# 13 Netherhall Gardens
# London NW3 5RN

## Desk Study
## & Basement Impact Assessment
## Report

Re-Creo Developments Limited

August 2021

J18176A
Issue 3

## Document Control

| **Project title** | 13 Netherhall Gardens, London, NW3 5RN | **Project ref** | J18176A |
|---|---|---|---|
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| **Issue No** | **Status** | **Date** | **Approved for Issue** |
|---|---|---|---|
| 3 | Final – reduced basement | 24 August 2021 | SB |

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This report is intended as a Ground Investigation Report (GIR) as defined in BS EN1997-2, unless specifically noted otherwise. The report is not a Geotechnical Design Report (GDR) as defined in EN1997-2 and recommendations made within this report are for guidance only.

## CONTENTS

**Part 3: GROUND MOVEMENT ASSESSMENT**

# 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 behalf of Re-Creo Developments Ltd, with respect to the redevelopment of the site through the refurbishment of the existing house and construction of a single level basement. It is understood that the refurbishment will include structural alterations in order to return the property to a habitable condition and it is anticipated that the existing foundations will need to be lowered in order to bear on more suitable stratum. The purpose of the investigation has been to research the history of the site with respect to possible contaminative uses, to determine the ground conditions, to assess the extent of any contamination and to provide information to assist with the design of suitable foundations for the remodelled building. The report also includes information required to comply with London Borough of Camden (LBC) Planning Guidance CPG Basements, relating to the requirement for a Basement Impact Assessment (BIA).

## SITE HISTORY

The earliest map studied, dated 1871, shows the site to have been undeveloped. The Belsize Tunnel was present in its existing alignment about 50 m to the south, whilst Finchley Road Station and associated railway tunnel was present about 150 m to the north. The next map studied, dated 1896, shows the site and the surrounding area largely in their existing conditions. The New Belsize Tunnel had been built, in addition to the surrounding existing road network and residential buildings. The site was occupied by what appears to be the existing building. Both the site and surrounding area have since remained essentially unchanged, although a small ancillary building is shown to have been present on the southern boundary of the site between 1954 and 2018. However, the ancillary building had been demolished by the time of the fieldwork.

## GROUND CONDITIONS

The investigation encountered a moderate thickness of made ground overlying the London Clay Formation. The made ground comprised brown silty sandy gravelly clay with fragments of coal, ash, brick, tarmac and flint gravel and generally extended to a depth of around 1.4 m. Within some of the trial pits the made ground extended to depths of between 2.0 m and 2.6 m. The London Clay comprised an initial horizon of high strength firm becoming stiff fissured orange-brown mottled grey silty clay with occasional fragments of decaying carbon, occasional partings of fine sand and selenite crystals and rare fine gravel sized clasts of pyrite and extended to depths of between 11.3 m and 11.7 m. Below this layer, the London Clay became high strength, stiff becoming very stiff fissured dark grey silty clay with occasional infilled bioturbations, occasional partings of fine sand and selenite crystals, and rare gravel sized clasts of pyrite, and extended to the full depth of the investigation of 30.0 m. Groundwater was not encountered during drilling and the two monitoring standpipes that were installed to a depth of 6.0 m have since been monitored as dry. The trial pits were excavated by the building contractor on site and were reported as dry during excavation. However, in order for the pits to be logged the trial pits were left open for two days and groundwater was found to be present at varying depths.

## RECOMMENDATIONS

It is assumed that the new lower ground floor extension will extend to a depth of 3.50 m (68.80 m OD), whilst the basement excavation will extend to depths of between 4.00 m and 6.00 m (64.50 m OD). Formation level for the proposed basement should therefore be within the firm becoming stiff silty clay of the London Clay. On the basis of the fieldwork and subsequent monitoring, groundwater is unlikely to be encountered within the basement excavation. It is anticipated that foundations bearing on the London Clay at a depth of between 3.5 m and 6.0 m below ground level may be designed to apply a net allowable bearing pressure of 150 kN/m$^2$. It is also recommended that existing foundations that do not form part of the underpinning process for the lower ground and basement works be lowered to a minimum depth of 2.5 m in accordance with NHBC guidelines and a similar allowable bearing pressure be adopted. It would be prudent for the formation level of the foundations be inspected by a suitably qualified engineer and to excavate trial excavations within the vicinity of the foundations in order to monitor any groundwater inflows.

## BASEMENT IMPACT ASSESSMENT

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice.

# 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 and an assessment of the ground movements associated with the basement excavation are included in Part 3.

## 1.0 INTRODUCTION

Geotechnical and Environmental Associates Limited (GEA) has been instructed by Re-Creo Developments Ltd, to carry out a desk study and ground investigation at 13 Netherhall Gardens, London NW3 5RN.

This report also forms part of 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 it is proposed to refurbish the existing building, extend the existing lower ground floor to the south and east, and construct a single level basement beneath part of the existing building footprint and into the existing rear garden. The lower ground floor extension will extend to a depth of about 3.5 m (68.8 m OD) below existing ground level, whilst the basement will extend to a depth of about 6.0 m below existing rear garden level and 4.0 m below existing lower ground floor level (approx. 64.5 m OD). It is understood that the retaining walls will be formed through typical ‘hit and miss’ underpins and that the existing foundations that are not part of the lower ground floor or basement works will be lowered to a more suitable bearing stratum. A section through the proposed development and floor plan of the new basement is presented below.


Section through proposed development

Floor plan of proposed basement

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

## 1.2 Purpose of Work

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

- to check the history of the site with respect to previous contaminative uses;
- to determine the risk of Unexploded Ordnance (UXO);
- to determine the ground conditions and their engineering properties;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to determine the nature of the existing footings;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and build environment;
- 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 historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- commissioning of 1st Line Defence to provide a preliminary UXO risk assessment of the site (report ref EP7070-00, dated 09/08/18);
- a check of records of data on groundwater, surface water and other publicly available environmental data;
- a review of planning records;
- a review of readily available geology maps; and
- 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 depths of 20.00 m and 30.00 m by a dismantlable cable percussion rig;
- standard penetration tests (SPTs) carried out at regular intervals within the cable percussion borehole to provide quantitative data on the strength of the soils;
- the logging of 11 trial pits, which were excavated via manual and machine methods by the on-site contractor to a maximum depth of 3.3 m to investigate the foundations of the existing building and boundary walls;

- 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.

The exploratory methods adopted in this investigation have been selected on the basis of the constraints of the site including but not limited to access and space limitations, together with any budgetary or timing constraints. Where it has not been possible to reasonably use an EC7 compliant investigation technique a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon GEA's engineering experience, local precedent where applicable and relevant published information.

### 1.3.1 Basement Impact Assessment

The work carried out 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 Planning Guidance (CPG)[2] and their Guidance for Subterranean Development[3] prepared by Arup ('the Arup Report') in accordance with Policy A5 of the Camden Local Plan 2017. The aim of the work is to provide information on surface water, groundwater and land stability 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 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 some 30 years' experience in geotechnical engineering and engineering geology.

All assessors meet the qualification requirements of the Council guidance.

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 (March 2018) *Basements*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

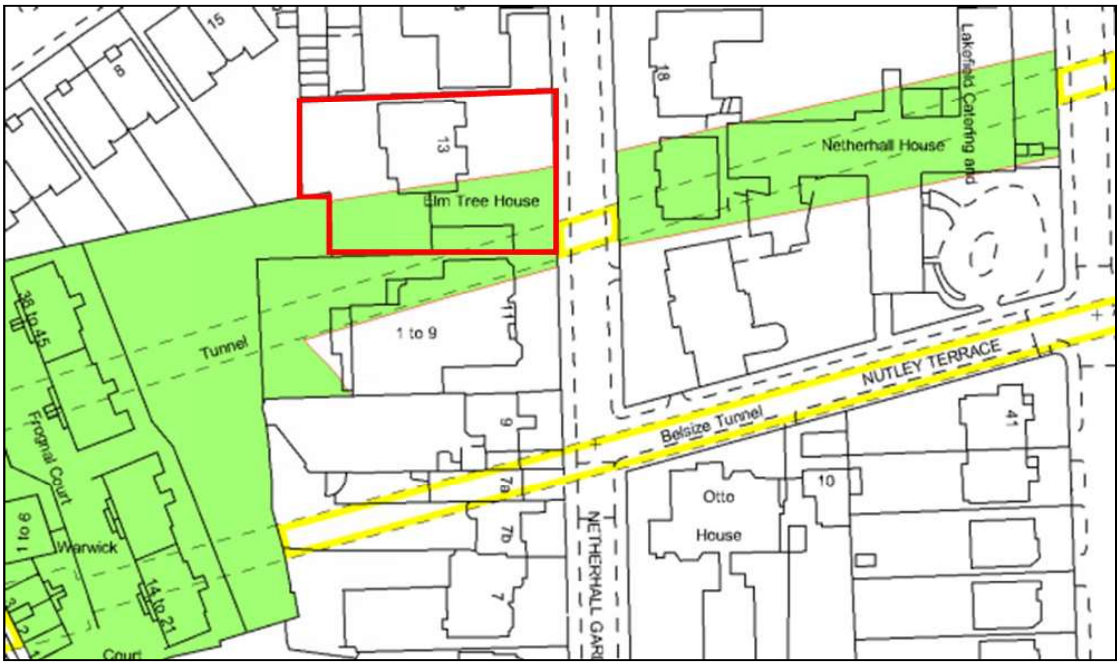
## 1.4 Limitations

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 rectangular in shape measuring about 50 m by 20 m and is located approximately 200 m east of Finchley Road & Frognal Station. It fronts onto Netherhall Gardens to the east and is bounded by No 11 Netherhall Gardens a three-storey apartment building to the south, No 15 Netherhall Gardens a five-storey apartment building to the north and rear gardens to the west. The Belsize New Tunnel runs in a roughly west-east alignment adjacent to the southern boundary of the site at an assumed depth of 15.0 m. The exclusion zone encroaches into the southern part of the site, as shown on the plans below. The site may also be located by National Grid Reference 526310, 184970.




A walkover of the site was carried out by a geotechnical engineer from GEA at the time of the fieldwork. The site is occupied by a three-storey house and associated front and rear gardens. The front of the site, which includes the front garden and existing house, is essentially level at about 72 m OD, whilst the rear garden dips down to the west to about 69 m OD and at an angle of about 12°. The wider environment dips slightly to the south at about 2°.

The front garden mainly comprises a gravel carriage drive onto Netherhall Gardens at a level of about 72.2 m OD, as well as dense overgrown foliage including three semi-mature deciduous trees. The centre of the site is occupied by the original part-three-storey, part four-storey house, and a single storey extension is present on its southern elevation. The existing lower ground floor level only covers part of the full footprint of the house, hence the part four-storey section. At about 68.7 m OD lower ground floor is approximately 1.0 m lower than the rear garden level and about 3.5 m lower than street level. The house is in a dilapidated state with significant cracking, especially towards its rear, in addition to ceiling beams and floors tilting toward the south. The rear garden generally slopes downward from 72.0 m OD to 69.1 m OD toward the west and locally to 68.8 m OD toward the north, and is densely vegetated with a number of immature to mature deciduous trees and general vegetation.

