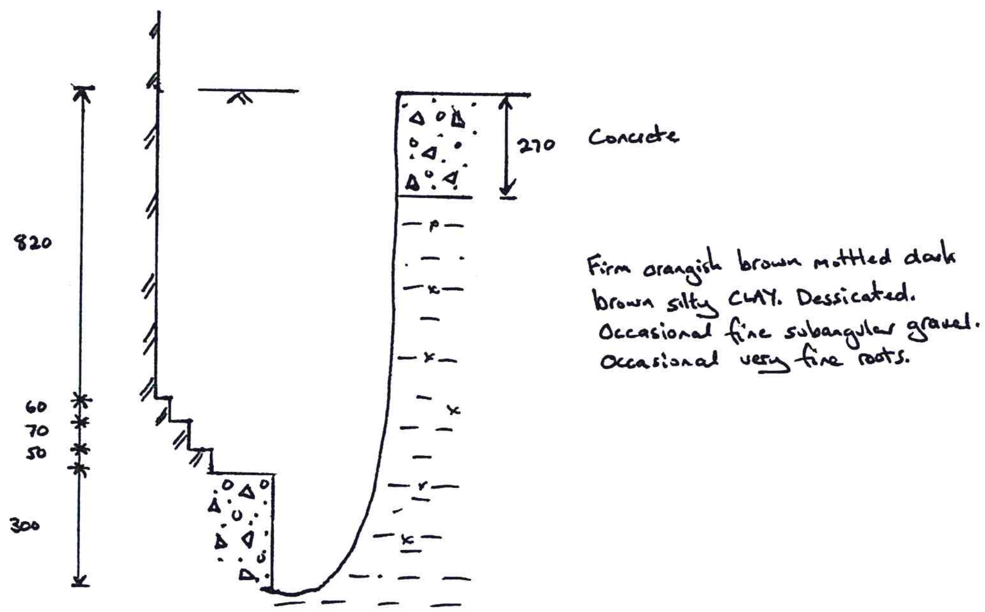
GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG	**Site** 4 Greenaway Gardens, NW3 7DJ	**Trial Pit Number** 7

Excavation Method	**Dimensions (mm)**	**Ground Level (mOD)**	**Client**	**Job Number**
Manual	630 x 300 x 1302		Mr Verdi Israelian	J14381
	Location	**Dates**	**Engineer**	**Sheet**
		13/01/2015	Richard Tant Associates	1 / 1

PLAN



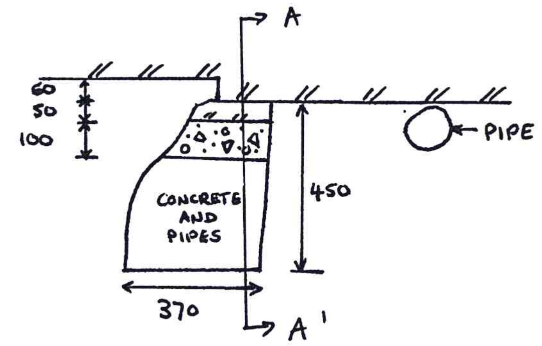
SECTION A – A'



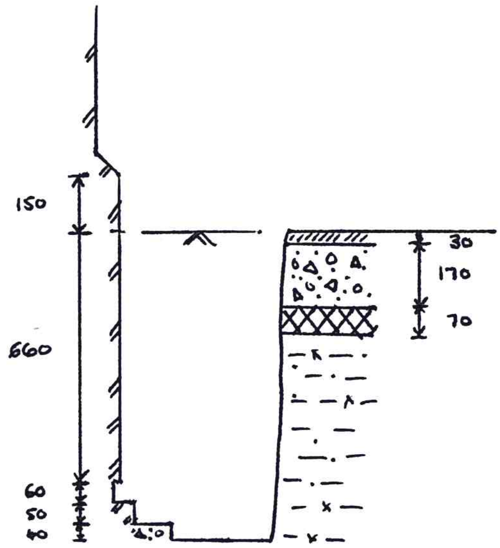
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: 1130mm	AB

GEA Geotechnical & Environmental Associates Tyttenhanger House Coursers Road Herts AL4 0PG			**Site** 4 Greenaway Gardens, NW3 7DJ	**Trial Pit Number** 8
Excavation Method Manual	**Dimensions (mm)** 450 x 370 x 810	**Ground Level (mOD)**	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN



SECTION A – A'



Paving slab

Concrete

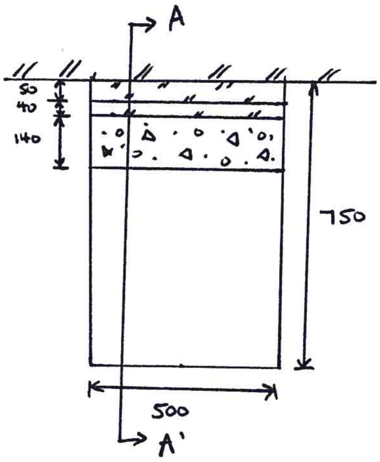
Made ground (Firm dark brown slightly sandy clay with occasional fine brick gravel.)

Stiff light orangish brown mottled orange slightly sandy silty CLAY with occasional fine subangular to subrounded gravel of flint. Frequent fine roots.

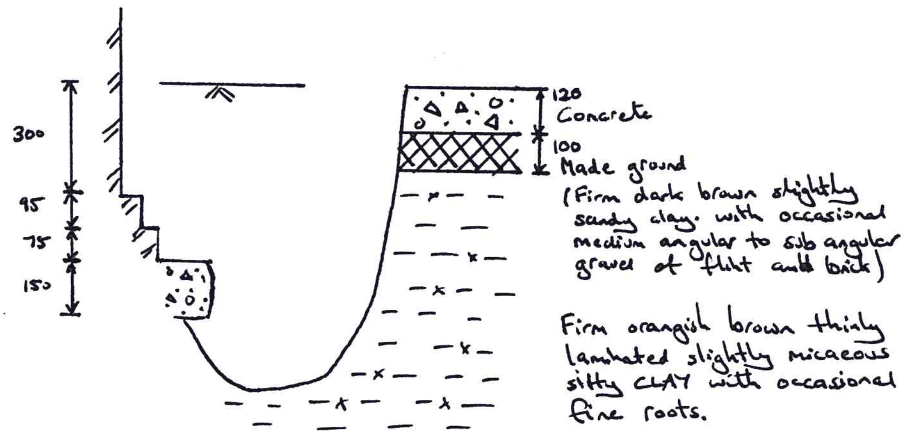
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: None encountered	AB

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road Herts AL4 0PG	Site 4 Greenaway Gardens, NW3 7DJ	Trial Pit Number 9
Excavation Method Manual	**Dimensions (mm)** 750 x 500 x 810	**Ground Level (mOD)** 750 x 500 x 810	**Client** Mr Verdi Israelian	**Job Number** J14381
	Location	**Dates** 13/01/2015	**Engineer** Richard Tant Associates	**Sheet** 1 / 1

PLAN



SECTION A - A'



Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: 630mm	AB

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

Trial Pit No TH 1

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number**	J14381
Client	Mr Verdi Israelian	**Sheet**	2 / 2
Engineer	Richard Tant Associates		

View of the footing encountered in Trial Pit 1 (13/01/2015).

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Trial Pit No TH 2**

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number** J14381
Client	Mr Verdi Israelian	**Sheet** 2 / 2
Engineer	Richard Tant Associates	

View of the footing encountered in Trial Pit 2 (13/01/2015).

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Trial Pit No TH 3**

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number** J14381
Client	Mr Verdi Israelian	**Sheet** 2 / 2
Engineer	Richard Tant Associates	

View of the footing encountered in Trial Pit 3 (13/01/2015).

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

Trial Pit No TH 4

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number** J14381
Client	Mr Verdi Israelian	**Sheet** 2 / 2
Engineer	Richard Tant Associates	

View of the footing encountered in Trial Pit 4 (13/01/2015).

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Trial Pit No TH 5**

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number** J14381
Client	Mr Verdi Israelian	**Sheet** 2 / 2
Engineer	Richard Tant Associates	

View of the footing encountered in Trial Pit 5 (13/01/2015).

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number**	J14381
Client	Mr Verdi Israelian	**Sheet**	2 / 2
Engineer	Richard Tant Associates		

View of the footing encountered in Trial Pit 6 (13/01/2015).

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Trial Pit No TH 7**

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number** J14381
Client	Mr Verdi Israelian	**Sheet** 2 / 2
Engineer	Richard Tant Associates	

View of the footing encountered in Trial Pit 7 (13/01/2015).

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number**	J14381
Client	Mr Verdi Israelian	**Sheet**	2 / 2
Engineer	Richard Tant Associates		

View of the footing encountered in Trial Pit 8 (13/01/2015).

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

Trial Pit No TH 9

Site	4 Greenaway Gardens, London, NW3 7DJ	**Job Number** J14381
Client	Mr Verdi Israelian	**Sheet** 2 / 2
Engineer	Richard Tant Associates	

View of the footing encountered in Trial Pit 9 (13/01/2015).

Project Name:	4 Greenaway Gardens	Samples Received:	22/12/2014
		Project Started:	05/01/2015
Client:	GEA	Testing Started:	21/01/2015
Project No:	J14381 Our job/report no: 18079	Date Reported:	29/01/2015

K4 SOILS

Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
BH1	D2	0.90	Orange brown and greyish brown sandy silty CLAY	29					
BH1	D4	1.90	Orange brown and greyish brown sandy silty CLAY with sandy patches	32					
BH1	D7	3.80	Orange brown and greyish brown sandy silty CLAY with sandy patches	25					
BH1	D9	5.50	Grey sandy silty CLAY with pale grey sandy patches	27	52	20	32	100	
BH1	D10	8.00	Grey sandy silty CLAY	30	47	20	27	100	
BH1	D12	14.00	Grey CLAY	29	71	27	44	100	
BH3	D2	1.50	Orange brown and greyish brown sandy silty CLAY	30	52	23	29	100	
BH3	D4	3.50	Orange brown and greyish brown sandy silty CLAY	30	48	22	26	100	
BH3	D7	6.60	Grey sandy silty CLAY	28	51	20	31	100	
BH3	D8	7.80	Grey silty CLAY with sandy patches	28					
BH4	D3	1.70	Orange brown and greyish brown sandy silty CLAY	27	46	21	25	100	
BH4	D5	3.60	Orange brown and greyish brown sandy silty CLAY	30	52	23	29	100	
BH4	D7	5.60	Brown slightly sandy silty CLAY	29	48	21	27	100	
BH4	D9	6.60	Grey and brown sandy silty CLAY	28	51	21	30	100	

UKAS TESTING 2519

Summary of Test Results

BS 1377 : Part 2 : Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method.
BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index.
BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method.

Checked and Approved
Initials: K.P
Date: 29/01/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Project Name:	4 Greenaway Gardens		K4 SOILS
Client:	GEA	Project no: J14381	
		Our job no: 18079	

Borehole No:	Sample No:	Depth m	Description	pH	Sulphate content (g/l)
BH3	D3	2.50	Brown fine sandy silty CLAY	7.3	0.27
BH3	D5	4.50	Dark grey and brown slightly fine sandy silty CLAY	7.2	0.09
BH4	D8	5.90	Dark grey slightly fine sandy silty CLAY	7.2	0.31

Date	Summary of Test Results	Checked and Approved
30/01/2015	BS 1377 : Part 3 :Clause 5 : 1990 Determination of sulphate content of soil and ground water : gravimetric method	Initials : kp

Client name & address:			Samples Received	22/12/2014	K4 SOILS
GEA			Project Started	05/01/2015	
Project Name:	4 Greenaway Gardens		Testing Started	13/01/2015	
Project No:	J14381	**Our Job / report no:** 18079	Date Reported:	30/01/2015	
Sample description:			Sample no/ type:	U3	**BH no:** BH1
High strength brown slightly sandy silty CLAY with orange brown sand partings					**Depth (m):** 5.00

Test details

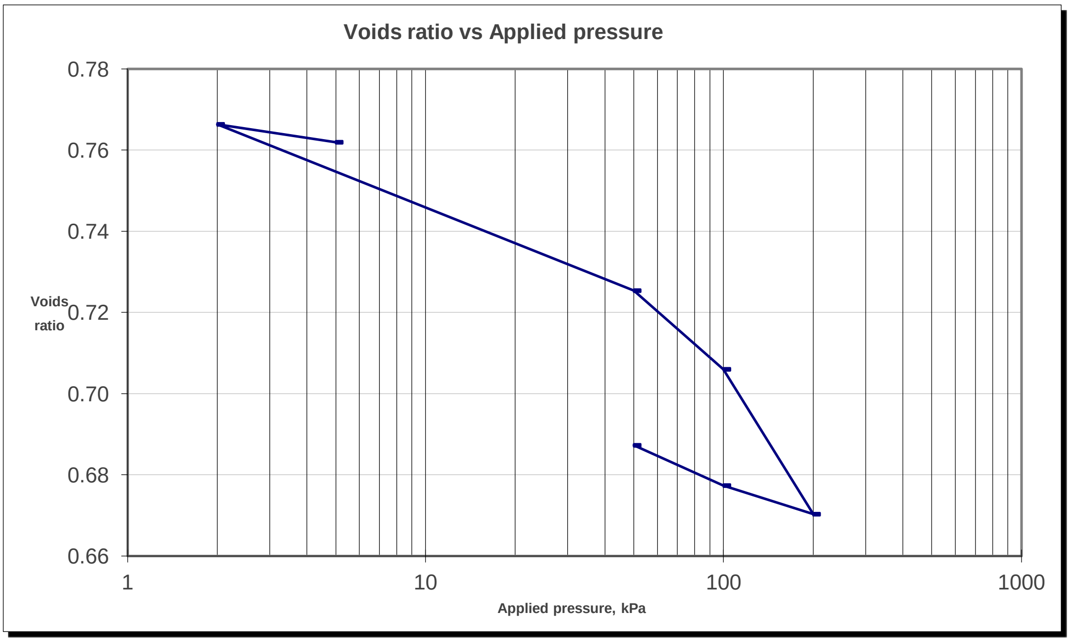
Depth within original sample m : 5.10 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	16.00	15.32
Diameter	mm :	75	-
Bulk density	Mg/m3 :	1.93	2.04
Moisture content	% :	26	28
Dry density	Mg/m3 :	1.53	1.59
Voids Ratio	:	0.76	0.69
Degree of saturation	% :	92.8	-
Particle density	Mg/m3 :	2.69	-
Swelling pressure	kPa :	5	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	5	0.7619	-	-	11				
2	2	0.7663	1.40	0.834	12				
3	50	0.7254	4.81	0.483	13				
4	100	0.7060	1.33	0.225	14				
5	200	0.6703	1.81	0.209	15				
6	100	0.6773	3.29	0.042	16				
7	50	0.6873	2.54	0.118	17				
8					18				
9					19				
10					20				



UKAS TESTING 2519

One-Dimensional Consolidation Test

BS 1377 : Part 5 : Clause 3 & 4 : 1990

Determination of the one-dimensional consolidation properties

Approved by

Initials : kp

Date : 30/01/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Client name & address:		**Samples Received**	22/12/2014
GEA		**Project Started**	05/01/2015
Project Name:	4 Greenaway Gardens	**Testing Started**	13/01/2015
Project No:	J14381 **Our Job / report no:** 18079	**Date Reported:**	30/01/2015
Sample description:		**Sample no/ type:**	U4

K4 SOILS

BH no:	BH1
Depth (m):	7.50

Medium strength dark grey slightly sandy silty CLAY with occasional light grey fine sand partings

Test details

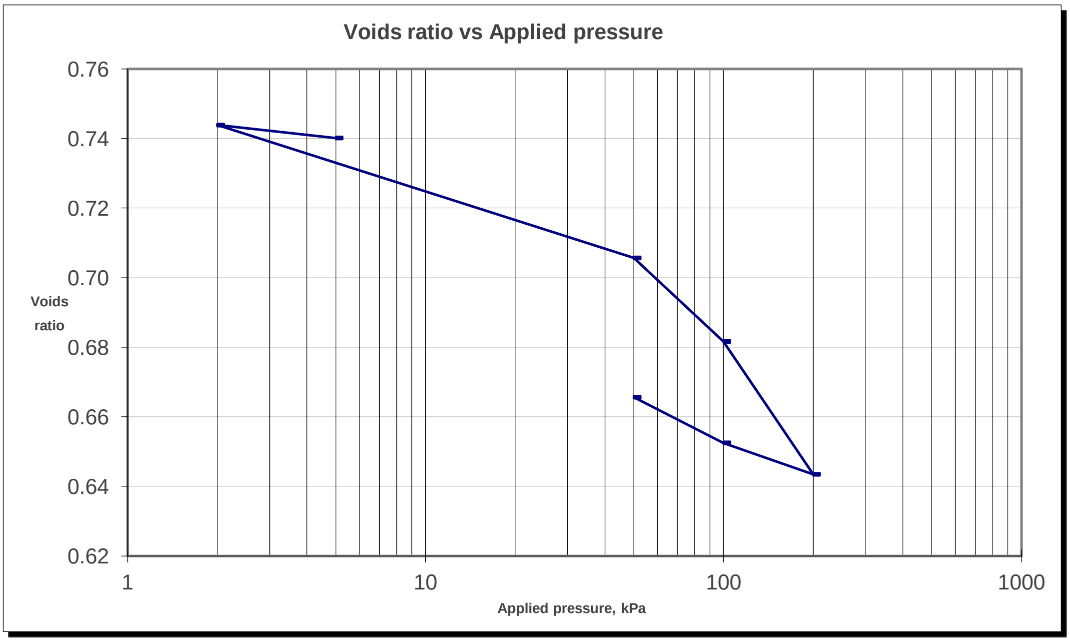
Depth within original sample m : 7.60 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	16.96	16.23
Diameter	mm :	75	-
Bulk density	Mg/m3 :	1.94	2.05
Moisture content	% :	26	27
Dry density	Mg/m3 :	1.55	1.61
Voids Ratio	:	0.74	0.67
Degree of saturation	% :	92.8	-
Particle density	Mg/m3 :	2.69	-
Swelling pressure	kPa :	5	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	5	0.7401	-	-	11				
2	2	0.7438	3.14	0.708	12				
3	50	0.7057	5.92	0.456	13				
4	100	0.6817	4.45	0.282	14				
5	200	0.6435	1.92	0.227	15				
6	100	0.6525	1.70	0.055	16				
7	50	0.6656	2.25	0.159	17				
8					18				
9					19				
10					20				



UKAS TESTING 2519

One-Dimensional Consolidation Test

BS 1377 : Part 5 : Clause 3 & 4 : 1990

Determination of the one-dimensional consolidation properties

Approved by

Initials : kp

Date : 30/01/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Client name & address:		**Samples Received**	22/12/2014	**K4 SOILS**
GEA		**Project Started**	05/01/2015	
Project Name:	4 Greenaway Gardens	**Testing Started**	13/01/2015	
Project No: J14381	**Our Job / report no:** 18079	**Date Reported:**	30/01/2015	
Sample description:		**Sample no/ type:**	U5	**BH no:** BH1
High strength slightly fissured dark grey silty CLAY with light grey fine sand partings and rare shell deposits				**Depth (m):** 10.50

Test details

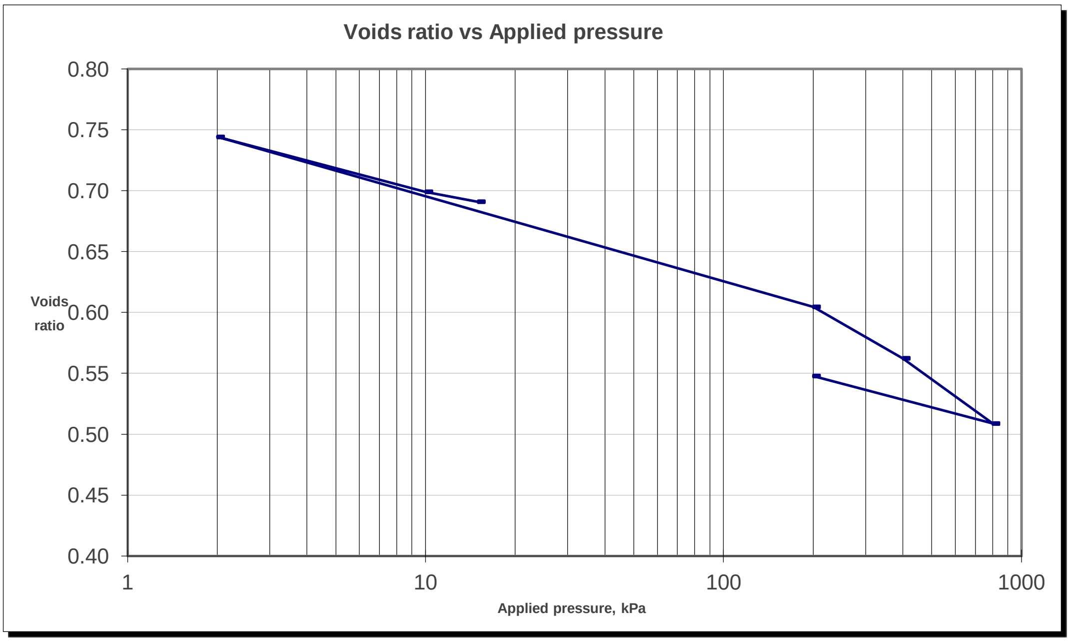
Depth within original sample m : 10.60 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	15.78	14.44
Diameter	mm :	75	-
Bulk density	Mg/m3 :	2.00	2.19
Moisture content	% :	25	25
Dry density	Mg/m3 :	1.60	1.74
Voids Ratio	:	0.69	0.55
Degree of saturation	% :	99.5	-
Particle density	Mg/m3 :	2.70	-
Swelling pressure	kPa :	15	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	15	0.6910	-	-	11				
2	10	0.6991	1.37	0.963	12				
3	2	0.7441	0.80	3.312	13				
4	200	0.6046	0.55	0.404	14				
5	400	0.5623	0.51	0.132	15				
6	800	0.5087	0.81	0.086	16				
7	200	0.5478	0.72	0.043	17				
8					18				
9					19				
10					20				



UKAS TESTING 2519

One-Dimensional Consolidation Test

BS 1377 : Part 5 : Clause 3 & 4 : 1990

Determination of the one-dimensional consolidation properties

Approved by
Initials : kp
Date : 30/01/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Client name & address:		Samples Received	22/12/2014	K4 SOILS
GEA		Project Started	05/01/2015	
Project Name: 4 Greenaway Gardens		**Testing Started**	13/01/2015	
Project No: J14381	**Our Job / report no:** 18079	**Date Reported:**	30/01/2015	
Sample description:		**Sample no/ type:**	U2	**BH no:** BH2
Medium strength brown and orange brown mottled slightly sandy silty CLAY				**Depth (m):** 4.00

Test details

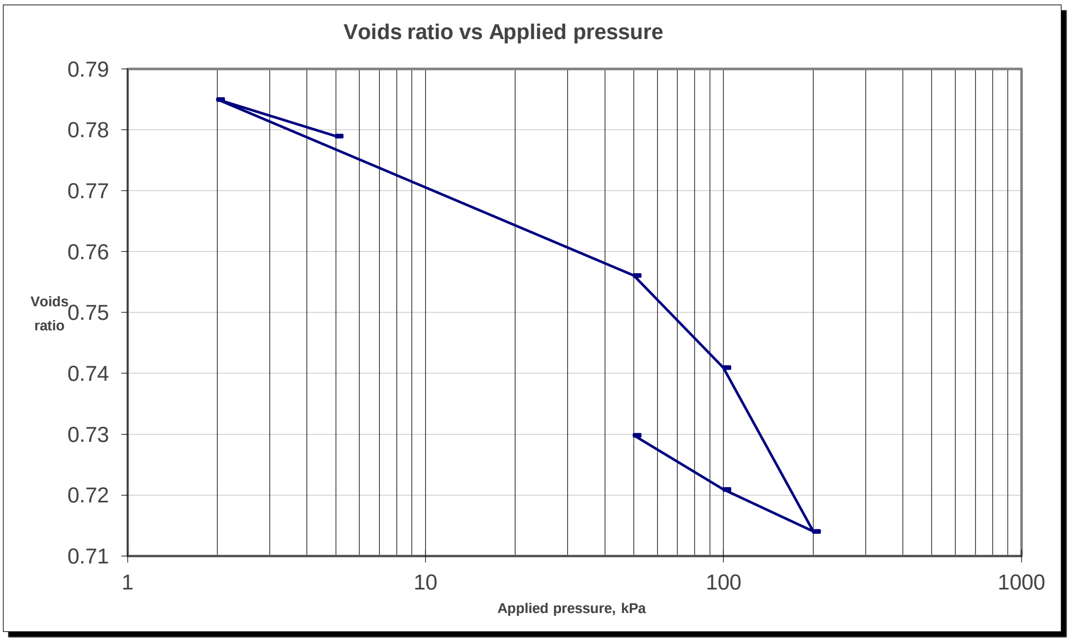
Depth within original sample m : 4.10 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	16.00	15.56
Diameter	mm :	75	-
Bulk density	Mg/m3 :	1.91	2.02
Moisture content	% :	26	29
Dry density	Mg/m3 :	1.52	1.56
Voids Ratio	:	0.78	0.73
Degree of saturation	% :	90.2	-
Particle density	Mg/m3 :	2.70	-
Swelling pressure	kPa :	5	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	5	0.7790	-	-	11				
2	2	0.7850	2.08	1.125	12				
3	50	0.7561	4.47	0.337	13				
4	100	0.7409	2.13	0.172	14				
5	200	0.7140	2.98	0.155	15				
6	100	0.7209	1.93	0.040	16				
7	50	0.7298	2.97	0.103	17				
8					18				
9					19				
10					20				



UKAS TESTING 2519

One-Dimensional Consolidation Test

BS 1377 : Part 5 : Clause 3 & 4 : 1990

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Approved by

Initials : kp

Date : 30/01/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

Client name & address:		**Samples Received**	22/12/2014	**K4 SOILS**
GEA		**Project Started**	05/01/2015	
Project Name:	4 Greenaway Gardens	**Testing Started**	13/01/2015	
Project No:	J14381 **Our Job / report no:** 18079	**Date Reported:**	30/01/2015	
Sample description:		**Sample no/ type:**	U3	**BH no:** BH2
High strength slightly fissured dark grey slightly sandy silty CLAY with light grey fine sand partings				**Depth (m):** 6.00