An old World War II Anderson shelter is present toward the western boundary of the site. Correspondence with the Client and discussion with the onsite contractor has indicated that Japanese Knotweed is present within some areas of the rear garden.

### 2.1.1 Neighbouring Structures

A search of the Camden Planning Portal indicates that No 11 (Samara Mansions) is founded on a raft foundation approximately 2.8 m below ground level at an elevation of 69.7 m OD. There are no records of a basement being constructed at Imperial Towers, however, observations made on site indicate the founding level to be similar to that of No.13 Netherhall Gardens lower ground floor level. The northern retaining wall was investigated as part of the site work and its founding level discussed in Section 6.5 of this report. There are no records of a basement constructed at No 22-27 Netherhall Way, however, OS map contours indicate ground level at about 65 m OD and so this has been taken as a conservative estimate of founding level.

The New Belsize Tunnel is located beneath the southern boundary of the site. Its exact construction type and location is unknown but discussions with the consulting Architect and reference to drawings held in house as supplied by Network Rail for previous projects in the area suggest the tunnel crown to be at a depth of approximately 15.0 m (57.2 m OD), and the tunnel to be 7.4 m in diameter.

## 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 1871, shows the site to have been undeveloped. The Belsize Tunnel was present on its existing alignment about 50 m to the south, whilst Finchley Road Station and associated railway tunnel was present about 150 m to the north. The next map studied, dated 1896, shows the site and the surrounding area largely in their existing conditions. The New Belsize Tunnel had been built, in addition to the surrounding existing road network and residential buildings. The site was occupied by what appears to be the existing building. Both the site and surrounding area have since remained essentially unchanged, although a small ancillary building is shown to have been present on the southern boundary of the site between 1954 and 2018. However, the ancillary building had been demolished by the time of the fieldwork.

## 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 located within 1 km but an infilled quarry is present 132 m east of the site.

The site is not within an area shown by the Environment Agency to be at risk from flooding from rivers or the sea or surface water and does not lie within any known areas of sensitive land use.

Within 100 m of the site, there are four contemporary trade industries of the site of which only one is still active, a dry cleaners on Frognal Parade, located around 87 m to the south west.

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.

## 2.4 Preliminary UXO Risk Assessment

A Preliminary UXO Risk Assessment has been completed by 1st Line Defence (report ref EP7070-00, dated 9th August 2018), and the report is included in the appendix. The risk assessment has been carried out in accordance with the guidelines provided by CIRIA, which state that the likelihood of encountering and detonating UXO below a site should be assessed along with establishing the consequences that may arise. The first phase comprises a preliminary risk assessment, which should be undertaken at an early stage of the development planning. If such an assessment identifies a high level of risk then a detailed risk assessment should be carried out by a UXO specialist, which will identify an appropriate course of action with regard to risk mitigation.

The report indicates that there were no bomb strikes on site or the surrounding area that caused any significant damage, and concludes that no further action is required with respect to intrusive works.

## 2.5 Geology

The British Geological Survey (BGS) map of the area indicates that the site is underlain by the London Clay Formation from the surface.

A previous GEA investigation, carried out at No 14 Netherhall Gardens, encountered a moderate thickness of made ground, overlying the London Clay. The made ground was found to extend to depths of between 0.40 m and 0.70 m, where proved, and generally comprised brown silty clay with brick, burnt coal, ash and rootlets. The London Clay comprised an upper weathered horizon extending to depths of 9.50 m and 10.00 m. Below this depth unweathered London Clay comprising stiff grey silty fissured clay with rare partings of grey fine sand and silt, was encountered and proved to the full depth of the investigation, of 20.0 m.

## 2.6 Hydrology and Hydrogeology

The London Clay Formation is designated by the Environmental Agency (EA) as an Unproductive Stratum, referring to rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Groundwater was not encountered in the previous GEA investigation but was subsequently measured within standpipes at depths of between 1.25 m and 6.65 m.

A tributary of the River Tyburn[4] flowed in a southerly direction on a north–south alignment parallel to Fitzjohn's Avenue approximately 230 m east of the site, whilst a tributary of the River Westbourne flowed in a southerly direction on the same north-south alignment of Frognal, approximately 60 m northwest of the site.

The site is partly covered by the existing building and partly by vegetation and therefore infiltration of rainwater into the ground beneath the site is highly likely such that the majority of surface runoff is likely to drain into the ground.

## 2.7 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.

### 2.7.1 Source

The desk study findings indicate the site not to have had a potentially contaminative history as the site has apparently been developed with the existing residential building since prior to 1896.

### 2.7.2 Receptor

The proposed redevelopment of the building for residential purposes will result in the end users representing relatively high sensitivity receptors, albeit a continuation of the existing state. Given their residential end use adjacent sites are considered to be a relatively high sensitive receptors, in addition to the deep aquifer. Buried services are also likely to come into contact with any contaminants present within the soils through which they pass and site workers are likely to come into contact with any contaminants present in the soils during construction works.

### 2.7.3 Pathway

Within the site, end users will be isolated from direct contact with any contaminants present within the made ground by the presence of the building. Only in areas of proposed soft landscaping will there conceivably be a pathway by which end users could come into direct contact with any contamination within shallow soils. The essentially impermeable London Clay will limit any potential soluble contaminants migrating onto and off of the site. This could however potentially occur via perched water movements within the made ground, although this is still considered to be a very limited pathway. The presence of the essentially impermeable London Clay also acts as a barrier to the percolation of any contamination down to the Principal Chalk Aquifer at depth.

### 2.7.4 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.

4 Barton, N, & Meyers, S (2016) *The Lost Rivers of London (revised and extended edition with colour maps).* Historical Publications Ltd.

## 3.0 SCREENING

The LBC guidance suggests that any development proposal that includes a basement should be screened to determine whether or not a full BIA is 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 Appendices E1, E2 and E3 which include a series of questions within screening flowcharts for surface flow and flooding, subterranean (groundwater) flow and land stability. The flowchart questions and responses to these questions are tabulated below.

#### 3.1.1 Subterranean (groundwater) Screening Assessment

| Question | Response for 13 Netherhall Gardens |
|---|---|
| 1a. Is the site located directly above an aquifer? | No – the site is underlain by the London Clay which is designated Non Aquifer. |
| 1b. Will the proposed basement extend beneath the water table surface? | No – the London Clay is a Non Aquifer comprising cohesive clay and as such cannot support any significant groundwater flow or therefore a water table. |
| 2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line? | *Yes – A tributary of the River Westbourne ran approximately 100 m northwest of he site before it was incorporated into the surface water sewage system.* |
| 3. Is the site within the catchment of the pond chains on Hampstead Heath? | No – the site lies over 1.2 km south of the Hampstead Heath pond chain. |
| 4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas? | The proposal is to refurbish the existing building and construct a single storey basement beneath. Therefore it is not envisaged that the proposed basement development would result in a change to the proportion of hard surfaced or paved areas. |
| 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)? | The London Clay, which underlies the site, is unsuitable for the design of soakaways or similar SUDS drainage solutions therefore no more surface water would be discharged to the ground as part of the development. |
| 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 – the proposal is for a single level basement within the London Clay Non Aquifer which cannot support significant groundwater flow and there are no local ponds or spring lines within 500m of the site. |

A tributary of the River Westbourne was located 100 m northwest of the site.

#### 3.1.2 Stability Screening Assessment

| Question | Response for 13 Netherhall Gardens |
|---|---|
| 1. Does the existing site include slopes, natural or manmade, greater than 7°? | *Yes – the rear garden contain localised slopes that dip away from the proposed basement excavation toward the northwest at angles of between 11° and 13°. These slopes are supported at their toe by the retaining wall bounding the site.* |
| 2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°? | No – according to proposed development drawings regrading of the site will result in slopes being less than 7° |
| 3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°? | No – not according to Figure 16 of the Arup report or OS maps of the area |
| 4. Is the site within a wider hillside setting in which the general slope is greater than 7°? | No – not according to Figure 16 of the Arup report, OS maps of the area or the topographical survey of the site. |

| Question | Response for 13 Netherhall Gardens |
|---|---|
| 5. Is the London Clay the shallowest strata at the site? | *Yes – according to Figure 3 of the Arup report and the BGS map of the area* |
| 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? | *Yes – the current proposed plans show the basement footprint to extend over the footprint of trees G16 to G18, as shown in the supplied Aboricultural report, which suggests these trees will need to be removed.* |
| 7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site? | *Yes – according to the Envirocheck report the site is at high risk to potential shrink-swell ground movements on account of the underlying London Clay. Furthermore, structural damage of the existing property suggests ground movement indicative that associated with the presence of trees.* |
| 8. Is the site within 100 m of a watercourse or potential spring line? | *Yes – according to the Lost Rivers of London book and Figure 11 of the Arup report a tributary of the River Westbourne flowed in a southerly direction approximately 100 m to the northwest of the site.* |
| 9. Is the site within an area of previously worked ground? | No – not according to Figure 3 of the Arup report |
| 10a. Is the site within an aquifer? | No – not according to Figure 8 of the Arup report |
| 10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction? | No – the London Clay is incapable of supporting a continuous groundwater table. |
| 11. Is the site within 50 m of Hampstead Heath ponds? | No – not according to Figure 14 of the Arup report |
| 12. Is the site within 5 m of a highway or pedestrian right of way? | *Yes – the site is bounded by Netherhall Gardens to the east* |
| 13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties? | *Yes – the proposed basement level of about 64.5 mOD will result in foundation level being lower than the neighbouring buildings* |
| 14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines? | *Yes – runs in a roughly west-east alignment adjacent to the southern boundary of the site at an assumed depth of 15.0 m. The exclusion zone encroaches into the southern part of the site* |

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

Q1 The rear garden contains a localised slope angle of 11° and 13°
Q5 The London Clay is the shallowest strata
Q6 Trees G16 to G18 will likely need to be removed as part of the proposed development
Q7 The site is at risk to shrink-swell related movements and there has been evidence of such observed on site
Q8 A tributary of the River Westbourne was located 100 m northwest of the site
Q12 Netherhall Gardens bounds the east of the site
Q13 Proposed foundation level will increase the differential foundation depth to neighbouring structures
Q14 The exclusion zone of the New Belsize Tunnel encroaches into the southern part of the site

### 3.1.3 Surface Flow and Flooding Screening Assessment

| Question | Response for 157 York Way |
|---|---|
| 1. Is the site within the catchment of the pond chains on Hampstead Heath? | No. Figure 14 of the Arup report 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 not be an increase in impermeable area across the ground surface above the basement, so the surface water flow regime will be unchanged.<br><br>The basement will entirely be beneath the footprint of the building, therefore the 1m distance between the roof of the basement and ground surface as recommended by the Arup report and para 2.16 of the CPG4 does not apply. |
| 3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas? | No. There will not be an increase in impermeable area across the ground surface above the basement or the site as a whole. |
| 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 not be an increase in impermeable area across the ground surface above the basement, so the surface water flow regime will be unchanged.<br><br>The basement will entirely be beneath the footprint of the building, therefore the 1m distance between the roof of the basement and ground surface as recommended by the Arup report and para 2.16 of the CPG4 does not apply. |
| 5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses? | No. The proposed basement is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses as the surface water drainage regime will be unchanged and the land uses will remain the same. |
| 6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level of nearby surface water feature? | No.<br><br>The findings of this BIA together with the Camden Flood Risk Management Strategy dated 2013, and Figures 3v, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a very low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses.<br><br>In accordance with paragraph 5.11 of the CPG a positive pumped device will be installed in the basement in order to further protect the site from sewer flooding. |

The above assessment has identified no potential issues that need to be assessed.

# 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.

## 4.1 Potential Impacts

The following potential impacts have been identified by the screening process

| Potential Impact | Consequence |
|---|---|
| The rear garden contains localised slopes of greater than 7°. | Local slope instability could result in damage to the proposed and neighbouring properties |
| The site is underlain by the London Clay and observations of damage indicative of shrink swell movements have been observed. Trees are also likely to be removed. | Ground movements relating to shrink swell could result in damage to the proposed property |
| A tributary of the River Westbourne was located 60 m northwest of the site. | The presence of the tributary could result in unexpected ground conditions |
| The site is located within 5 m of a highway or pedestrian right of way | The proposed development could result in ground movements that would affect the stability of the nearby public right of way |
| The proposed development will result in an increase to differential foundation depth to neighbouring properties. | Ground movements related to the proposed development could result in damage to the neighbouring structures |
| The exclusion zone to the New Belsize Tunnel encroaches into the southern part of the site | Ground movements related to the proposed development could result in damage to the underlying tunnel |

These potential impacts have been investigated through the site investigation, as detailed in Section 10.0.

# 5.0 EXPLORATORY WORK

In order to meet the objectives described in Section 1.2, two boreholes were advanced, to depths of 20.0 m and 30.0 m using a dismantlable cable percussion rig. Additionally, 11 trial pits were excavated by the on-site contractor, using combined machine and manual methods to a maximum depth of 3.3 m to expose the existing foundations and these were logged by an engineer from GEA. The drilling of Borehole No 2 was supervised by a Japanese Knotweed contractor in order to prevent the spread of the plant.

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. Under the instruction of the contractor, samples were not collected from the top 3.0 m of Borehole No 2.

Groundwater monitoring standpipes were installed to a depth of 6.0 m in each of the boreholes to facilitate groundwater monitoring, which has been carried out on a single occasion, approximately three weeks after installation.

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.

The borehole and trial pit records and results of the laboratory testing are appended, together with a site plan indicating the exploratory positions. The Ordnance Datum (OD) levels shown on the borehole and trial pit records have been interpolated from spot heights shown on a topographical survey drawing provided by the consulting engineers (ref 11845-TOPO-001, dated April 2018).

Originally, four open-drive window sample boreholes were to be included within the scope of works in order to provide additional coverage of the site. However, due to the presence of the Network Rail exclusion zone over the southern half of the site, these were postponed and will be completed following approval from Network Rail, which is understood to be in hand.

### 5.1 Sampling Strategy

The trial pit and borehole locations were agreed with the consulting Architects, Re-Creo, in an initial site meeting with GEA.

Four samples of the made ground have been tested for the presence of contamination. The analytical suite of testing was selected to identify a range of typical industrial contaminants for the purposes of general coverage. 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. All samples were also inspected for the presence of asbestos fibres.

The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. A summary of the MCERTs accreditation and test methods are included with the attached results and further details are available upon request.

No samples were recovered from the rear trial pits and borehole on account of the presence of the Japanese Knotweed.

## 6.0 GROUND CONDITIONS

The investigation has generally confirmed the expected ground conditions in that, beneath a moderate thickness of made ground the London Clay Formation was encountered to the full depth of the investigation, of 30.0 m.

### 6.1 Made Ground

The made ground comprised brown silty sandy gravelly clay with fragments of coal, ash, brick, chalk, tarmac, pottery and flint and typically extended to a depth of around 1.4 m. Within some of the trial pits the made ground extended to depths of between 2.0 m and 2.6 m.

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 of the made ground has however been analysed for a range of contaminants as a precautionary measure and the results are detailed within Section 6.4.

### 6.2 London Clay

The London Clay comprised an initial horizon of high strength firm becoming stiff fissured orange-brown mottled grey silty clay with occasional fragments of decaying carbon, occasional partings of fine sand and selenite crystals and rare fine gravel sized clasts of pyrite that extended to depths of between 11.3 m and 11.7 m.

Below this layer, the London Clay became high strength becoming very high strength stiff becoming very stiff fissured dark grey silty clay with occasional infilled bioturbations, occasional partings of fine sand and selenite crystals, and rare gravel sized clasts of pyrite, that extended to the full depth of the investigation of 30.0 m.

The London Clay was noted to be sandier in Borehole No 2 than in Borehole No 1.

The results of plasticity index tests indicate the clay to be of high volume change potential, and the results of quick undrained triaxial compression tests indicate the clay to be of high strength.

## 6.3 Groundwater

Groundwater was not encountered during drilling and both standpipes were monitored as dry approximately three weeks after installation.

The trial pits were excavated by the building contractor on site and were reported as dry during excavation. However, in order for the pits to be logged the trial pits were left open for two days and water was found to be present, the details of which can be seen on the logs in the appendix.

## 6.4 Soil Contamination

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

| Determinant | BH1 0.30 m | TP2 0.3 m | TP1 0.3 m | TP7 0.3 m |
|---|---|---|---|---|
| pH | 7.6 | 8.3 | 8.2 | 8.4 |
| Asbestos | Loose chrysotile fibres | Loose Amosite fibres | Undetected | Loose chrysotile fibres |
| Arsenic | 20 | 27 | 20 | 22 |
| Cadmium | 0.8 | 1.0 | <0.2 | <0.2 |
| Chromium | 26 | 31 | 38 | 37 |
| Lead | **520** | **1300** | **1000** | **810** |
| Mercury | <0.3 | <0.3 | <0.3 | <0.3 |
| Selenium | <1.0 | <1.0 | <1.0 | <1.0 |
| Copper | 48 | 64 | 52 | 59 |
| Nickel | 25 | 34 | 23 | 27 |
| Zinc | 330 | 370 | 300 | 330 |
| Total Cyanide | <1 | <1 | <1 | <1 |
| Total Phenols | <1 | <1 | <1 | <1 |
| Total PAH | **118.0** | **65.0** | 41.9 | **153.0** |
| Sulphide | <1.0 | 1.9 | 4.2 | 3.9 |
| Benzo(a)pyrene | **12** | **6.2** | **4.1** | **12** |
| Naphthalene | <0.05 | <0.05 | <0.05 | <0.05 |

| Determinant | BH1 0.30 m | TP2 0.3 m | TP1 0.3 m | TP7 0.3 m |
|---|---|---|---|---|
| TPH | **1500** | 360 | 260 | 840 |
| Total Organic Carbon % | 2.7 | 1.4 | 1.4 | 1.6 |
| Figures in **bold** indicate values in excess of the assumed generic screening values for a residential end use with plant uptake | | | | |

All of the samples tested contained elevated concentrations of lead, whilst three of the samples contained elevated concentrations of Polyaromatic Hydrocarbons (PAH). A single sample contained elevated Total Petroleum Hydrocarbon, although when speciated, the concentrations of the individual hydrocarbon chains were below the threshold limits. Three of the samples were found to contain loose asbestos fibres.

### 6.4.1 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. Contaminants of concern are those that have values in excess of generic human health risk based guideline values which are the CLEA[5] Soil Guideline Values where available, or Generic Screening Values calculated using the CLEA UK Version 1.06[6] software assuming a residential end use with plant uptake, or are based on the DEFRA Category 4 Screening values[7]. 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, consumption of home grown produce, consumption of soil adhering to home grow produce, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a three-storey semi-detached 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.

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;

5 *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.
6 Contaminated Land Exposure Assessment (CLEA) Software Version 1.06 Environment Agency 2009
7 CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

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

## 6.5 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 | Southern elevation near bay window | Concrete underpin<br>Top 0.70 m<br>Base 1.40 m<br>Lateral projection 1.10 m to 2.15 m | Firm orange- brown mottled grey silty CLAY |
| 2 | Eastern elevation near bay window | Concrete Strip Footing<br>Top 1.30 m<br>Base 1.65 m<br>Lateral projection 0.20 m | Firm orange- brown mottled grey silty CLAY |
| 3 | Western elevation | Concrete underpin<br>Top 2.00 m<br>Base 2.10 m<br>Lateral projection 0.80 m | Firm orange- brown mottled grey silty CLAY |
| 4 | Western elevation near lightwell | Concrete Strip Footing<br>Top approx. 1.60 m<br>Base 2.00 m<br>Lateral projection 0.80 m | Firm orange- brown mottled grey silty CLAY |
| 5 | Northern retaining wall | Concrete Strip Footing<br>Top 2.60 m<br>Base 3.30 m<br>Lateral projection 0.35 m | Firm orange- brown mottled grey silty CLAY |
| 6 | Northern retaining wall | Concrete Strip Footing<br>Top 2.60 m<br>Base 3.30 m<br>Lateral projection 0.35 m | Firm orange- brown mottled grey silty CLAY |
| 7 | Northern elevation | Inconclusive – concrete obstruction at 1.40 m | Unknown |
| 8 | Internal wall | Concrete strip footing – possibly underpinned<br>Top 0.65 m to 0.95 m<br>Base Unknown<br>Lateral projection >0.65 m | Unknown – limited access restricted pit size |
| 9 | Internal western elevation | Brick corbels over concrete footing<br>Top 1.20 m<br>Base 2.00 m<br>Lateral projection 0.30 m | Made ground (brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery and chalk).<br><br>Groundwater present at 1.75 m |

| Trial Pit No | Structure | Foundation detail | Bearing Stratum |
|---|---|---|---|
| **10** | Internal basement wall | Brick corbels over concrete footing<br>Top 0.40 m<br>Base 1.10 m<br>Lateral projection 0.30 m | Made ground (brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery and chalk).<br><br>Groundwater present at 0.55 m |
| **11** | Internal northern elevation at basement level | Brick corbels over concrete footing<br>Top 0.12 m<br>Base 1.25 m<br>Lateral projection 0.90 m | Made ground (brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery and chalk).<br><br>Groundwater present at 1.25 m |

# 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 proposed development.

## 7.0 INTRODUCTION

It is understood that it is proposed to refurbish the existing building, extend the existing lower ground floor to the south and east, and construct a single level basement beneath part of the existing building footprint and into the existing rear garden.