Test details

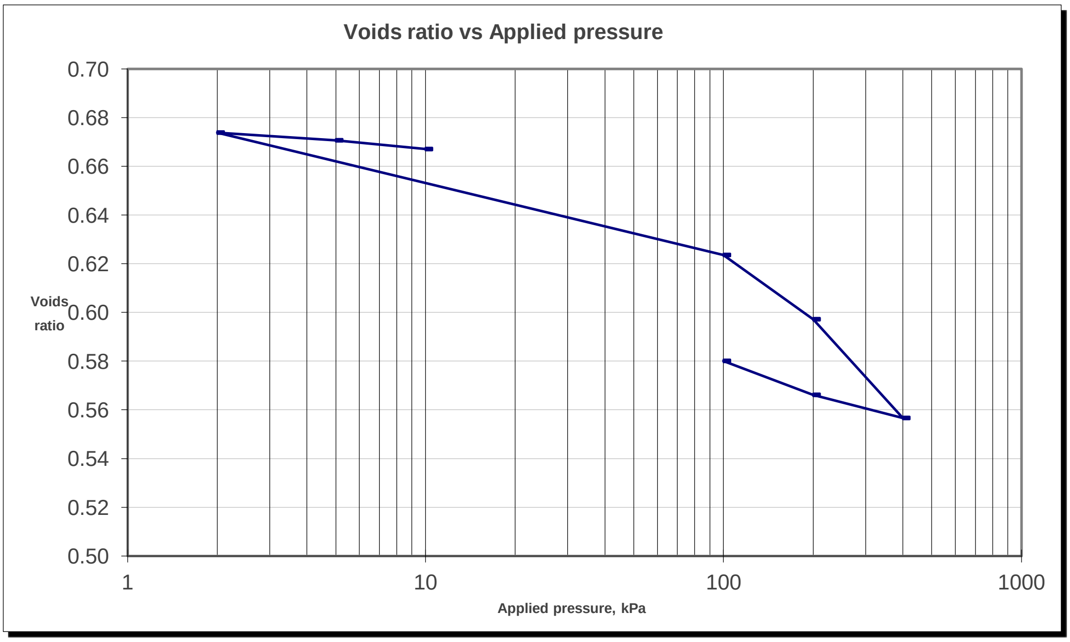
Depth within original sample m : 6.10 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	15.80	14.97
Diameter	mm :	75	-
Bulk density	Mg/m3 :	1.98	2.13
Moisture content	% :	23	25
Dry density	Mg/m3 :	1.61	1.70
Voids Ratio	:	0.67	0.58
Degree of saturation	% :	91.9	-
Particle density	Mg/m3 :	2.69	-
Swelling pressure	kPa :	10	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	10	0.6671	-	-	11				
2	5	0.6707	16.31	0.431	12				
3	2	0.6739	2.26	0.632	13				
4	100	0.6236	9.33	0.306	14				
5	200	0.5972	2.87	0.163	15				
6	400	0.5567	2.75	0.127	16				
7	200	0.5662	3.57	0.031	17				
8	100	0.5801	2.93	0.089	18				
9					19				
10					20				



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Client name & address:		**Samples Received**	22/12/2014	**K4 SOILS**
GEA		**Project Started**	05/01/2015	
Project Name:	4 Greenaway Gardens	**Testing Started**	13/01/2015	
Project No:	J14381 **Our Job / report no:** 18079	**Date Reported:**	30/01/2015	
Sample description:		**Sample no/ type:**	U4	**BH no:** BH2
High strength slightly fissured dark grey silty CLAY with light grey fine sand partings				**Depth (m):** 9.00

Test details

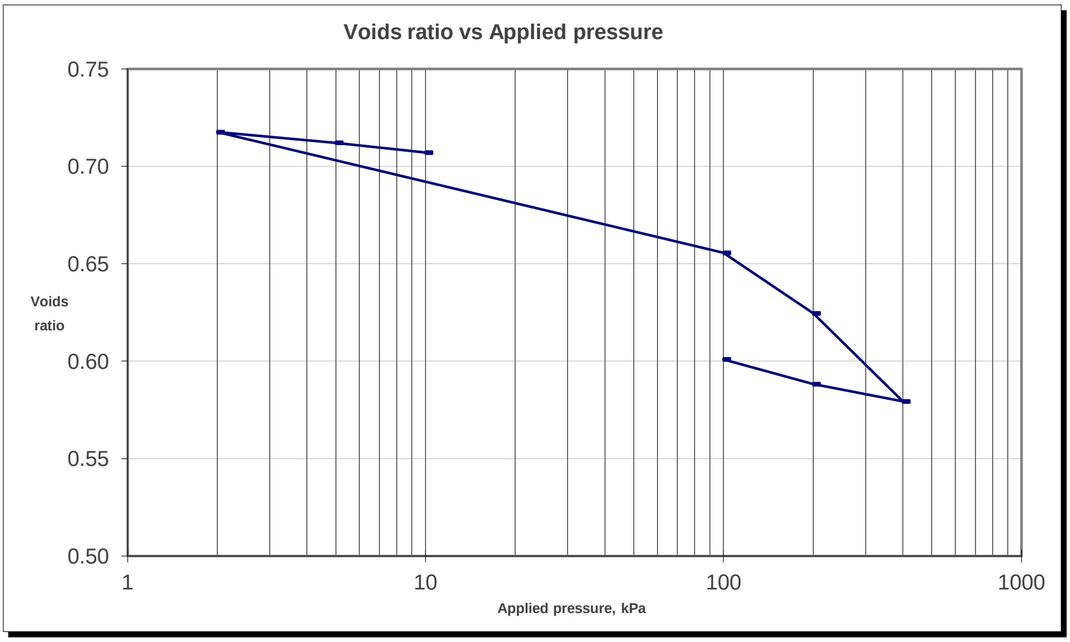
Depth within original sample m : 9.10 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	16.92	15.87
Diameter	mm :	75	-
Bulk density	Mg/m3 :	1.95	2.10
Moisture content	% :	24	25
Dry density	Mg/m3 :	1.58	1.68
Voids Ratio	:	0.71	0.60
Degree of saturation	% :	90.1	-
Particle density	Mg/m3 :	2.69	-
Swelling pressure	kPa :	10	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	10	0.7070	-	-	11				
2	5	0.7121	0.44	0.591	12				
3	2	0.7175	0.65	1.061	13				
4	100	0.6556	10.69	0.368	14				
5	200	0.6245	1.83	0.188	15				
6	400	0.5793	1.75	0.139	16				
7	200	0.5882	3.04	0.028	17				
8	100	0.6009	1.25	0.080	18				
9					19				
10					20				



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Approved by

Initials : kp

Date : 30/01/2015

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH1	**Sample no:**	U1	**Depth (m):**	1.20

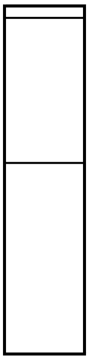
Soil Description: Medium strength brown and orange brown mottled slightly sandy silty CLAY

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	31
Bulk Density	Mg/m³	1.96
Dry Density	Mg/m³	1.49

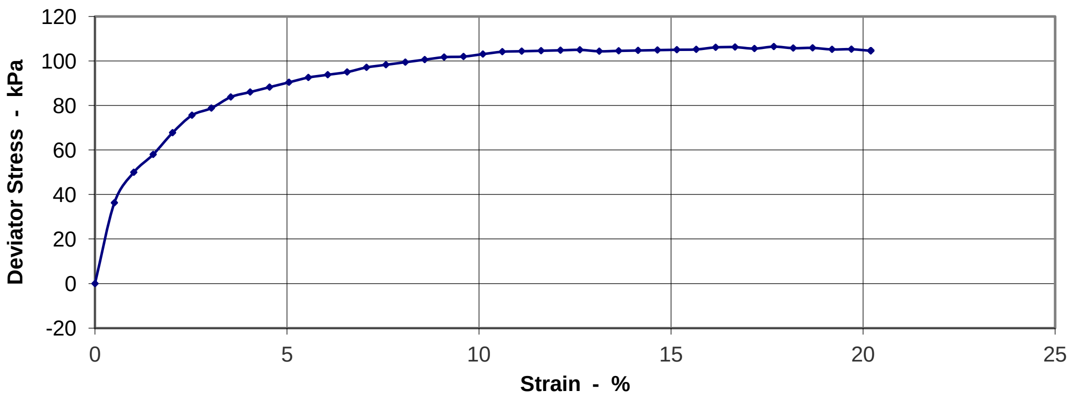
Test Details

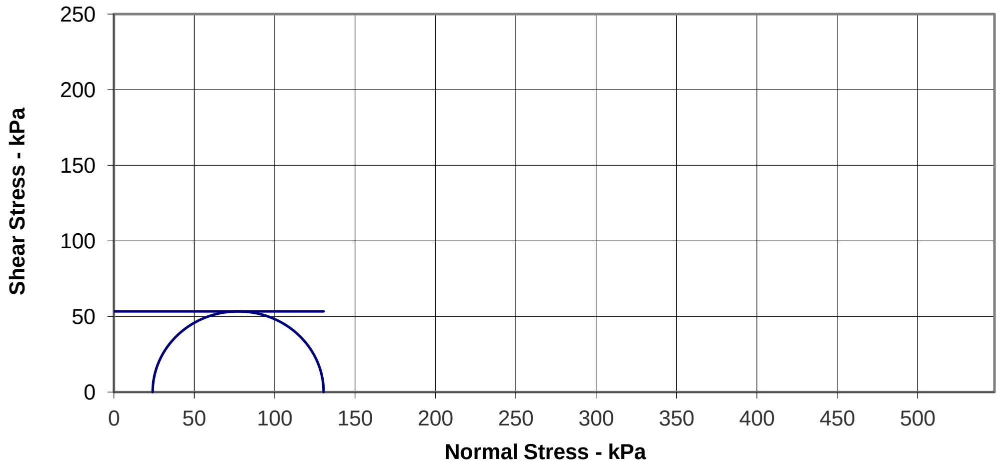
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.68
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	24
Strain at Failure	%	17.7
Maximum Deviator Stress	kPa	106
Shear Strength	kPa	53
Mode of Failure		Compound



Shear Strength Parameters	
C	53 kPa
Phi	0.0 °

Specimen 1





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E-mail: k4soils@aol.com

Approved Signatories: K.Phaure(Tech.Mgr)
J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 30/01/2015

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K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH1	**Sample no:**	U2	**Depth (m):**	3.00

Soil Description: High strength brown and orange brown mottled slightly sandy silty CLAY

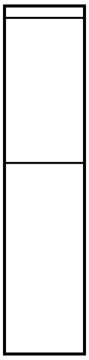
Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	28
Bulk Density	Mg/m³	1.96
Dry Density	Mg/m³	1.53

Test Details

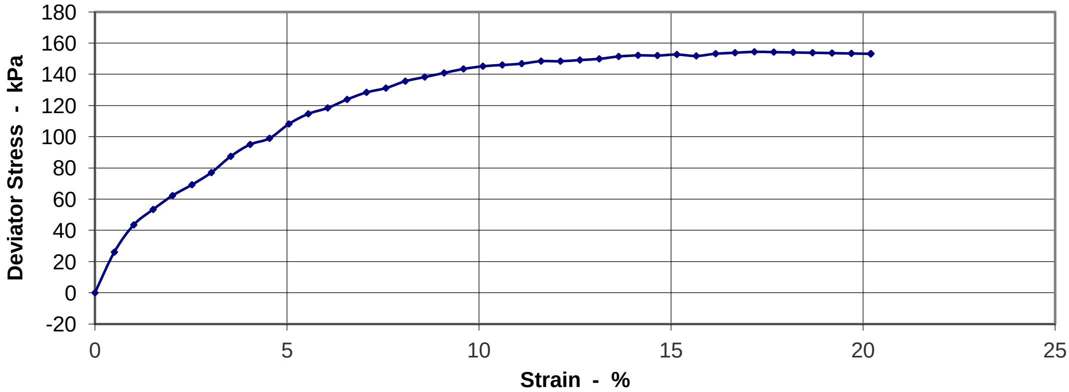
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.67
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	60
Strain at Failure	%	17.2
Maximum Deviator Stress	kPa	154
Shear Strength	kPa	77
Mode of Failure		Compound

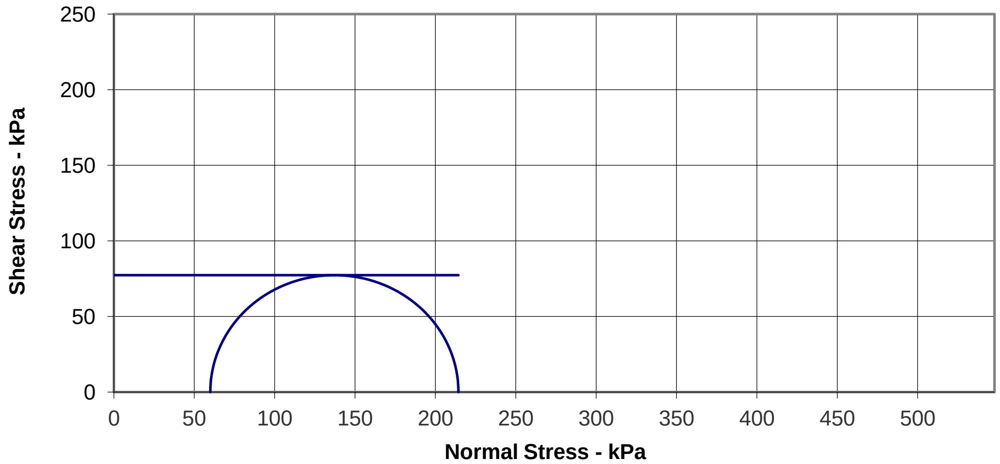
Position and orientation within the original sample