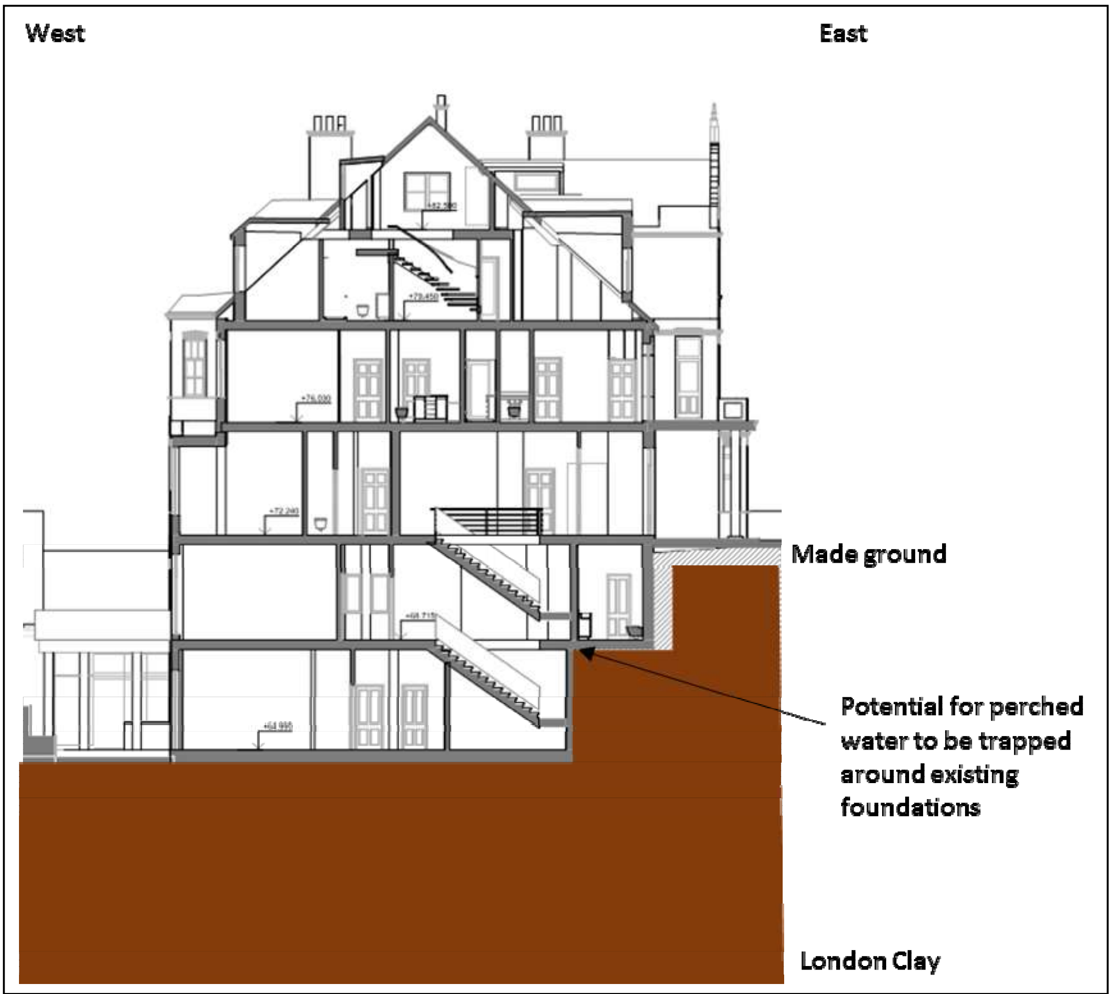
## 8.0 GROUND MODEL

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 since prior to 1896, and on the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- below a moderate thickness of made ground, the London Clay is present and extended to the maximum depth of the investigation, of 30.00 m;
- the made ground comprises brown silty sandy gravelly clay with fragments of coal, ash, brick, chalk, pottery and flint and typically extends to a depth of around 1.40 m. Within some of the trial pits the made ground extends to depths of between 2.00 m and 2.60 m;
- the London Clay comprises an initial horizon of high strength firm becoming stiff fissured orange-brown mottled grey silty clay with occasional fragments of decaying carbon, occasional partings of fine sand and selenite crystals and rare fine gravel sized clasts of pyrite that extends to depths of between 11.30 m and 11.70 m.
- below the initial layer, the London Clay became high strength becoming very high strength stiff becoming very stiff fissured dark grey silty clay with occasional infilled bioturbations, occasional partings of fine sand and selenite crystals, and rare gravel sized clasts of pyrite, that extends to the full depth of the investigation of 30.00 m.
- the London Clay was noted to be sandier in Borehole No 2 than in Borehole No 1;
- groundwater is not present as a continuous water body across site but is present around some of the foundations of the existing building; and
- the made ground contains elevated concentrations of lead, PAH and TPH, as well as fibres of Chrysotile and Amosite asbestos.

## 8.1 Conceptual Site Model

A section through the proposed scheme with the above ground model is shown below.




## 8.2 Recommended Parameters

The table overleaf summarises the vertical soil parameters to be used in any subsequent analysis and is based on the findings of the investigation. Values of stiffness for the soils at this site have been derived from the insitu and laboratory test data, which indicate a design line for the London Clay of 55+5z. All depths are given relative to existing ground level.

| Stratum | Base of Stratum (m) [m OD] | Bulk Unit Weight (kN/m$^3$) | Effective Friction Angle ($\varphi'$ °) | Undrained Cohesion ($C_u$ - kN/m$^2$) | Drained Young's Modulus** ($E'$ - kN/m$^2$) | Undrained Young's Modulus** ($E_u$ - kN/m$^2$) |
|---|---|---|---|---|---|---|
| Made Ground | 2.0 (varies) [~70 m OD] | 17 | 22 | 20 | 7500 | 10000 |
| London Clay | 73.0* [~-1.0 m OD] | 20 | 24 | 50 to 420 | 28125 to 236250 | 37500 to 315000 |

*Assumed depth taken from nearby BGS borehole data **Values[8] based on the conservative relationship of $E_u$ = 750 $C_u$ and E' = 0.75 $E_u$,.

[8] Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension* CIRIA Special Publication 200

# 9.0 ADVICE AND RECOMMENDATIONS

It is assumed that the new lower ground floor extension will extend to a depth of 3.50 m (68.80 m OD), whilst the basement excavation will extend to depths of between 4.00 m and 6.00 m (64.50 m OD). Formation level for the proposed basement should therefore be within the firm becoming stiff silty clay of the London Clay. On the basis of the fieldwork and subsequent monitoring, groundwater is unlikely to be encountered within the basement excavation.

The trial pit records indicate that many of the existing foundations have previously undergone some form of underpinning. Given the dilapidated condition of the existing house and the evidence of foundation movements it is recommended that those foundations that aren't already being lowered through the lower ground floor extension and basement construction, be lowered to more suitable bearing stratum where required and in accordance with NHBC guidelines. The trial pit records indicate that the majority of the internal walls are supported on foundations bearing onto made ground and it is recommended these be underpinned to bear into the firm silty clay of the London Clay.

## 9.1 Basement Construction

Formation level for the lower ground floor extension and basement is likely to be within the firm silty clay of the London Clay at a depth of 3.50 m (68.8 m OD) and between 4.00 m and 6.00 m (64.50 m OD), respectively. Significant inflows of groundwater were not encountered during drilling and groundwater monitoring has subsequently recorded the standpipes as dry; on this basis inflows of groundwater are unlikely to be encountered within the basement excavation, although monitoring of the standpipes should be continued to confirm the groundwater level. Shallow inflows of perched water may also be encountered from within the made ground and ideally a number of trial excavations should be carried out, to depths as close to the full basement depth as possible, to provide an indication of stability and the extent of any potential groundwater inflows.

The design of lower ground floor and basement support in the temporary and permanent conditions needs to take account of the necessity to maintain the stability of the surrounding structures and the possible requirement to control groundwater inflows.

There are a number of methods by which the sides of the lower ground floor extensions and basement excavation could be supported in the temporary and permanent conditions. The choice of wall may be governed to a large extent by whether it is to be incorporated into the permanent works and have a load bearing function. It is understood that the preferred option for the formation of new retaining walls combines the use of traditional underpins, formed in a typical 'hit and miss' sequence with sections of contiguous bored pile wall. This combination is considered appropriate in these ground conditions. The middle section of the proposed basement wall that extends into the rear garden is likely to be formed through open-cut excavation.

A full construction sequence will need to be developed at a later date during detailed design, but at this stage it is considered that an open cut excavation could be sequenced from the crest of the localised garden slope to the toe, with appropriate propping where necessary. In situ retaining walls should be constructed within the excavation and the area behind the walls backfilled on completion. Suitable angles for the battered sides of the excavation are expected to be approximately 25° for the made ground and whilst it is possible that a slope angle of 1 (vertical) to ½ (horizontal) could be adopted for the London Clay, the presence of nearby ancillary structures is likely to make an angle of 1 in 2 more acceptable, unless the slope face is strutted. It would be prudent to excavate a number of trial pits to obtain a better idea of the stability of the underlying London Clay. Care should be taken to protect the sides of any unsupported cut slopes during periods of rainfall and any run-off from construction operations until the retaining walls have been installed. Movement of plant at the top of any open cut should be prevented and daily inspections of the cut faces should be carried out to check stability.

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 movements has been carried out and is discussed in Part 3 of this report.

### 9.1.1 Basement 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 ($\phi'$ – degrees) |
|---|---|---|---|
| Made ground | 1800 | Zero | 27 |
| London Clay | 1950 | Zero | 24 |

Monitoring of the standpipe should be continued to assess the design water level but at this stage it would appear that groundwater may be assumed to be below basement level; the advice in BS8102:2009[9] should also be followed in this respect.

### 9.1.2 Basement Heave

The 3.5 m deep excavation of the lower ground floor will result in a net unloading of around 65 $kN/m^2$, whilst the 4.0 m to 6.0 m deep excavation will result in a net unloading of between 80 $kN/m^2$ and 120 $kN/m^2$ and result in heave of the underlying London Clay. This will comprise immediate elastic movement, which will account for approximately 40 % of the total movement and be expected to be complete during the construction period, and long term movements, which will theoretically take many years to complete. These movements will, to some extent, be mitigated by the loads applied by the proposed development, but the ground movements associated with the proposed basement excavation and construction have been considered in more detail in Part 3 of this report.

## 9.2 Spread foundations

### 9.2.1 Underpins

Typical width underpins bearing at a depth of approximately 4.0 m level may be designed to apply a net allowable bearing pressure of 150 $kN/m^2$. This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlements remain within normal tolerable limits.

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

### 9.2.2 Existing Foundations

The existing foundations that are not scheduled to be underpinned should be deepened to depths determined by reference to NHBC guidelines due to the presence of the existing trees. Where trees are to be removed the required founding depth should be determined on the basis of the existing tree height if it is less than 50% of the mature height and on the basis of full mature height if the current height is more than 50% of the mature height. Where a tree is to be retained the final mature height should be adopted. 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 the trees. It is anticipated that foundations bearing on the London Clay at a depth of about 2.5 m below ground level may be designed to apply a net allowable bearing pressure of 150 $kN/m^2$. This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlements remain within normal tolerable limits.

The London Clay was not noted to be desiccated on site and the laboratory test are inconclusive. In any case and as mentioned above, foundation depths will need to be determined by NHBC guidelines. If trees are to be planted in close proximity to the existing building, founding depths should be deepened in accordance with NHBC guidelines and using the mature height of the tree. High shrinkability clay should be assumed.

It would be prudent to have all foundation excavations inspected by a suitably experienced engineer.

## 9.3 Piled Foundations

For the ground conditions at this site either a driven or bored pile could be adopted, although the noise and vibrations associated with the installation of driven piles is likely to render them unacceptable. A conventional rotary augered pile could be utilised but consideration will need to be given to the possible instability and water ingress within the made ground. The use of bored piles installed using continuous flight auger (cfa) techniques may therefore be the most appropriate.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, based on the SPT and cohesion / depth graph in the appendix.

| Stratum | Depths m | $kN / m^2$ |
|---|---|---|
| Ultimate Skin Friction | | |
| Made ground and Basement excavation | GL to 6.0 | Ignore |
| London Clay ($\alpha = 0.5$) | 6.0 to 30.0 | Increasing linearly from 40 to 110 |
| Ultimate End Bearing | | |
| London Clay | 15.00 to 30.00 | Increasing linearly from 1170 to 1980 |

In the absence of pile tests, guidance from the London District Surveyors Association (LDSA)[10] suggests that a factor of safety of 2.6 should be applied to the above coefficients in the computation of safe theoretical working loads. On the basis of the above coefficients the following pile capacities have been estimated.

10 LDSA (2009) *Foundations No 1 – Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA

| Pile diameter mm | Depth Below Basement Level m | Safe Working Load kN |
|---|---|---|
| 300 | 9 | 200 |
| | 14 | 320 |
| | 19 | 485 |
| | 24 | 670 |

The above example is 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. In the design of piled foundations, the effect of potential future shrinkage and swelling of the clay should be taken into account. In designing for compressive loads it should be assumed that further desiccation, and hence shrinkage of the clay, could continue where trees are to remain. Pile shaft adhesion within the theoretical maximum future desiccated thickness should therefore be ignored.

Heave of the clay soils could also occur due to future swelling as a result of trees being removed. This would exert a tensile uplift force on the piles, unless piles are effectively isolated from the surrounding soil by means of a slip layer or sleeve around the pile shaft.

On completion of construction the uplift forces would, to some extent, be counteracted by the applied loads. However, since the full structural loads may well be less than the potential uplift forces the piles would, in the absence of sleeving, need to be sufficiently "anchored" below the desiccated zone to withstand the uplift forces. Adequate reinforcement would need to be provided to accommodate the resulting tension.

Specialist piling contractors should be consulted with regard to the design of a suitable piling scheme and their attention should be drawn to potential groundwater inflows and instability within the made ground, as well as the presence of silt layers and claystones within the London Clay.

Some restrictions on the use of piles are likely to apply due the proximity of the site to the nearby Network Rail tunnel, which should be confirmed through further consultation with the relevant asset protection team

## 9.4 Shallow Excavations

On the basis of the borehole findings it is considered that it will be generally feasible to form relatively shallow excavations terminating within the made ground or London Clay without the requirement for lateral support, although localised instabilities may occur where more granular material or groundwater is encountered.

Significant inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the made ground, although such inflows should be suitably controlled by sump pumping.

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.

## 9.5 Effect of Sulphates

Chemical analyses has revealed relatively low concentrations of soluble sulphate and near-neutral pH in accordance with Class DS-2 conditions of Table C2 of BRE Special Digest 1:SD Third Edition (2005). The measured pH values of the samples show that an ACEC class of AC-1s would be appropriate for the site. This assumes a static water condition at the site. The guidelines contained in the digest should be followed in the design of foundation concrete.

## 9.6 Contamination Risk Assessment

The desk study findings indicate the site not to have had a potentially contaminative history as the site has apparently been developed with the existing house since prior to 1896. The results of the chemical analyses have indicated elevated concentrations of lead, Polyaromatic Hydrocarbon (PAH) and Total Petroleum Hydrocarbon (TPH). In addition, loose fibres of Chrysotile and Amosite were identified in three of the four samples tested.

The sources of the high concentrations of lead, PAH and TPH are unknown but the made ground was noted as containing fragments of extraneous material and it is possible that fragments of such material, for example, coal, ash or old paint fragments, could account for the elevated concentrations. Furthermore, comparison of the ratios of fluoranthene to pyrene and phenanthrene to anthracene indicate the high concentrations to be typical of made ground containing part burnt coal and pre-war tarmac. It is therefore considered likely that fragments of such material within the made ground account for the concentrations. As a result, the contamination within the made ground is not considered to be in a soluble form and does not, therefore, pose a risk to adjacent sites, groundwater or buried services.

The elevated concentrations of lead, TPH and PAH, and the presence of asbestos fibres will pose a risk to end users and site workers.

End users would only be at risk in areas of soft landscaping, as the presence of the proposed buildings and surrounding areas of hardstanding will form a physical barrier between end users and the made ground. Whilst there may be some benefit in carrying out further testing in order to determine the extent of the contamination to the rear of the site. Given that the majority of the samples tested contained a degree of contamination, it is unlikely that samples obtained from the remaining made ground, which was of similar composition, would differ from those samples tested. Therefore, at this stage it is recommended that in order to protect end users, a clean fill cover system be adopted. The scheme should involve a marker membrane installed on top of any existing made ground and a cover thickness of imported subsoil and topsoil of 600 mm, specified to ensure successful plant growth in accordance with recommendations from the BRE. Any topsoil brought on to site will need to be certified as ‘clean’ with the appropriate documentation and must be classified as a topsoil in accordance with BS3882:2007. Upon completion of the installation of the topsoil, inspection and validation testing should be carried out by a suitably qualified Engineer, who will need to provide certification and photographic evidence of the installation. These will be provided to the Local Authority by way of a validation completion report.

### 9.6.1 Site Workers

Apart from the physical hazards represented by the fill materials, concentrations of potentially carcinogenic lead and mutagenic hydrocarbons have been measured in the made ground, in addition to asbestos fibres. 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[11] and the requirements of the Local Authority Environmental Health Officer. Care should be taken when moving the soil in order to prevent the disturbance and release of the asbestos fibres into the air. A specialist asbestos contractor should be appointed in order to input into the safe programme of working, which may comprise mitigation measures such as damping down the soil, air dust monitoring and handpicking / segregation.

## 9.7 Waste Disposal

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 classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3[12] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[13] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £94.15 per tonne (about £170 per $m^3$) or at the lower rate of £3.00 per tonne (roughly £6 per $m^3$). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the EA it is considered likely that the soils encountered during this ground investigation, as represented by the chemical analyses carried out, would be generally classified as follows;

| Soil Type | Waste Classification (Waste Code) | WAC Testing Required Prior to Landfill Disposal? | Current applicable rate of Landfill Tax |
|---|---|---|---|
| Made ground | Hazardous (17 05 04) | Possibly – check with receiving landfill | £94.15/tonne (Standard rate) |
| London Clay | Inert (17 05 04) | Should not be required but confirm with receiving landfill | £3.00 / tonne (Reduced rate for uncontaminated naturally occurring rocks and soils) |

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

11 CIRIA (1996) *A guide for safe working on contaminated sites* - Report 132, Construction Industry Research and Information Association
12 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition
13 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2

Environment Agency has issued a position paper[14] 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 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 (EA) 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.

14 Environment Agency 23 Oct 2007 *Regulatory Position Statement Treating non-hazardous waste for landfill - Enforcing the new requirement*

# Part 3: GROUND MOVEMENT ANALYSIS

This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme discussed in Part 2 and the information obtained from the investigation, presented in Part 1 of the report.

## 10.0 INTRODUCTION

The sides of an excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed during underpinning and the efficiency or stiffness of any support structures used.

An analysis has been carried out of the likely movements arising from the proposed excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

### 10.1 Ground Movements

An assessment of ground movements within and surrounding the excavation has been undertaken using the X-Disp and P-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The analysis of potential ground movements within the excavation, as a result of unloading of the underlying soils, has been carried out using the Oasys P-Disp (Version 19.4 – Build 12) software package and is based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains.

The X-Disp program (Version 20.0) has been used to predict ground movements likely to arise from the construction of the proposed basement. This includes the settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement).

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction parallel with the orientation east-west, whilst the y-direction is parallel with the orientation of north-south and have been taken from a survey drawing (ref. Site Plan with Proposed Basement, issued 07/11/2018) which was provided by the consulting structural engineer. Vertical movement is in the z-direction. Wall lengths of less than 10 m have been modelled as 1 m long structural elements, while walls greater than 10 m in length have been modelled as 2 m elements to reflect their greater stiffness.

The full outputs of all the analyses can be provided on request, but samples of the output movement contour plots are included within the appendix.

#### 10.1.1 Construction Sequence

For the purposes of the ground movement assessment, ground level has been taken as the existing ground floor level, at an elevation of 72.2 m OD. It is proposed to extend the existing lower ground floor level to 68.8 m OD beneath the eastern and southern part of the property, whilst constructing a basement level beneath most of the new lower ground floor footprint and beneath part of the existing rear garden to a depth of 64.5 m OD. It is understood that the proposed basement walls will be constructed through a combination of standard underpinning and sections of contiguous bored pile wall.

In general, the sequence of works for basement construction will comprise the following stages.

1. construct piled and underpinned retaining walls. These are commonly formed in a 'hit and miss' sequence using a trench box excavation, commonly sheet lined, shored and strutted; all temporary shoring and propping to be inspected by a suitably qualified person;

2. excavate new lower ground floor level and temporarily retain and strengthen, with sufficient propping and walling beams, the new retaining walls. Construct new floor slab; and

3. construct underpinned retaining walls for new basement level through same process as point 1. Excavate new basement level and temporarily retain and strengthen, with sufficient propping and walling beams, the new retaining walls. Construct new basement slab.

The underpins will be adequately laterally propped and sufficiently dowelled together, and the concrete will be cast and adequately cured prior to excavation of the lower ground floor and basement. Similarly, piles will be installed, and the capping beam cast and allowed to cure prior to excavation and the removal of the formwork and supports. It is assumed that the corners of the excavation will be locally stiffened by cross-bracing or similar and that the new retaining walls will not be cantilevered at any stage during the construction process.

The detail of the support provided to adjacent walls is beyond the scope of this report at this stage and the structural engineer will be best placed to agree a methodology with the underpinning contractor once appointed.

The relatively small diameter piles will be constructed using small piling rigs using either case-and-auger or continuous flight auger (CFA) methods. A formal design will be undertaken when a piling contractor has been appointed but at this stage it has been assumed that an embedded length of 4.5 m is reasonable for the temporary multi-propped piled walls. Assuming a ground level of 71.6 m OD and an excavation of 7.1 m (formation level of 64.5 m OD) then a pile length of 11.6 m and a toe level of 60.0 m OD represents a conservative assessment.

When the final excavation depths have been reached, the permanent works will be formed, which are likely to comprise reinforced concrete walls with a drained cavity lining the inside of the underpinned walls. Reinforced concrete will be used for the floor slabs and it is anticipated that heave protection may be installed beneath the basement slab. Following this, the floor slab will be constructed at basement depth and the temporary props will be removed.