Shear Strength Parameters	
C	77 kPa
Phi	0.0 °

Specimen 1





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K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH1	**Sample no:**	U3	**Depth (m):**	5.00

Soil Description: High strength brown slightly sandy silty CLAY with orange brown sand partings

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	27
Bulk Density	Mg/m³	2.01
Dry Density	Mg/m³	1.59

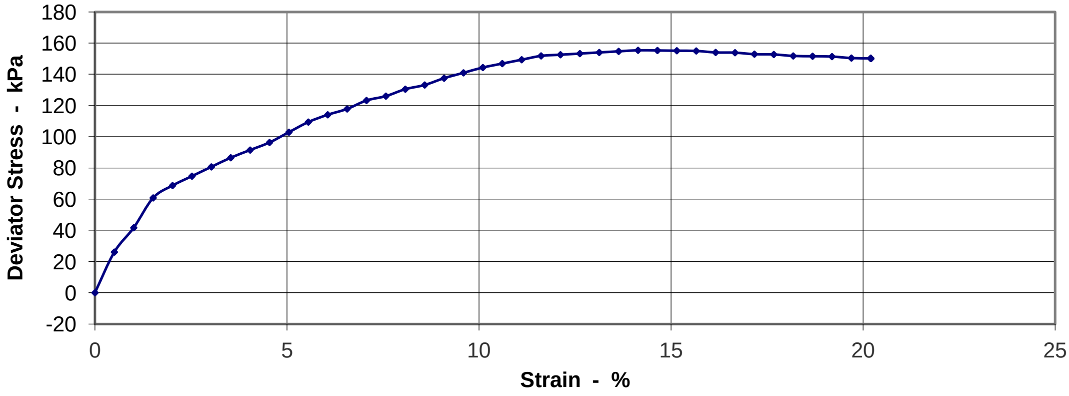
Test Details

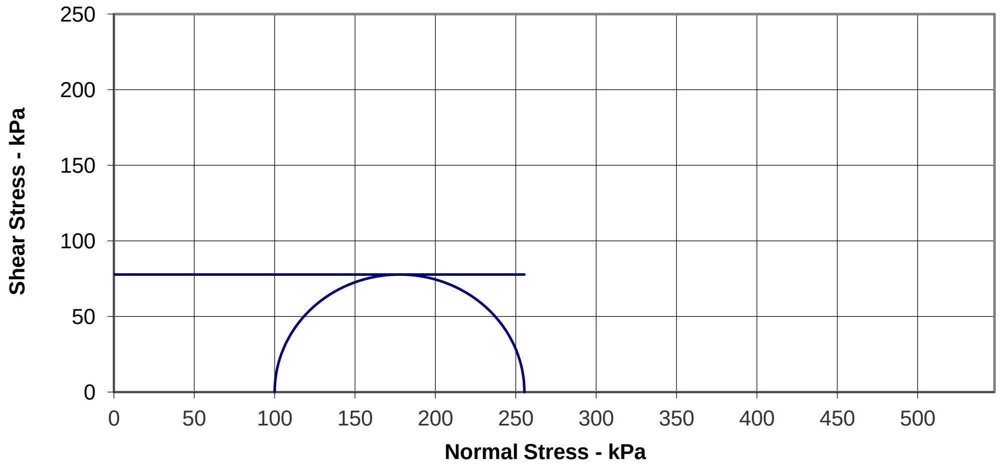
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.58
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	100
Strain at Failure	%	14.1
Maximum Deviator Stress	kPa	155
Shear Strength	kPa	78
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters	
C	78 kPa
Phi	0.0 °

Specimen 1





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K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name: 4 Greenaway Gardens		**Samples Received:**	22/12/2014
		Project Started:	05/01/2015
Client: GEA		**Testing Started:**	26/01/2015
Project no: J14381	**Our job /report no:** 18079	**Date Reported:**	30/01/2015
BH / TP no: BH1	**Sample no:** U4	**Depth (m):** 7.50	

Soil Description: Medium strength dark grey slightly sandy silty CLAY with occasional light grey fine sand partings

Sample Details **Specimen** **1**

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	25
Bulk Density	Mg/m³	1.99
Dry Density	Mg/m³	1.59

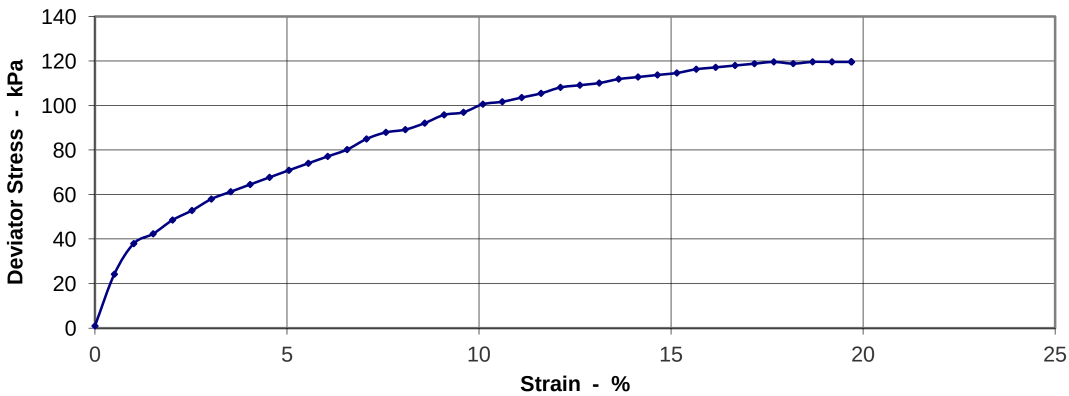
Test Details

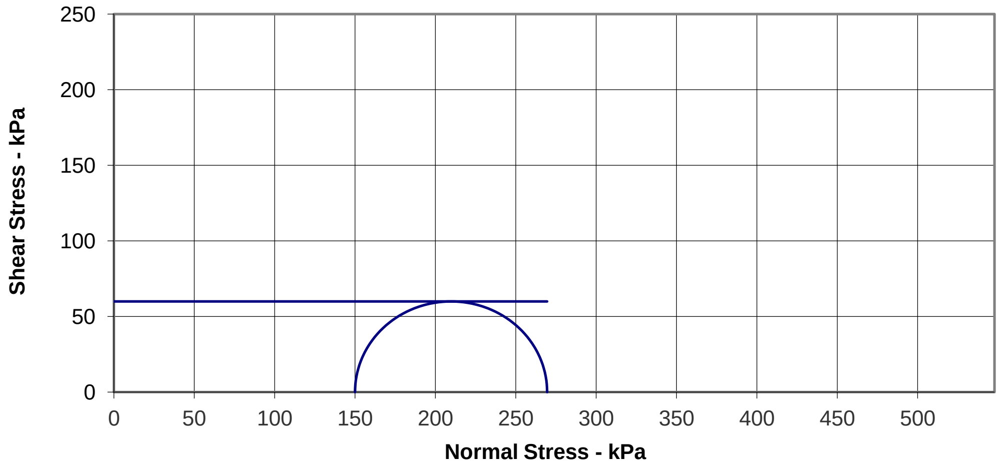
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.71
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	150
Strain at Failure	%	18.7
Maximum Deviator Stress	kPa	120
Shear Strength	kPa	60
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters		
C	60	kPa
Phi	0.0	°

Specimen 1





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UKAS TESTING 2519

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH1	**Sample no:**	U5	**Depth (m):**	10.50

Soil Description: High strength slightly fissured dark grey silty CLAY with light grey fine sand partings and rare shell deposits

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	26
Bulk Density	Mg/m³	2.06
Dry Density	Mg/m³	1.63

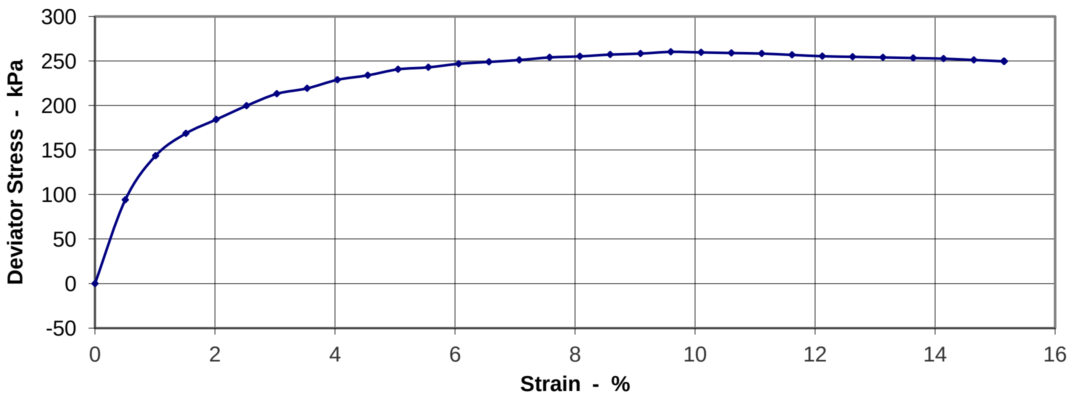
Test Details

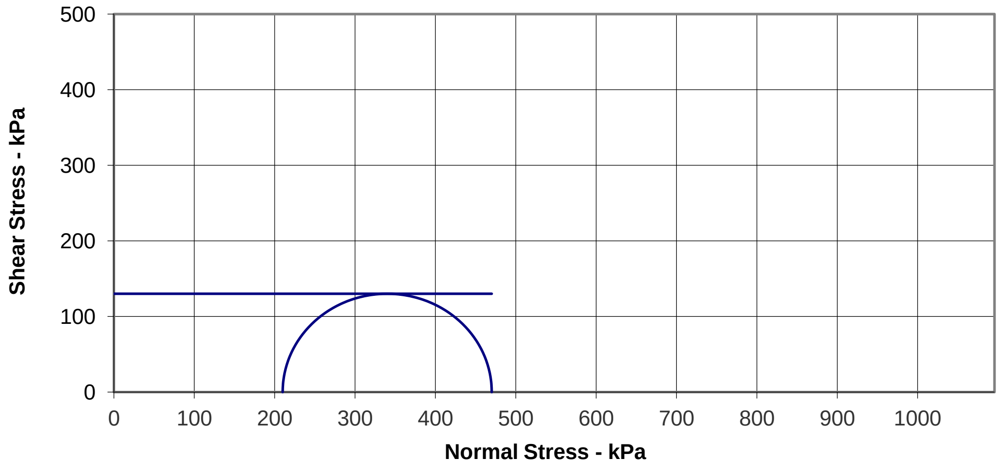
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.43
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	210
Strain at Failure	%	9.6
Maximum Deviator Stress	kPa	260
Shear Strength	kPa	130
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters	
C	130 kPa
Phi	0.0 °

Specimen 1





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K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH1	**Sample no:**	U6	**Depth (m):**	13.50

Soil Description: High strength fissured dark grey silty CLAY

Sample Details

Specimen		1
Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	27
Bulk Density	Mg/m³	2.04
Dry Density	Mg/m³	1.61

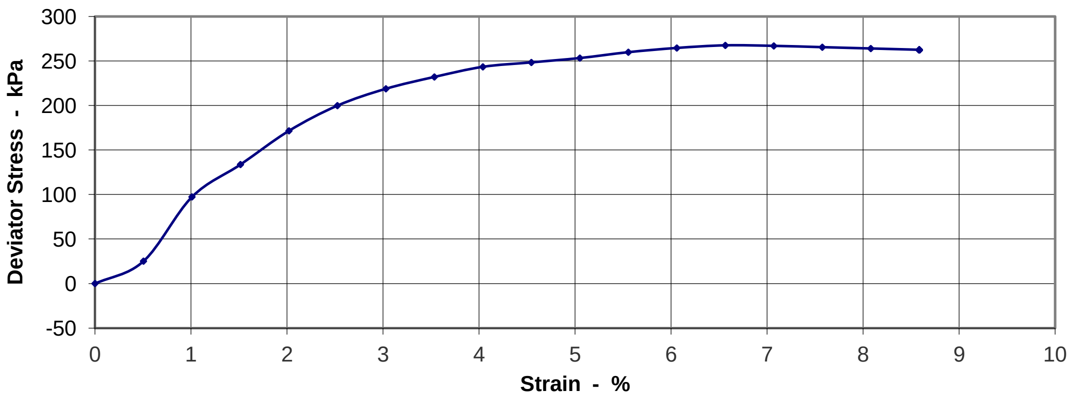
Test Details

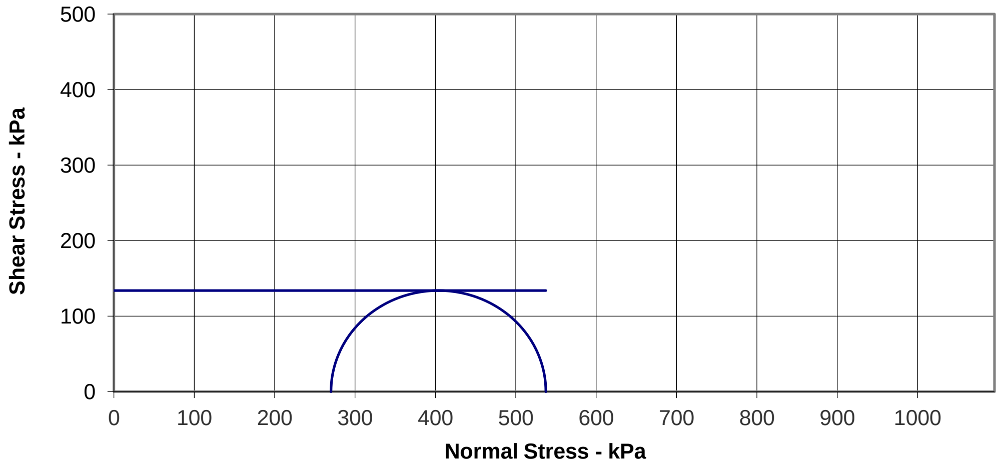
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.32
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	270
Strain at Failure	%	6.6
Maximum Deviator Stress	kPa	267
Shear Strength	kPa	134
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters	
C	134 kPa
Phi	0.0 °

Specimen 1





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K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client: GEA				**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH2	**Sample no:**	U1	**Depth (m):**	2.00

Soil Description: Low strength brown and orange brown mottled slightly sandy silty CLAY

Sample Details **Specimen 1**

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	26
Bulk Density	Mg/m³	1.94
Dry Density	Mg/m³	1.54

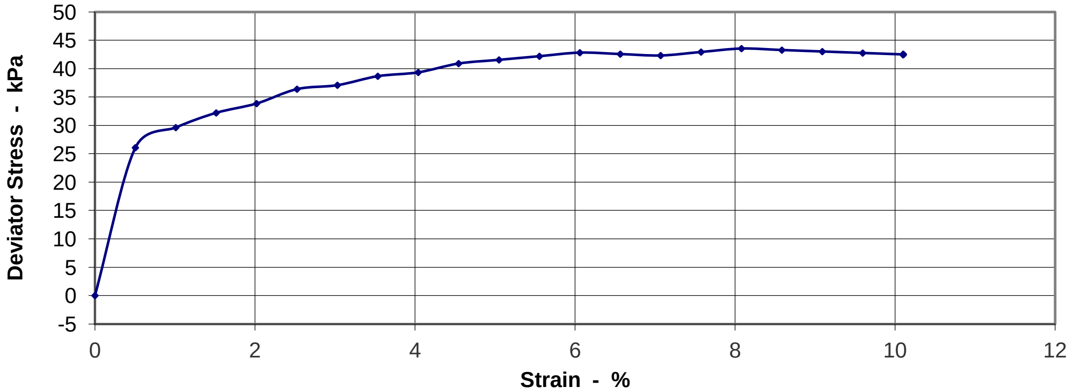
Test Details

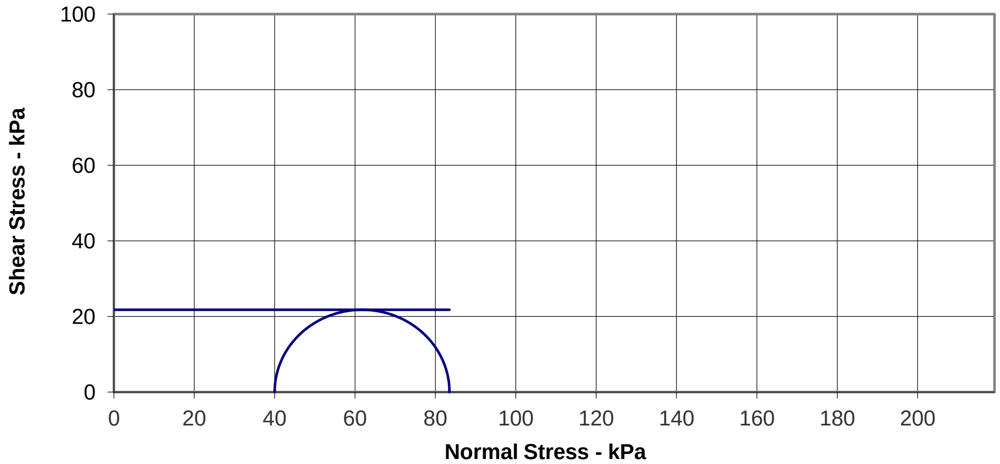
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.38
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	40
Strain at Failure	%	8.1
Maximum Deviator Stress	kPa	44
Shear Strength	kPa	22
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters	
C	22 kPa
Phi	0.0 °

Specimen 1





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UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH2	**Sample no:**	U2	**Depth (m):**	4.00

Soil Description: Medium strength brown and orange brown mottled slightly sandy silty CLAY

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	28
Bulk Density	Mg/m³	1.96
Dry Density	Mg/m³	1.53

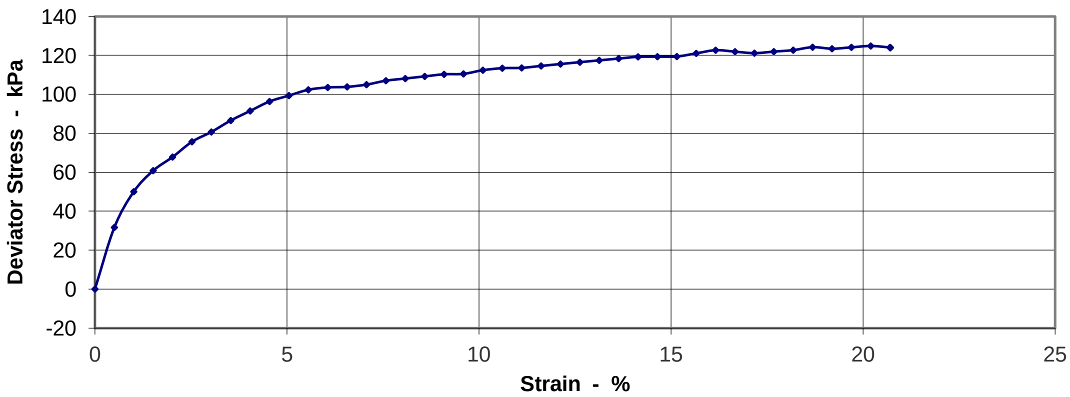
Test Details

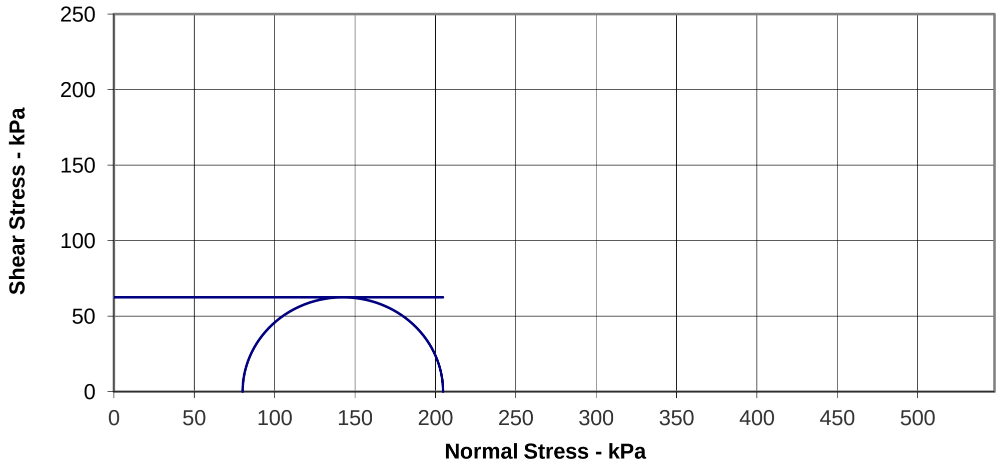
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.75
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	80
Strain at Failure	%	20.2
Maximum Deviator Stress	kPa	125
Shear Strength	kPa	62
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters	
C	62 kPa
Phi	0.0 °

Specimen 1





K4 SOILS LABORATORY
Unit 8, Olds Close, Watford, Herts, WD18 9RU.
Tel:01923711288 Fax:01923711311
E-mail: k4soils@aol.com

Approved Signatories: K.Phaure(Tech.Mgr)
J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 30/01/2015

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH2	**Sample no:**	U3	**Depth (m):**	6.00

Soil Description: High strength slightly fissured dark grey slightly sandy silty CLAY with light grey fine sand partings

Sample Details **Specimen** **1**

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	26
Bulk Density	Mg/m³	2.06
Dry Density	Mg/m³	1.63

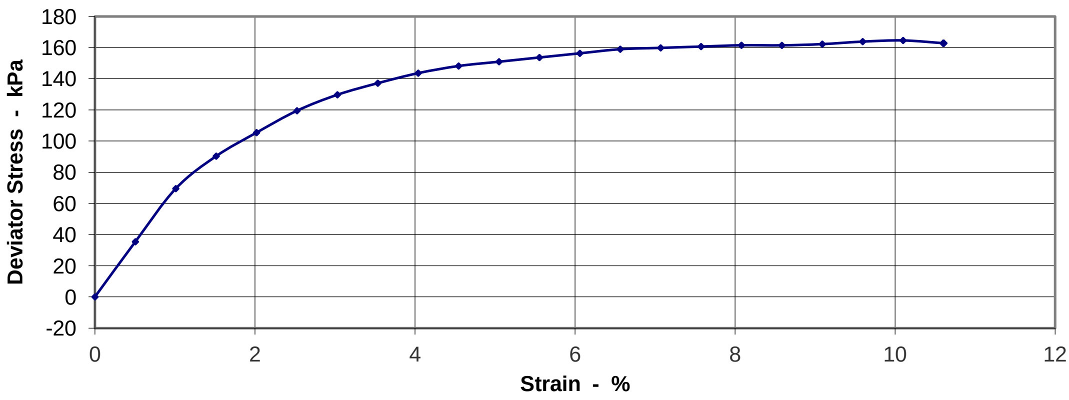
Test Details

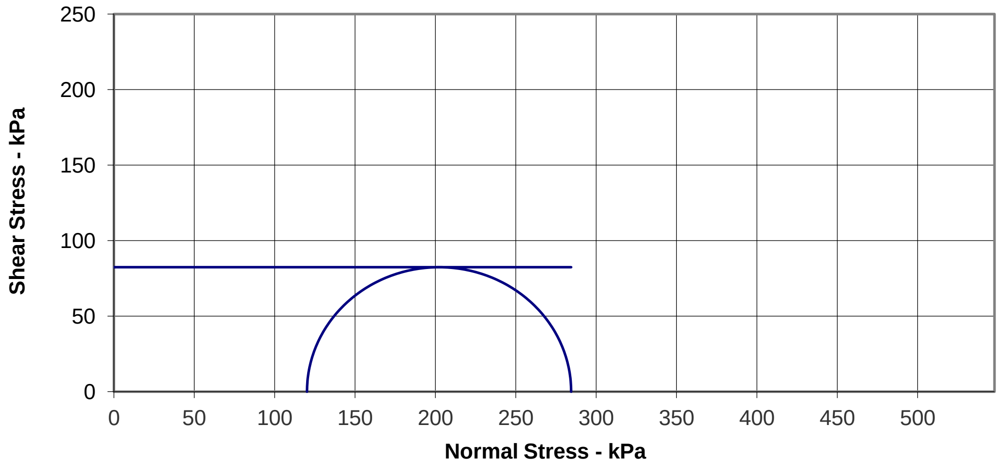
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.45
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	120
Strain at Failure	%	10.1
Maximum Deviator Stress	kPa	165
Shear Strength	kPa	82
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters	
C	82 kPa
Phi	0.0 °

Specimen 1





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Initials: kp
Date: 30/01/2015

UKAS TESTING 2519

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client: GEA				**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH2	**Sample no:**	U4	**Depth (m):**	9.00

Soil Description: High strength slightly fissured dark grey silty CLAY with light grey fine sand partings

Sample Details

		Specimen 1
Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	24
Bulk Density	Mg/m³	2.08
Dry Density	Mg/m³	1.67