### 10.1.2 P-Disp Model

At this site, unloading of the underlying London Clay will take place as a result of the excavation of the lower ground floor and basement, such that the reduction in vertical stress in the short term will cause heave to take place. Undrained soil parameters have been used to estimate the potential short-term movements, which include the "immediate" or elastic movements as a result of the basement excavation. The model is based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains. Drained parameters have been used to provide an estimate of the total movement, which includes long term swelling that will continue for a number of years.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. This relates values of $E_u$ and E', the undrained and drained stiffness respectively, to values of undrained cohesion, as described by published data[15] indicating stiffness values of 750 x Cu for the London Clay and a ratio of E' to Eu of 0.75, which is considered a sensible approach for this stage in the design. The profile of the underlying London Clay has been interpolated from the results of the ground investigation on the site and a design line of 55+5z has been adopted for this analysis.

Due to the complex shape of the proposed building footprint and the different depths of excavations, the excavation footprints had to be simplified in order to generate a ground movement assessment. The proposed lower ground floor extension excavation will result in a short term unloading of around 65 kN/m$^2$ and has been modelled to act at the excavation level of 68.5 m OD. The southern part of the lower ground floor level (as highlight by red box in the plan below) will eventually be underpinned and excavated again as part of the basement level, therefore this has been modelled as a greater unloading at the new basement level of 64.5 m OD. The new basement level excavation will result in an unloading of 150 kN/m$^2$ in the area that is being excavated from existing ground level, and of 80 kN/m$^2$ beneath the area of the existing lower ground floor footprint.

The loading arrangement has been modelled in accordance with loading details as supplied by the consulting structural engineer (drawing series 2180456; EW-00-00-DR-S-1000 Rev P1, EW-00-B1-DR-S-0900 Rev P1 and EW-00-B2-DR-S-0800 rev P1, dated January 2019).

### 10.1.3 Results

The P-Disp analysis has predicted the following movements and for clarity has been referred back to the plan above. Contour plots are also presented in the appendix.

| Lower Ground Floor Extension | Movement (mm)<br>+ = settlement / - = heave | |
|---|---|---|
| | Short-term | Total |
| Centre of excavation<br>(light blue unloading) | -6 | -7 |
| Beneath underpins<br>(yellow and green) | 1 to 5 | 3 to 8 |

| Basement Excavation | Movement (mm)<br>+ = settlement / - = heave | |
|---|---|---|
| | Short-term | Total |
| Centre of excavation<br>(light green unloading) | -3 to 2 | -2 to 4 |
| Centre of excavation<br>(dark blue unloading) | -11 | -13 |
| Beneath underpins<br>(Red) | 1 to 5 | 2 to 11 |
| Beneath underpins<br>(Orange) | -3 to 2 | -5 to 3 |

15 Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension* CIRIA Special Publication 200

### 10.1.4 Tunnel Assessment

The New Belsize Tunnel has been modelled as four displacement lines, representing the crown, invert and right and left axis of the tunnel. As mentioned earlier the exact details of the tunnel are unknown, but with reference to in house documents as supplied by Network Rail and discussions with the consulting architect, it has been assumed that the tunnel crown is located at a depth of approximately 15.0 m (57.2 m OD), and the tunnel to be of 7.4 m in diameter. The same documents describe stress change and displacement to the tunnel lining must remain within 20 kN/m$^2$ and 3 mm, respectively. Each displacement line was modelled using the following assumptions and located along the lines shown on the plan below.

### 10.1.5 Results

The P-Disp analysis has predicted the following movement and stress changes along each tunnel element.

**Short Term Movement**

| Tunnel Reference Point | Maximum Vertical Displacement (mm) | Maximum vertical stress kN/m$^2$ | Strain % |
|---|---|---|---|
| Left Axis | -0.10 | 0.58 | $1.96 \times 10^{-6}$ |
| Right Axis | -0.04 | 0.23 | $-0.66 \times 10^{-6}$ |
| Crown | -0.06 | 0.29 | $-1.01 \times 10^{-6}$ |
| Invert | -0.06 | 0.41 | $1.21 \times 10^{-6}$ |

**Total Movement**

| Tunnel Reference Point | Maximum Vertical Displacement (mm) | Maximum vertical stress kN/m$^2$ | Strain % |
|---|---|---|---|
| Left Axis | -0.15 | 0.41 | $2.85 \times 10^{-6}$ |
| Right Axis | -0.08 | 0.13 | $3.70 \times 10^{-6}$ |
| Crown | -0.11 | 0.12 | $0.53 \times 10^{-6}$ |
| Invert | -0.11 | 0.12 | $2.16 \times 10^{-6}$ |

The P-Disp analysis indicates that the predicted movements and stress change at the crown, invert, left and right axis are less than the threshold criteria set out by Network Rail of 20kN/m$^2$ total stress change and 3 mm displacement. Displacement line charts are given in the appendix. The exact location and depth of the tunnel should be established in order to confirm the above findings

### 10.1.6 Ground Movements – Surrounding the Basement

**Vertical Movements:**

The X-Disp program has been used to predict ground movements likely to arise from the installation of the bored piled walls, underpinning and then from the subsequent excavation of the basement. For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are those taken from CIRIA report C760[16].

In addition to this analysis, the pile installation has been modelled as a contiguous bored pile wall and the ground movements are based on the standard movement curves in CIRIA For the purpose of this analysis, the total movements have been adopted as the most critical case in terms of potential damage to the neighbouring properties.

**Horizontal Movements:**

Settlement of the soil behind the new retaining wall may occur during installation due to the excavation in front of the wall causing the wall to deflect. For an underpinned wall this movement is likely to be small as the wall will be subject to a continued vertical loading from the structure above, which will also act as additional support at ground level. The magnitude of the settlement will be controlled to a large extent by the quality of workmanship of the underpins and by the existing building that is likely to provide additional rigidity.

For the purpose of this X-Disp analysis, a ground movement curve assuming that horizontal settlement behind the wall will be equivalent to 0.15% of the retained height, with movement that diminishes with distance from the wall according to the trend line set by a wall within clay (see Fig 6.15a of CIRIA C760[17]).

The movements predicted by X-Disp are summarised in the table below; and are presented to the degree of accuracy required to allow predicted variations in ground movements around the structure to be illustrated, but may not reflect the anticipated accuracy of the predictions.

### 10.1.7 Results

| Phase of Works | Wall Movement (mm) | |
|---|---|---|
| | Vertical Settlement (+ = settlement / - + heave) | Horizontal Movement |
| Combined Movements | -3 mm to 10 mm | 10 mm to 19 mm |

The analysis has indicated that the maximum vertical settlement that will result from basement construction is between 3 mm heave and 10 mm settlement, depending on the part of the site. The maximum horizontal movements behind the retaining wall are predicted to be between 10 mm and 19 mm.

## 10.2 Damage Assessment

In addition to the above assessment of the likely movements that will result from the proposed development, the neighbouring buildings are considered to be sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 6.4 of C760[1].

[16] Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

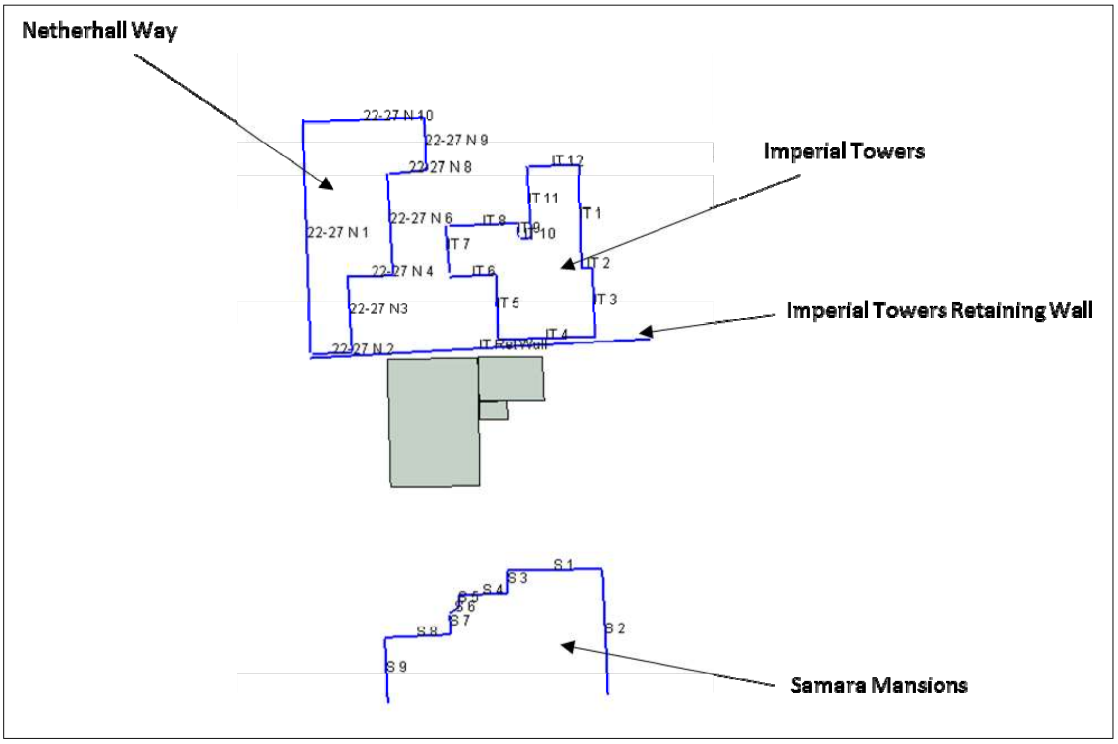
[17] Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760.

These buildings are as follows:

- Samara Mansions, Imperial Towers (including the neighbouring retaining wall) and 22-27 Netherhall Way.

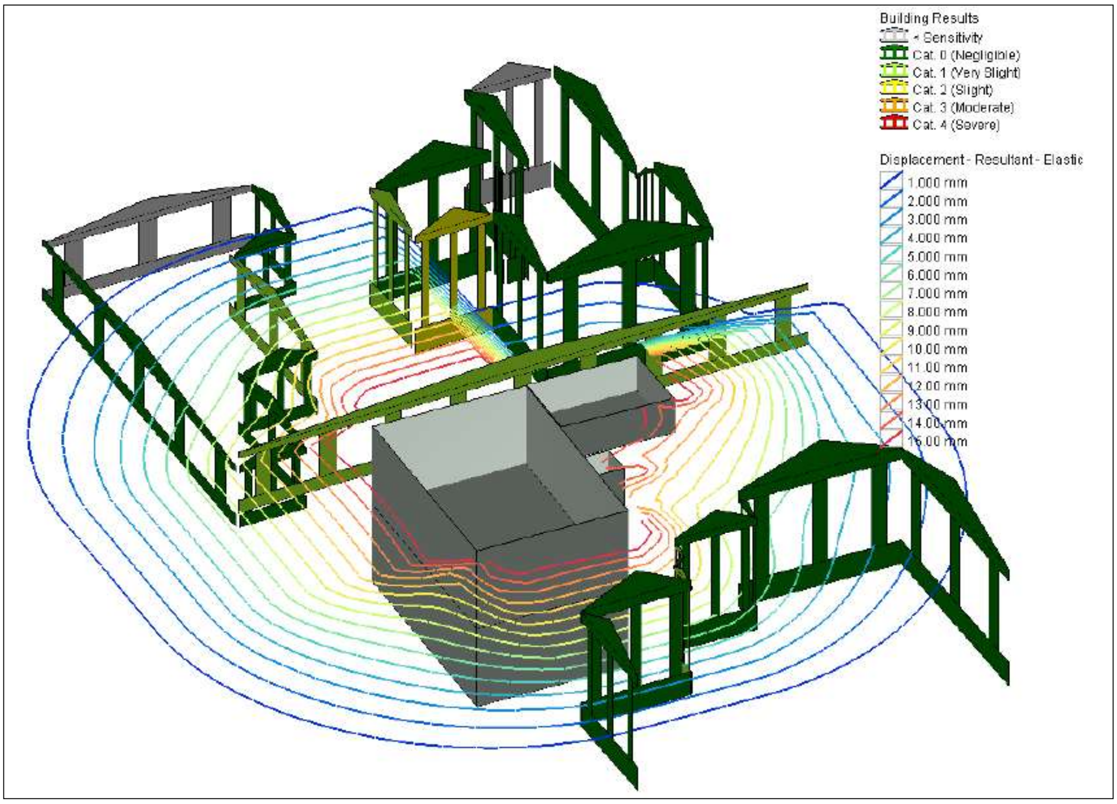
The sensitive structures outlined above have been modelled as lines in the analysis and are the lines along which the damage assessment has been undertaken. The location of each of the buildings is detailed on the plan below.