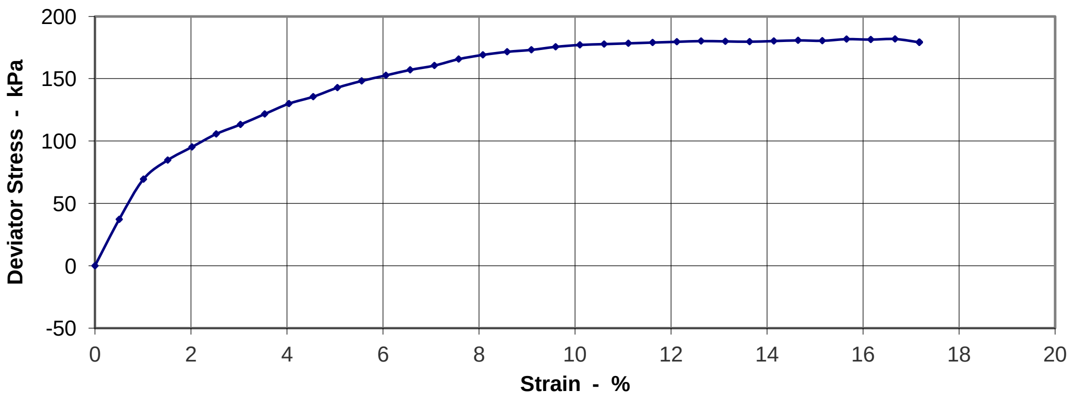
Test Details

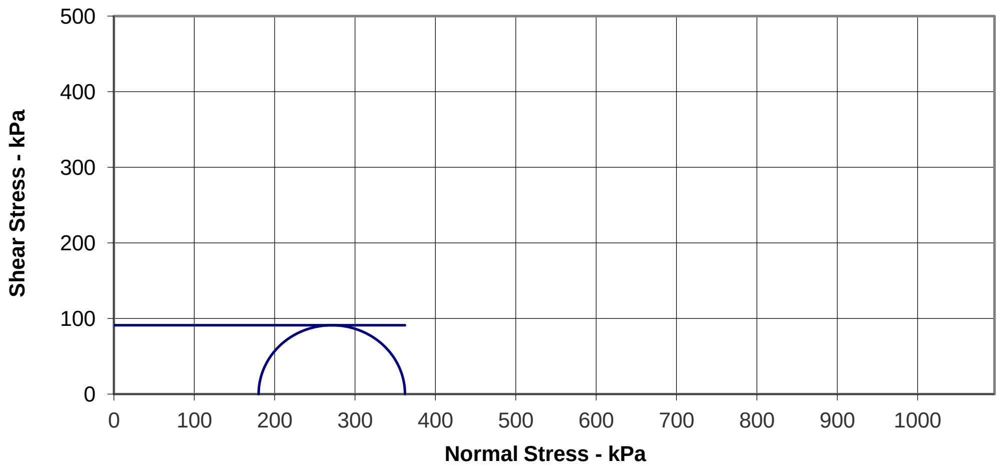
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.65
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	180
Strain at Failure	%	16.7
Maximum Deviator Stress	kPa	182
Shear Strength	kPa	91
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters	
C	91 kPa
Phi	0.0 °

Specimen 1





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Date: 30/01/2015

UKAS TESTING 2519

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH2	**Sample no:**	U5	**Depth (m):**	12.00

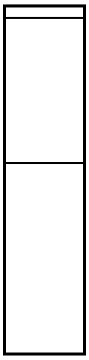
Soil Description: High strength slightly fissured dark grey silty CLAY with light grey fine sand partings

Sample Details

		Specimen 1
Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	27
Bulk Density	Mg/m^3	2.00
Dry Density	Mg/m^3	1.57

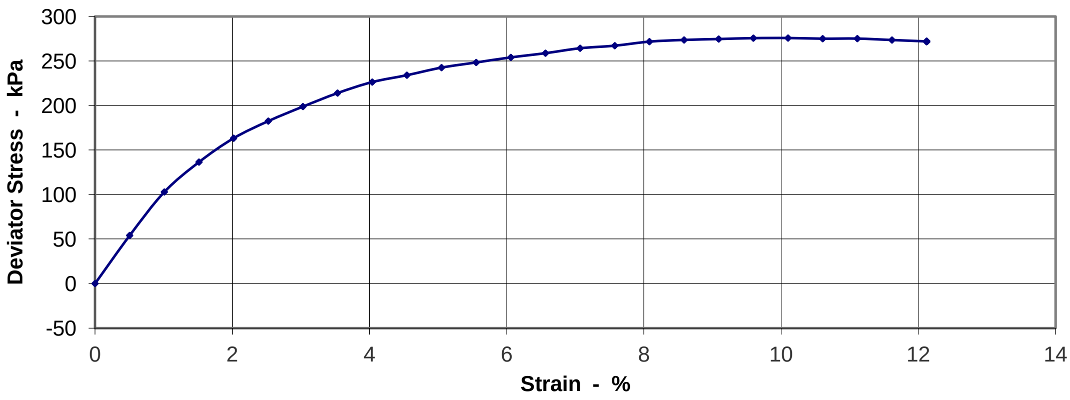
Test Details

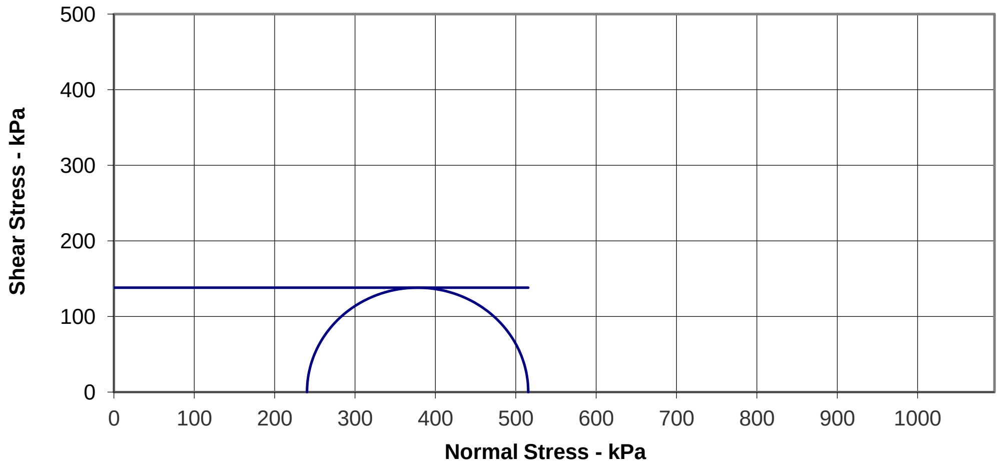
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.45
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	240
Strain at Failure	%	10.1
Maximum Deviator Stress	kPa	276
Shear Strength	kPa	138
Mode of Failure		Compound



Shear Strength Parameters	
C	138 kPa
Phi	0.0 °

Specimen 1





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Initials: kp
Date: 30/01/2015

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	4 Greenaway Gardens			**Samples Received:**	22/12/2014
				Project Started:	05/01/2015
Client:	GEA			**Testing Started:**	26/01/2015
Project no:	J14381	**Our job /report no:**	18079	**Date Reported:**	30/01/2015
BH / TP no:	BH2	**Sample no:**	U6	**Depth (m):**	13.50

Soil Description: High strength fissured dark grey silty CLAY

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	28
Bulk Density	Mg/m³	2.01
Dry Density	Mg/m³	1.58

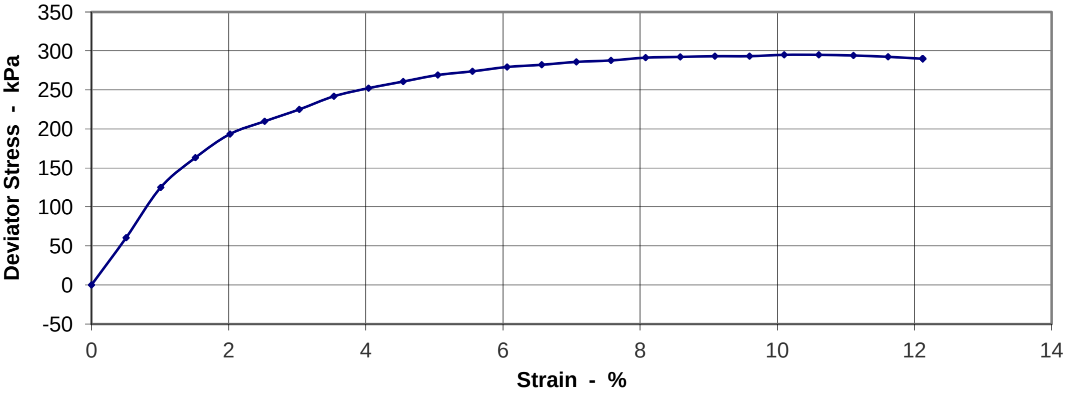
Test Details

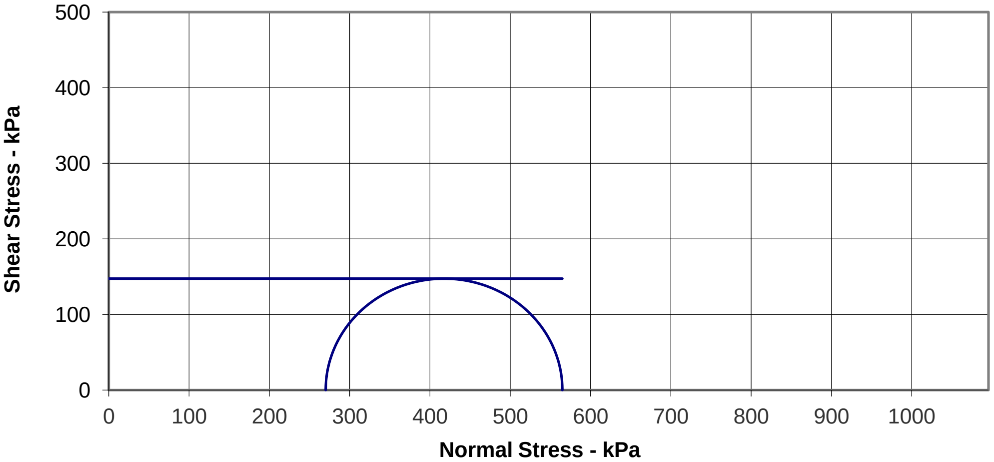
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.45
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	270
Strain at Failure	%	10.1
Maximum Deviator Stress	kPa	295
Shear Strength	kPa	147
Mode of Failure		Compound

Position and orientation within the original sample

Shear Strength Parameters	
C	147 kPa
Phi	0.0 °

Specimen 1





K4 SOILS LABORATORY

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Approved Signatories: K.Phaure(Tech.Mgr)
J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 30/01/2015

UKAS TESTING 2519

Client :	GEA	Our Job/report no:	18079	Samples Rec :	22/12/2014	Testing Started:	26/01/2015
Project name:	4 Greenaway Gardens	**Project No:**	**J14381**	**Project Started:**	05/01/2015	**Date reported:**	30/01/2015

BH / TP No	Sample no / ref	Sample depth (m)	Description	Moisture content (%)	Bulk Density (Mg/m3)	Dry density (Mg/m3)	Cell Pressure (kPa)	Strain at failure (%)	Max Deviator Stress (kPa)	Mode of failure	Shear Strength (kPa)	Phi (deg)
BH1	U1	1.20	Medium strength brown and orange brown mottled slightly sandy silty CLAY	31	1.96	1.49	24	18	106	Compound	53	NA
BH1	U2	3.00	High strength brown and orange brown mottled slightly sandy silty CLAY	28	1.96	1.53	60	17	154	Compound	77	NA
BH1	U3	5.00	High strength brown slightly sandy silty CLAY with orange brown sand partings	27	2.01	1.59	100	14	155	Compound	78	NA
BH1	U4	7.50	Medium strength dark grey slightly sandy silty CLAY with occasional light grey fine sand partings	25	1.99	1.59	150	19	120	Compound	60	NA
BH1	U5	10.50	High strength slightly fissured dark grey silty CLAY with light grey fine sand partings and rare shell deposits	26	2.06	1.63	210	9.6	260	Brittle	130	NA
BH1	U6	13.50	High strength fissured dark grey silty CLAY	27	2.04	1.61	270	6.6	267	Brittle	134	NA
BH2	U1	2.00	Low strength brown and orange brown mottled slightly sandy silty CLAY	26	1.94	1.54	40	8.1	44	Compound	22	NA
BH2	U2	4.00	Medium strength brown and orange brown mottled slightly sandy silty CLAY	28	1.96	1.53	80	20	125	Compound	62	NA
BH2	U3	6.00	High strength slightly fissured dark grey slightly sandy silty CLAY with light grey fine sand partings	26	2.06	1.63	120	10	165	Compound	82	NA
BH2	U4	9.00	High strength slightly fissured dark grey silty CLAY with light grey fine sand partings	24	2.08	1.67	180	17	182	Compound	91	NA
BH2	U5	12.00	High strength slightly fissured dark grey silty CLAY with light grey fine sand partings	27	2.00	1.57	240	10	276	Compound	138	NA
BH2	U6	13.50	High strength fissured dark grey silty CLAY	28	2.01	1.58	270	10	295	Compound	148	NA

K4 SOILS

Summary of Undrained Triaxial Compression Testing

BS 1377 : Part 7 : Clause 8 : 1990

Checked and approved

Initials kp

UKAS TESTING 2519

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford WD18 9RU Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Final Report

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

Report Number:	14-17318 Issue-1		
Initial Date of Issue:	07-Jan-15		
Client:	GEA		
Client Address:	Tyttenhanger House Coursers Road Saint Albans Hertfordshire AL4 0PG		
Contact(s):	Tacita Wallace		
Project:	J14381 4 Greenaway Gardens		
Quotation No.:		**Date Received:**	23-Dec-14
Order No.:	J14381	**Date Instructed:**	23-Dec-14
No. of Samples:	2	**Results Due:**	08-Jan-15
Turnaround: (Weekdays)	10		
Date Approved:	07-Jan-15		

Approved By:

Details: Phil Hellier, Project Director

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Project: J14381 4 Greenaway Gardens

Client: GEA	Chemtest Job No.:				14-17318	14-17318
Quotation No.:	Chemtest Sample ID.:				85024	85025
Order No.: J14381	Client Sample Ref.:					
	Client Sample ID.:				BH3	BH4
	Sample Type:				SOIL	SOIL
	Top Depth (m):				0.20	0.20
	Bottom Depth(m):					
	Date Sampled:				18-Dec-14	18-Dec-14
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Moisture	N	2030	%	0.02	20	31
Stones	N	2030	%	0.02	< 0.020	< 0.020
Soil Colour	N				Brown	Brown
Other Material	N				Stones	Stones
Soil Texture	N				Sand	Clay
pH	M	2010			8.9	7.4
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.01	0.24	0.075
Chloride (Extractable)	U	2220	g/l	0.01	0.013	< 0.010
Cyanide (Total)	M	2300	mg/kg	0.5	< 0.50	< 0.50
Sulphide (Easily Liberatable)	M	2325	mg/kg	0.5	1.9	1.4
Sulphate (Total)	M	2430	mg/kg	100	1400	1300
Arsenic	M	2450	mg/kg	1	12	20
Cadmium	M	2450	mg/kg	0.1	< 0.10	0.43
Chromium	M	2450	mg/kg	1	40	56
Copper	M	2450	mg/kg	0.5	13	46
Mercury	M	2450	mg/kg	0.1	0.15	0.53
Nickel	M	2450	mg/kg	0.5	16	21
Lead	M	2450	mg/kg	0.5	67	260
Selenium	M	2450	mg/kg	0.2	< 0.20	< 0.20
Zinc	M	2450	mg/kg	0.5	48	130
Total Organic Carbon	M	2625	%	0.2	0.31	4.5
TPH >C5-C6	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C6-C7	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C7-C8	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C8-C10	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C10-C12	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C12-C16	N	2670	mg/kg	1	< 1.0	2.9
TPH >C16-C21	N	2670	mg/kg	1	< 1.0	10
TPH >C21-C35	N	2670	mg/kg	1	< 1.0	20
Total TPH >C5-C35	N	2670	mg/kg	10	< 10	33
Naphthalene	M	2700	mg/kg	0.1	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.1	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.1	< 0.10	< 0.10

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Project: J14381 4 Greenaway Gardens

Client: GEA	**Chemtest Job No.:**				14-17318	14-17318
Quotation No.:	**Chemtest Sample ID.:**				85024	85025
Order No.: J14381	Client Sample Ref.:					
	Client Sample ID.:				BH3	BH4
	Sample Type:				SOIL	SOIL
	Top Depth (m):				0.20	0.20
	Bottom Depth(m):					
	Date Sampled:				18-Dec-14	18-Dec-14
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Fluorene	M	2700	mg/kg	0.1	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.1	0.19	0.76
Anthracene	M	2700	mg/kg	0.1	< 0.10	0.14
Fluoranthene	M	2700	mg/kg	0.1	0.28	0.96
Pyrene	M	2700	mg/kg	0.1	0.35	0.98
Benzo[a]anthracene	M	2700	mg/kg	0.1	< 0.10	0.42
Chrysene	M	2700	mg/kg	0.1	< 0.10	0.73
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	< 0.10	0.72
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	< 0.10	0.38
Benzo[a]pyrene	M	2700	mg/kg	0.1	< 0.10	0.42
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	< 0.10	0.34
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	< 0.10	0.34
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	< 0.10	0.29
Total Of 16 PAH's	M	2700	mg/kg	2	< 2.0	6.5
Total Phenols	M	2920	mg/kg	0.3	< 0.30	< 0.30

Chemtest
The right chemistry to deliver results

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

Final Report

Report Number:	15-00814 Issue-1		
Initial Date of Issue:	26-Jan-15		
Client:	GEA		
Client Address:	Tyttenhanger House Coursers Road Saint Albans Hertfordshire AL4 0PG		
Contact(s):	Angela Baird		
Project:	J14381 - 4 Greenaway Gardens, London, NW3 7DJ		
Quotation No.:		**Date Received:**	16-Jan-15
Order No.:		**Date Instructed:**	16-Jan-15
No. of Samples:	1	**Results Due:**	26-Jan-15
Turnaround: (Weekdays)	7		
Date Approved:	26-Jan-15		

Approved By:

Details: Phil Hellier, Project Director

Results Summary - Soil

Project: J14381 - 4 Greenaway Gardens, London, NW3 7DJ

Client: GEA	**Chemtest Job No.:**				15-00814
Quotation No.:	**Chemtest Sample ID.:**				89820
Order No.:	Client Sample Ref.:				
	Client Sample ID.:				TH6
	Sample Type:				SOIL
	Top Depth (m):				0.5
	Bottom Depth(m):				0.8
	Date Sampled:				13-Jan-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Moisture	N	2030	%	0.02	27

Chemtest
The right chemistry to deliver results

Results Summary - 2 Stage WAC

Project: J14381 - 4 Greenaway Gardens, London, NW3 7DJ

Chemtest Job No: 15-00814
Chemtest Sample ID: 89820
Sample Ref:
Sample ID: TH6
Top Depth(m): 0.5
Bottom Depth(m): 0.8
Sampling Date: 13-Jan-2015

Determinand	SOP	Accred.	Units				Landfill Waste Acceptance Criteria Limits: Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous	Hazardous Waste Landfill
Total Organic Carbon	2625	U	%			2.3	3	5	6
Loss on Ignition	2610	U	%			5.2	--	--	10
Total BTEX	2760	U	mg/kg			C < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			C < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			4	100	--	--
pH	2010	U				7.8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.097	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.018	0.005	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.001	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.011	0.002	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	0.005	< 0.010	0.044	0.5	10	50
Antimony	1450	U	0.002	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.003	0.004	< 0.50	< 0.50	4	50	200
Chloride	1220	U	3.3	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.45	0.13	< 1.0	1.6	10	150	500
Sulphate	1220	U	46	1.3	88	61	1000	20000	50000
Total Dissolved Solids	1020	N	190	36	360	520	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	10	6.4	< 50	67	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	27

Leachate Test Information	
Leachant volume 1st extract/l	0.286
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.19

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Deviations

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Chemtest Sample ID:	Sample Ref:	Sample ID:	Sampled Date:	Containers Received:	Deviation Code(s):
89820		TH6	13-Jan-2015	Plastic Bag	C

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Sample Deviation Codes

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B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

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customerservices@chemtest.co.uk

Chemtest
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Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

Final Report

Report Number:	15-00819 Issue-1		
Initial Date of Issue:	20-Jan-15		
Client:	GEA		
Client Address:	Tyttenhanger House Coursers Road Saint Albans Hertfordshire AL4 0PG		
Contact(s):	Angela Baird		
Project:	J14381 - 4 Greenaway Gardens, London, NW3 7DJ		
Quotation No.:		**Date Received:**	16-Jan-15
Order No.:		**Date Instructed:**	16-Jan-15
No. of Samples:	2	**Results Due:**	20-Jan-15
Turnaround: (Weekdays)	3		
Date Approved:	20-Jan-15		
Approved By:			

KTJones

Details:	Keith Jones, Technical Manager

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Results Summary - Soil

Project: J14381 - 4 Greenaway Gardens, London, NW3 7DJ

Client: GEA				**Chemtest Job No.:**	15-00819	15-00819
Quotation No.:				**Chemtest Sample ID.:**	89833	89834
Order No.:				Client Sample Ref.:		
				Client Sample ID.:	TH2	TH8
				Sample Type:	SOIL	SOIL
				Top Depth (m):	0.2	0.21
				Bottom Depth(m):		
				Date Sampled:	13-Jan-15	13-Jan-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Moisture	N	2030	%	0.02	8.4	18
Stones	N	2030	%	0.02	< 0.020	< 0.020
Soil Colour	N				Brown	Brown
Other Material	N				Stones	Stones
Soil Texture	N				Sand	Clay
pH	M	2010			10.4	9.8
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.01	0.83	0.20
Chloride (Extractable)	U	2220	g/l	0.01	0.034	0.015
Cyanide (Total)	M	2300	mg/kg	0.5	2.0	0.50
Sulphide (Easily Liberatable)	M	2325	mg/kg	0.5	3.9	3.6
Sulphate (Total)	M	2430	mg/kg	100	3800	1300
Arsenic	M	2450	mg/kg	1	32	18
Cadmium	M	2450	mg/kg	0.1	0.15	0.30
Chromium	M	2450	mg/kg	1	29	29
Copper	M	2450	mg/kg	0.5	48	45
Mercury	M	2450	mg/kg	0.1	0.10	0.44
Nickel	M	2450	mg/kg	0.5	35	20
Lead	M	2450	mg/kg	0.5	500	890
Selenium	M	2450	mg/kg	0.2	< 0.20	< 0.20
Zinc	M	2450	mg/kg	0.5	79	340
Total Organic Carbon	M	2625	%	0.2	3.8	2.6
TPH >C5-C6	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C6-C7	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C7-C8	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C8-C10	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C10-C12	N	2670	mg/kg	1	< 1.0	< 1.0
TPH >C12-C16	N	2670	mg/kg	1	11	9.5
TPH >C16-C21	N	2670	mg/kg	1	48	14
TPH >C21-C35	N	2670	mg/kg	1	93	28
Total TPH >C5-C35	N	2670	mg/kg	10	150	52
Naphthalene	M	2700	mg/kg	0.1	0.43	0.27
Acenaphthylene	M	2700	mg/kg	0.1	0.43	0.34
Acenaphthene	M	2700	mg/kg	0.1	0.77	0.53

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Results Summary - Soil

Project: J14381 - 4 Greenaway Gardens, London, NW3 7DJ

Client: GEA				**Chemtest Job No.:**	15-00819	15-00819
Quotation No.:				**Chemtest Sample ID.:**	89833	89834
Order No.:				Client Sample Ref.:		
				Client Sample ID.:	TH2	TH8
				Sample Type:	SOIL	SOIL
				Top Depth (m):	0.2	0.21
				Bottom Depth(m):		
				Date Sampled:	13-Jan-15	13-Jan-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Fluorene	M	2700	mg/kg	0.1	0.85	0.34
Phenanthrene	M	2700	mg/kg	0.1	6.2	3.0
Anthracene	M	2700	mg/kg	0.1	1.6	0.75
Fluoranthene	M	2700	mg/kg	0.1	12	6.5
Pyrene	M	2700	mg/kg	0.1	12	6.6
Benzo[a]anthracene	M	2700	mg/kg	0.1	5.4	3.4
Chrysene	M	2700	mg/kg	0.1	6.0	3.7
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	7.8	5.4
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	3.6	2.0
Benzo[a]pyrene	M	2700	mg/kg	0.1	5.9	4.0
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	10	5.2
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	5.1	2.5
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	3.9	1.8
Total Of 16 PAH's	M	2700	mg/kg	2	82	46
Total Phenols	M	2920	mg/kg	0.3	< 0.30	< 0.30

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B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

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All water samples will be retained for 14 days from the date of receipt
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If you require extended retention of samples, please email your requirements to:
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UKAS TESTING 2183

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Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Report Number:	15-00822 Issue-1		
Initial Date of Issue:	26-Jan-15		
Client:	GEA		
Client Address:	Tyttenhanger House Coursers Road Saint Albans Hertfordshire AL4 0PG		
Contact(s):	Angela Baird		
Project:	J14381 - 4 Greenaway Gardens, London, NW3 7DJ		
Quotation No.:		**Date Received:**	16-Jan-15
Order No.:		**Date Instructed:**	16-Jan-15
No. of Samples:	1	**Results Due:**	26-Jan-15
Turnaround: (Weekdays)	7		
Date Approved:	26-Jan-15		

Approved By:

Details: Phil Hellier, Project Director

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Results Summary - Soil

Project: J14381 - 4 Greenaway Gardens, London, NW3 7DJ

Client: GEA	**Chemtest Job No.:**				15-00822
Quotation No.:	**Chemtest Sample ID.:**				89839
Order No.:	Client Sample Ref.:				
	Client Sample ID.:				TH4
	Sample Type:				SOIL
	Top Depth (m):				0.8
	Bottom Depth(m):				1.0
	Date Sampled:				13-Jan-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Moisture	N	2030	%	0.02	24

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Results Summary - 2 Stage WAC

Project: J14381 - 4 Greenaway Gardens, London, NW3 7DJ

Chemtest Job No: 15-00822 Chemtest Sample ID: 89839 Sample Ref: Sample ID: TH4 Top Depth(m): 0.8 Bottom Depth(m): 1.0 Sampling Date: 13-Jan-2015							Landfill Waste Acceptance Criteria Limits		
Determinand	**SOP**	**Accred.**	**Units**				**Inert Waste Landfill**	**Stable Non-reactive Hazardous waste in non-hazardous**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%			0.52	3	5	6
Loss on Ignition	2610	U	%			4.8	--	--	10
Total BTEX	2760	U	mg/kg			C < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			C < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			< 2.0	100	--	--
pH	2010	U				7.8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.081	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	0.004	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.007	0.004	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.002	0.003	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.005	0.002	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	0.002	0.004	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	0.011	< 0.010	0.1	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	0.008	< 0.50	< 0.50	4	50	200
Chloride	1220	U	2.4	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.55	0.44	1.1	4.4	10	150	500
Sulphate	1220	U	17	1.6	33	27	1000	20000	50000
Total Dissolved Solids	1020	N	130	34	250	410	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	38	13	73	150	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	24