The founding levels of the neighbouring structures were modelled as per those quoted in Section 2.1.1.




### 10.2.1 Damage to Neighbouring Structures

The combined movements resulting from both retaining wall installation and basement excavation calculated using the X-Disp modelling software have been used to carry out an assessment of the likely damage to adjacent properties. The analysis has predicted that all structures will be subject to Category 0 (Negligible) damage as displayed in the image below, with certain structures subject to segment combination to mitigate local exceedances of Category 0.




On this basis, the damage that would inevitably occur as a result of basement construction would fall within the acceptable limits. The detailed tabular output is provided in the Appendix alongside a key plan for reference.

### 10.2.2 Monitoring of Ground Movements

Given the predicted damage categories, monitoring of the surrounding structures is unlikely to be required. However, should a monitoring regime be requested in order to ensure the ground movements align with those predicted by the analysis, it is recommended that Samara Mansions and Imperial Towers be considered for monitoring.

Condition surveys of the above existing nearby structures would need to be carried out before and after the proposed works.

The precise monitoring strategy would be developed at a later stage and it will be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

# Part 4: BASEMENT IMPACT ASSESSMENT

This section of the report evaluates the direct and indirect implications of the proposed project, based on the findings of the previous screening and scoping, site investigation and ground movement assessment.

## 11.0 INTRODUCTION

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

### 11.1 Potential Impacts

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

| Potential Impact | Site Investigation Conclusions |
|---|---|
| The rear garden contains localised slopes of greater than 7°. | Construction of the proposed basement is below the crest of the localised slopes that fall away from the development toward the northwest. These slopes are supported at their toe by the retaining wall bounding the site such that the basement development should not have an effect on slope stability. |
| The site is underlain by the London Clay and observations of damage indicative of shrink swell movements have been observed. Trees are also likely to be removed. | The London Clay is prone to seasonal shrink-swell that can cause structural damage. Desiccation was not noted during the fieldwork. |
| A tributary of the River Westbourne was located 60 m northwest of the site. | The investigation encountered the expected geology of London Clay from the surface. No deposits associated with the presence of the River Westbourne were encountered and standpipe installations were monitored as dry. |
| The site is located within 5 m of a highway or pedestrian right of way | The site fronts onto Netherhall Gardens. However, the proposed basement extension is set back beneath the existing property, approximately 10 m from the public right of way. |
| The proposed development will result in an increase to differential foundation depth to neighbouring properties. | Ground movements related to the proposed development could result in damage to the neighbouring structures |
| The exclusion zone to the New Belsize Tunnel encroaches into the southern part of the site | Ground movements related to the proposed development could result in damage to the underlying tunnel |

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

*The rear garden contains localised slopes of greater than 7°.*

The topographical survey indicates that the rear garden contains localised slopes that dip downward toward the northwest between 11° and 13°. The overall site dips to the west, in unison with the surrounding setting, at an angle of about 4°. The proposed basement construction effectively removes the localised slope through its extension into the rear garden, and therefore, does not present anything exceptional that would give rise to any concerns with regard to stability over and above any development of this nature. Following construction, the steepest angle from road level of 72.2 m OD to the deepest part of the basement development of 64.9 m OD generates a gradient of 10°, which is not deemed to be of concern. Care should be taken when re-profiling the rear garden to ensure the stability of the site.

*London Clay is the shallowest stratum / Seasonal Shrink-Swell*

The proposed basement will extend to a depth such that new foundations will be expected to bypass any desiccated soils. Any existing foundations that are not scheduled to be underpinned as part of the basement works should be lowered in accordance with the advice given in Part 2 of this report.

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.

*Presence of the nearby River Westbourne*

The site investigation did not encounter any specific ground conditions that would be associated with the River Westbourne. Furthermore, both monitoring standpipes have been recorded as dry such that the groundwater conditions are expected to be typical of that associated with the sites underlain by London Clay. It is therefore considered that the presence of the River Westbourne to the northwest of the site will not affect the proposed development.

*Location of public highway*

The proposed excavations for the proposed basement extension are restricted to beneath the footprint of the existing house and rear garden at a distance greater than 5.0 m from any nearby highway or pedestrian right of way.

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.

*Ground movements associated with differential founding depth to the neighbouring properties and nearby Belsize Tunnel*

The ground movement assessment predicts that the surrounding buildings and New Belsize Tunnel will not be adversely affected by the proposed development.

## 11.2 BIA Conclusion

A Basement Impact Assessment has been carried out following the information and guidance published by the London Borough of Camden.

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

## 11.3 Non-Technical Summary of Evidence

This section provides a short summary of the evidence acquired and used to form the conclusions made within the BIA.

### 11.3.1 Screening

The following table provides the evidence used to answer the surface water flow and flooding screening questions.

| Question | Evidence |
|---|---|
| 1. Is the site within the catchment of the pond chains on Hampstead Heath? | Topographical maps acquired as part of the desk study and Figures 12, 13 and 14 of the Arup report. |
| 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? | A site walkover and existing plans of the site have confirmed that the proposed basement scheme will not increase the amount of hardstanding. |
| 3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas? | |
| 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? | As above. |
| 5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses? | |
| 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? | Flood risk maps acquired from the Environment Agency as part of the desk study, Figure 15 of the Arup report, the Camden Flood Risk Management Strategy dated 2013 and SFRA dated 2014. |

The following table provides the evidence used to answer the subterranean (groundwater flow) screening questions.

| Question | Evidence |
|---|---|
| 1a. Is the site located directly above an aquifer? | Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3 and 8 of the Arup report. |
| 1b. Will the proposed basement extend beneath the water table surface? | Previous nearby GEA investigations and BGS archive borehole records. |
| 2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line? | Topographical and historical maps acquired as part of the desk study, Figures 11 and 12 of the Arup report and the Lost Rivers of London book. |
| 3. Is the site within the catchment of the pond chains on Hampstead Heath? | Topographical maps acquired as part of the desk study and Figures 12, 13 and 14 of the Arup report. |
| 4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas? | A site walkover and existing plans of the site have confirmed that the basement development will only replace existing hardstanding areas. |
| 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)? | The details of the proposed development do not indicate the use soakaway drainage. |
| 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? | Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report. |

The following table provides the evidence used to answer the slope stability screening questions.

| Question | Evidence |
|---|---|
| 1. Does the existing site include slopes, natural or manmade, greater than 7°? | Topographical maps and Figures 16 and 17 of the Arup report and confirmed during a site walkover. |
| 2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°? | The details of the proposed development provided do not include the re-profiling of the site to create new slopes. |
| 3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°? | Topographical maps and Figures 16 and 17 of the Arup report and confirmed during a site walkover. |
| 4. Is the site within a wider hillside setting in which the general slope is greater than 7°? | |
| 5. Is the London Clay the shallowest strata at the site? | Geological maps and Figures 3 and 8 of the Arup report. |
| 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? | Arboricultural report as supplied by consulting architect. |
| 7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site? | Knowledge on the ground conditions of the area and reference to NHBC guidelines were used to make an assessment of this, in addition to a visual inspection of the buildings carried out during the site walkover. |
| 8. Is the site within 100 m of a watercourse or potential spring line? | Topographical maps acquired as part of the desk study, Figures 11 and 12 of the Arup report and the Lost Rivers of London book. |
| 9. Is the site within an area of previously worked ground? | Geological maps and Figures 3 and 8 of the Arup report. |
| 10. Is the site within an aquifer? | Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3 and 8 of the Arup report. |
| 11. Is the site within 50 m of Hampstead Heath ponds? | Topographical maps acquired as part of the desk study and Figures 12, 13 and 14 of the Arup report. |
| 12. Is the site within 5 m of a highway or pedestrian right of way? | Site plans and the site walkover. |
| 13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties? | Camden planning portal and the site walkover confirmed the position of the proposed basement relative the neighbouring properties. |
| 14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines? | Maps and plans of infrastructure tunnels were reviewed. |

### 11.3.2 Scoping and Site Investigation

The questions in the screening stage that there were answered 'yes', were taken forward to a scoping stage and the potential impacts discussed in Section 4.0 of this report, with reference to the possible impacts outlined in the Arup report.

A ground investigation has been carried out, which has allowed an assessment of the potential impacts of the basement development on the various receptors identified from the screening and scoping stages. Principally the investigation aimed to establish the ground conditions, including the groundwater level and the engineering properties of the underlying soils to enable suitable design of the basement development.

The findings of the investigation are discussed in Part 2 of this report and summarised in the Executive Summary.

### 11.3.3 Impact Assessment

Section 11.0 of this report summarises whether, on the basis of the findings of the investigation, the potential impacts still need to be given consideration and identifies ongoing risks that will require suitable engineering mitigation. Section 9.0 of this report also provides recommendations for the design of the proposed development.

A ground movement analysis and building damage assessment has been carried out and its findings are presented in Part 3.

## 12.0 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 may 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 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.

Monitoring of the standpipes should be continued to determine equilibrium groundwater levels and to establish any seasonal fluctuations. Ideally, trial excavations extending to as close to the full depth of the proposed foundations as possible should be carried out to determine likely groundwater inflows into the basement excavation. Once confirmation from Network Rail has been obtained, the outstanding shallow open-drive sampler boreholes should be carried out in order to confirm the ground conditions to the south of the existing house.