Leachate Test Information	
Leachant volume 1st extract/l	0.296
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.129

Deviations

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Chemtest Sample ID:	Sample Ref:	Sample ID:	Sampled Date:	Containers Received:	Deviation Code(s):
89839		TH4	13-Jan-2015	Plastic Bag	C

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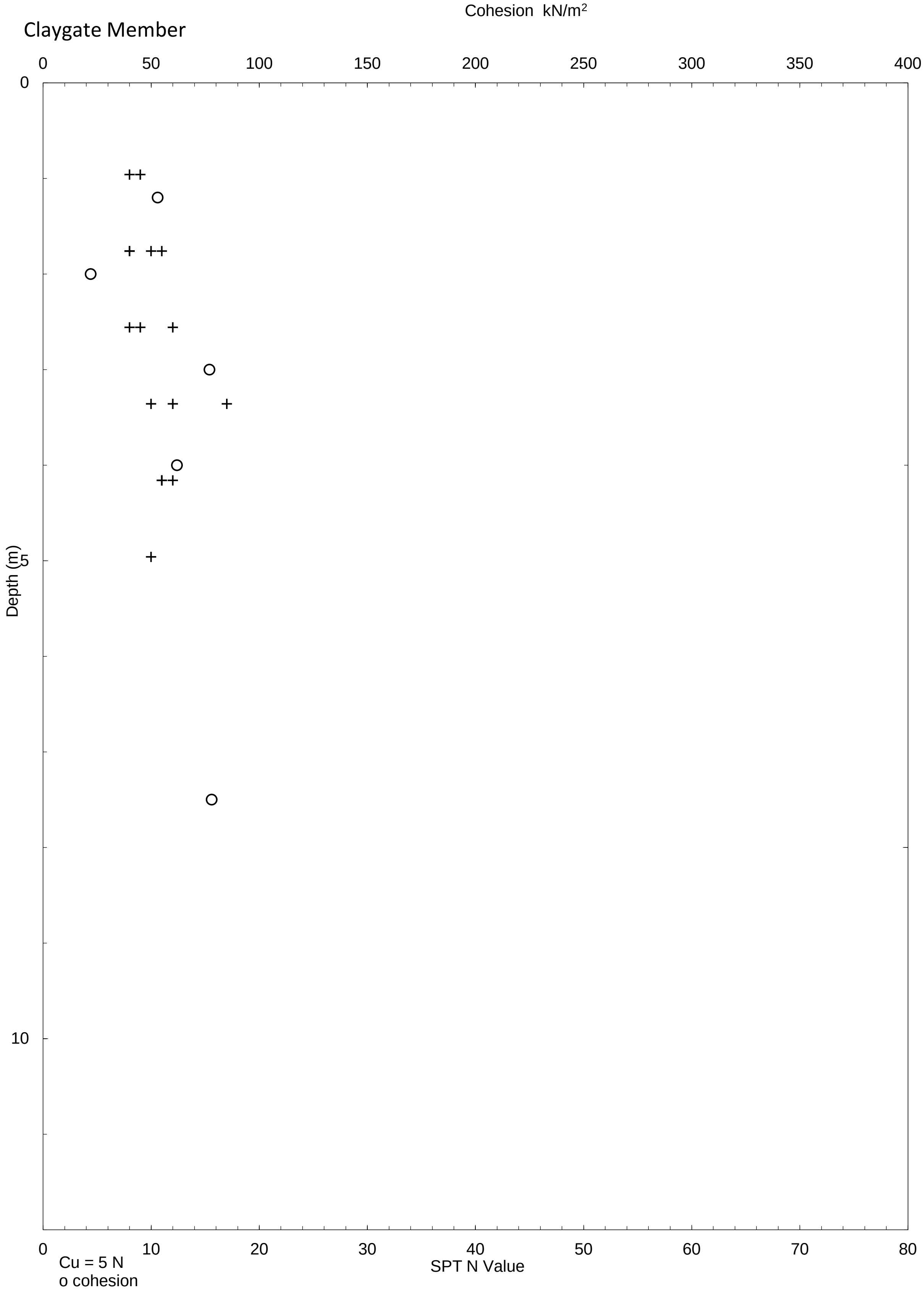
Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**SPT & Cohesion / Depth Graph**

Site	4 Greenaway Gardens, London, NW6 7DJ	**Job Number** J14381
Client	Mr V Israelian	**Sheet** 1 / 2
Engineer	Richard Tant Associates	



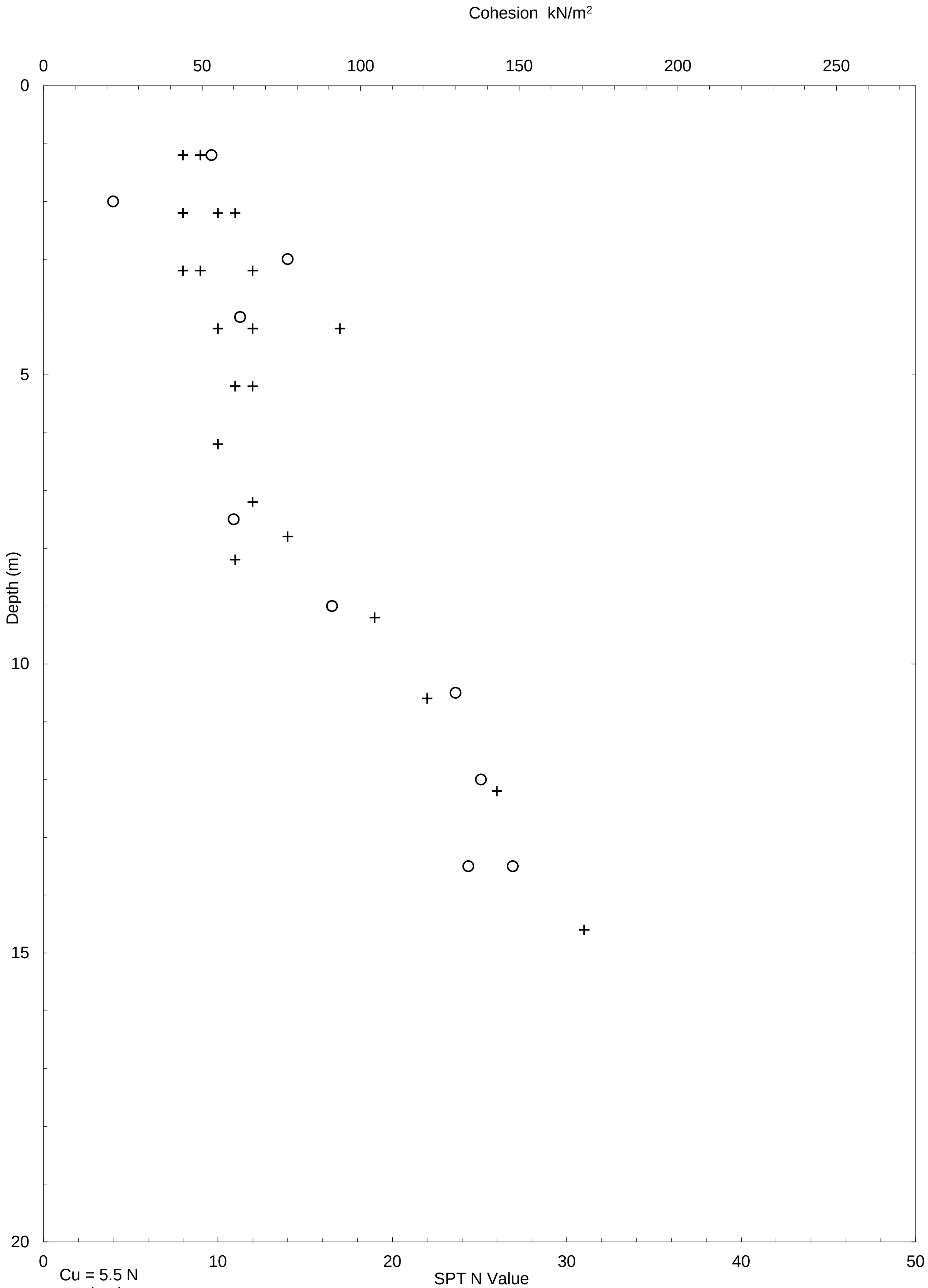
Cu = 5 N
o cohesion
+ SPT N Value

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

SPT & Cohesion / Depth Graph

Site	4 Greenaway Gardens, London, NW6 7DJ	**Job Number** J14381
Client	Mr V Israelian	**Sheet** 1/1
Engineer	Richard Tant Associates	



Cu = 5.5 N
o cohesion
+ SPT N Value

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	**Generic Risk-Based Soil Screening Values**

Site	4 Greenaway Gardens, NW3 7DJ	**Job Number** J14318
Client	Mr Verdi Israelian	**Sheet** 1 / 1
Agent	Richard Tant Associates	

Proposed End Use Residential with plant uptake

Soil pH 8

Soil Organic Matter content % 2.5

Contaminant	Screening Value mg/kg	Data Source
Metals		
Arsenic	37	C4SL
Cadmium	26	C4SL
Chromium (III)	3000	LQM/CIEH
Chromium (VI)	21	C4SL
Copper	2,330	LQM/CIEH
Lead	200	C4SL
Elemental Mercury	1	SGV
Inorganic Mercury	170	SGV
Nickel	130	LQM/CIEH
Selenium	350	SGV
Zinc	3,750	LQM/CIEH
Hydrocarbons		
Benzene	0.34	C4SL
Toluene	320	SGV
Ethyl Benzene	180	SGV
Xylene	120	SGV
Aliphatic C5-C6	55	LQM/CIEH
Aliphatic C6-C8	160	LQM/CIEH
Aliphatic C8-C10	46	LQM/CIEH
Aliphatic C10-C12	230	LQM/CIEH
Aliphatic C12-C16	1700	LQM/CIEH
Aliphatic C16-C35	64,000	LQM/CIEH
Aromatic C6-C7	See Benzene	LQM/CIEH
Aromatic C7-C8	See Toluene	LQM/CIEH
Aromatic C8-C10	65	LQM/CIEH
Aromatic C10-C12	160	LQM/CIEH
Aromatic C12-C16	310	LQM/CIEH
Aromatic C16-C21	480	LQM/CIEH
Aromatic C21-C35	1100	LQM/CIEH
PRO (C_5 –C_{10})	646	Calc
DRO (C_{12} –C_{28})	66,490	Calc
Lube Oil (C_{28} –C_{44})	65,100	Calc
TPH	**1000**	Trigger for speciated testing

Contaminant	Screening Value mg/kg	Data Source
Anions		
Soluble Sulphate	0.5 g/l	Structures
Sulphide	50	Structures
Chloride	400	Structures
Others		
Organic Carbon (%)	6	Methanogenic potential
Total Cyanide	140	WRAS
Total Mono Phenols	290	SGV
PAH		
Naphthalene	5.30	Rev. LQM/CIEH
Acenaphthylene	400	LQM/CIEH
Acenaphthene	480	LQM/CIEH
Fluorene	380	LQM/CIEH
Phenanthrene	200	LQM/CIEH
Anthracene	4,900	LQM/CIEH
Fluoranthene	460	LQM/CIEH
Pyrene	1,000	LQM/CIEH
Benzo(a) Anthracene	6.7	Rev. LQM/CIEH
Chrysene	11	Rev. LQM/CIEH
Benzo(b) Fluoranthene	9.5	Rev. LQM/CIEH
Benzo(k) Fluoranthene	14.1	Rev. LQM/CIEH
Benzo(a) pyrene	4.40	C4SL
Indeno(1 2 3 cd) Pyrene	5.6	Rev. LQM/CIEH
Dibenzo(a h) Anthracene	1.27	Rev. LQM/CIEH
Benzo (g h i) Perylene	69	Rev. LQM/CIEH
Screening value for PAH	**62.9**	B(a)P / 0.15
Chlorinated Solvents		
1,1,1 trichloroethane (TCA)	12.9	LQM/CIEH
tetrachloroethane (PCA)	2.1	LQM/CIEH
tetrachloroethene (PCE)	2.1	LQM/CIEH
trichloroethene (TCE)	0.22	LQM/CIEH
1,2-dichloroethane (DCA)	0.008	LQM/CIEH
vinyl chloride (Chloroethene)	0.00064	LQM/CIEH
tetrachloromethane (Carbon tetra	0.039	LQM/CIEH
trichloromethane (Chloroform)	1.3	LQM/CIEH

Notes

Concentrations measured below the above values may be considered to represent 'uncontaminated conditions' which pose 'LOW' risk to human health. Concentrations measured in excess of these valuesindicate a potential risk which require further, site specific risk assessment.

SGV - Soil Guideline Value, derived from the CLEA model and published by Environment Agency 2009

LQM/CIEH - Generic Assessment Criteria for Human Health Risk Assessment 2nd edition (2009)derived using CLEA 1.04 model 2009

C4SL - Defra Category 4 Screening value based on Low Level of Toxicological Risk

Rev LQM/CIEH calculated using C4SL revisions to exposure assessment but LQM/CIEH health croiteria values

Calc - sum of nearest available carbon range specified including BTEX for PRO fraction

B(a)P / 0.15 - GEA experince indicates that Benzo(a) pyrene (one of the most common and most carcenogenic of the PAHs) rarely exceeds 15% of the total PAH concentration, hence this Total PAH threshold is regarded as being conservative