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

## APPENDIX 1

Borehole Records

Trial Pit Records

Geotechnical Test Results

CBR Results

SPT & Cohesion/Depth Graph

Contamination Test Results

Generic Risk-Based Screening Values

Envirocheck Extracts

Historical Maps

UXO Preliminary Risk Assessments

Utility Searches

Site Plans

| GEA Geotechnical & Environmental Associates<br>Widbury Barn \| Widbury Hill \| Ware \| SG12 7QE | | | **Site**<br>13 Netherhall Gardens, London, NW3 | **Borehole Number**<br>**BH1** |
|---|---|---|---|---|
| **Boring Method**<br>Cable Percussion | **Casing Diameter**<br>150mm cased to 1.70m | **Ground Level (mOD)**<br>71.90 | **Client**<br>Re-Creo Developments Ltd | **Job Number**<br>J18176 |
| | **Location** | **Dates**<br>15/08/2018-16/08/2018 | **Engineer**<br>Elliott Wood | **Sheet**<br>1/3 |

| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.70) | Made ground (brown silty sandy gravelly clay with fragments of brick, coal, ash and flint). | | |
| 0.50 | D1 | | | | | | | | |
| | | | | | 71.20 | 0.70 | Firm becoming stiff high strength fissured brown silty CLAY with occasional partings of fine sand. Occasional selenite crystals and fine gravel sized clasts of pyrite. Decaying carbonaceous material present to a depth of 1.5 m . | | |
| 1.00 | D2 | | | | | | | | |
| 1.20-1.65<br>1.20-1.65 | SPT N60=13<br>D3 | 1.70 | DRY | 2,2/3,2,3,4 | | | | | |
| 1.75 | D4 | | | | | | | | |
| 2.00-2.45<br>2.00-2.45 | SPT N60=12<br>D5 | 1.70 | DRY | 1,2/2,3,3,3 | | | | | |
| 3.00-3.45<br>3.00-3.45 | SPT N60=12<br>D6 | 1.70 | DRY | 2,2/3,2,3,3 | | | | | |
| 4.00-4.45<br>4.00-4.45 | SPT N60=13<br>D7 | 1.70 | DRY | 1,3/3,2,3,4 | | | | | |
| 5.00-5.45 | D8 | | | | | | | | |
| | | | | | | (10.60) | | | |
| 6.50-6.95<br>6.50-6.95 | SPT N60=15<br>D9 | 1.70 | DRY | 2,3/3,4,3,4 | | | | | |
| 8.00-8.45 | D10 | | | | | | | | |
| 9.50-9.95<br>9.50-9.95 | SPT N60=20<br>D11 | 1.70 | DRY | 2,3/5,4,4,5 | | | | | |

**Remarks**
Service pit dug to a depth of 1.2 m
Groundwater not encountered
2 hours dayworks
Standpipe installed to a depth of 6.0 m

| **Scale (approx)** | **Logged By** |
|---|---|
| 1:50 | JD |

**Figure No.**
J18176.BH1

| Geotechnical & Environmental Associates<br>Widbury Barn \| Widbury Hill \| Ware \| SG12 7QE | | | Site<br>13 Netherhall Gardens, London, NW3 | Borehole Number<br>**BH1** |
|---|---|---|---|---|
| **Boring Method**<br>Cable Percussion | **Casing Diameter**<br>150mm cased to 1.70m | **Ground Level (mOD)**<br>71.90 | **Client**<br>Re-Creo Developments Ltd | **Job Number**<br>J18176 |
| | **Location** | **Dates**<br>15/08/2018-<br>16/08/2018 | **Engineer**<br>Elliott Wood | **Sheet**<br>2/3 |

| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| 11.00-11.45 | D12 | | | | | | | | |
| | | | | | 60.60 | 11.30 | Stiff becoming very stiff high strength dark grey silty CLAY with occasional partings of fine sand. Rare infilled bioturbations and selenite crystals and rare fine gravel sized clasts of pyrite. Claystone fragments at 14.5 m and 18.5 m. | | |
| 12.50-12.95 | SPT N60=22 | 1.70 | DRY | 2,4/4,5,5,6 | | | | | |
| 12.50-12.95 | D13 | | | | | | | | |
| 14.00-14.45 | D14 | | | | | | | | |
| 15.00 | D15 | | | | | | | | |
| 15.50-15.95 | SPT N60=24 | 1.70 | DRY | 2,4/5,5,6,6 | | | | | |
| 15.50-15.95 | D16 | | | | | | | | |
| 16.50 | D17 | | | | | | | | |
| 17.00-17.45 | SPT N60=26 | 1.70 | DRY | 2,5/5,6,6,7 | | | | | |
| 17.00-17.45 | D18 | | | | | | | | |
| 18.00 | D19 | | | | | | | | |
| 18.50-18.95 | SPT N60=29 | 1.70 | DRY | 2,5/6,7,6,7 | | | | | |
| 18.50-18.95 | D20 | | | | | | | | |
| 19.50 | D21 | | | | | | | | |
| 20.00-20.45 | SPT N60=31 | 1.70 | DRY | 3,5/6,7,7,8 | | | | | |

| Remarks | Scale (approx) | Logged By |
|---|---|---|
| Service pit dug to a depth of 1.2 m<br>Groundwater not encountered<br>2 hours dayworks<br>Standpipe installed to a depth of 6.0 m | 1:50 | JD |
| | **Figure No.**<br>J18176.BH1 | |

Geotechnical & Environmental Associates
Widbury Barn | Widbury Hill | Ware | SG12 7QE

| | | | | |
|---|---|---|---|---|
| **Site** | 13 Netherhall Gardens, London, NW3 | | | **Borehole Number** BH1 |
| **Boring Method** Cable Percussion | **Casing Diameter** 150mm cased to 1.70m | **Ground Level (mOD)** 71.90 | **Client** Re-Creo Developments Ltd | **Job Number** J18176 |
| | **Location** | **Dates** 15/08/2018-16/08/2018 | **Engineer** Elliott Wood | **Sheet** 3/3 |

| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| 20.00-20.45 | D22 | | | | | | | | |
| | | | | | | (18.70) | | | |
| 21.00 | D23 | | | | | | | | |
| 21.50-21.95<br>21.50-21.95 | SPT N60=46<br>D24 | 1.70 | DRY | 4,8/11,13,9,9 | | | | | |
| 22.50 | D25 | | | 15/08/2018:DRY<br>16/08/2018:DRY | | | | | |
| 23.00-23.45<br>23.00-23.45 | SPT N60=34<br>D26 | 1.70 | DRY | 3,5/7,8,8,8 | | | | | |
| 24.00 | D27 | | | | | | | | |
| 24.50-24.95<br>24.50-24.95 | SPT N60=36<br>D28 | 1.70 | DRY | 2,6/7,8,9,9 | | | | | |
| 25.50 | D29 | | | | | | | | |
| 26.00-26.45<br>26.00 | SPT N60=39<br>D30 | 1.70 | DRY | 3,7/7,9,9,10 | | | | | |
| 27.00 | D31 | | | | | | | | |
| 27.50-27.95<br>27.50-27.95 | SPT N60=44<br>D32 | 1.70 | DRY | 3,7/8,10,10,12 | | | | | |
| 28.50 | D33 | | | | | | | | |
| 29.00 | D34 | | | | | | | | |
| 29.55-30.00<br>29.55-30.00 | SPT N60=47<br>D35 | 1.70 | DRY | 24,7/9,10,11,13<br>16/08/2018:DRY | 41.90 | 30.00 | | | |

**Remarks**
Service pit dug to a depth of 1.2 m
Groundwater not encountered
2 hours dayworks
Standpipe installed to a depth of 6.0 m

| | |
|---|---|
| **Scale (approx)** 1:50 | **Logged By** JD |
| **Figure No.** J18176.BH1 | |

| GEA Geotechnical & Environmental Associates<br>Widbury Barn \| Widbury Hill \| Ware \| SG12 7QE | | | Site<br>13 Netherhall Gardens, London, NW3 | Borehole Number<br>BH2 |
|---|---|---|---|---|
| Boring Method<br>Cable Percussion | Casing Diameter<br>150mm cased to 3.00m | Ground Level (mOD)<br>69.60 | Client<br>Re-Creo Developments Ltd | Job Number<br>J18176 |
| | Location | Dates<br>21/08/2018 | Engineer<br>Elliott Wood | Sheet<br>1/2 |

| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | (2.10) | Made ground (brown silty clay with fragments of brick and concrete) | | |
| 2.00-2.45<br>2.00-2.45 | SPT N60=11<br>D1 | 1.00 | DRY | 4,2/2,2,3,3 | 67.50 | 2.10 | Firm becoming stiff high strength fissured brown silty slightly sandy CLAY with occasional partings of fine sand. Occasional selenite crystals and fine gravel sized clasts of pyrite. Decaying carbonaceous material present to a depth of 1.5 m . | | |
| 3.00-3.45<br>3.00-3.45 | SPT N60=12<br>D2 | 2.00 | DRY | 2,3/2,3,3,3 | | | | | |
| 4.00-4.45<br>4.00-4.45 | SPT N60=13<br>D3 | 3.00 | DRY | 1,2/3,3,3,3 | | | | | |
| 5.00-5.45 | U4 | | | | | | | | |
| 6.50-6.95<br>6.50-6.95 | SPT N60=17<br>D5 | 3.00 | DRY | 2,3/3,4,3,5 | | (9.60) | | | |
| 8.00-8.45<br>8.00-8.45 | SPT N60=34<br>D6 | 3.00 | DRY | 6,11/13,8,5,5 | | | | | |
| 9.50-9.95 | U7 | | | | | | | | |

| Remarks | Scale (approx) | Logged By |
|---|---|---|
| Service pit dug to a depth of 1.2 m<br>Groundwater not encountered<br>2 hours dayworks<br>Standpipe installed to a depth of 6.0 m | 1:50 | JD |
| | Figure No.<br>J18176.BH1 | |

| GEA Geotechnical & Environmental Associates<br>Widbury Barn \| Widbury Hill \| Ware \| SG12 7QE | | | Site<br>13 Netherhall Gardens, London, NW3 | Borehole Number<br>**BH2** |
|---|---|---|---|---|
| **Boring Method**<br>Cable Percussion | **Casing Diameter**<br>150mm cased to 3.00m | **Ground Level (mOD)**<br>69.60 | **Client**<br>Re-Creo Developments Ltd | **Job Number**<br>J18176 |
| | **Location** | **Dates**<br>21/08/2018 | **Engineer**<br>Elliott Wood | **Sheet**<br>2/2 |

| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| 11.00-11.45<br>11.00-11.45 | SPT N60=24<br>D8 | 3.00 | DRY | 2/5,5,6,6 | | | | | |
| | | | | | 57.90 | 11.70 | Stiff becoming very stiff high strength dark grey silty slightly sandy CLAY with occasional partings of fine sand. Rare infilled bioturbations and selenite crystals and rare fine gravel sized clasts of pyrite. Claystone fragments at 12.0 m. | | |
| 12.00 | D9 | | | | | | | | |
| 12.50-12.95<br>12.50-12.95 | SPT N60=22<br>D10 | 3.00 | DRY | 2,5/5,4,5,6 | | | | | |
| 13.50 | D11 | | | | | | | | |
| 14.00-14.45<br>14.00-14.45 | SPT N60=23<br>D12 | 3.00 | DRY | 2,4/5,5,5,6 | | | | | |
| 15.00 | D13 | | | | | | | | |
| 15.50-15.95<br>15.50-15.95 | SPT N60=24<br>D14 | 3.00 | DRY | 3,5/5,6,5,6 | | | | | |
| | | | | | | (8.30) | | | |
| 16.50 | D15 | | | | | | | | |
| 17.00-17.45<br>17.00-17.45 | SPT N60=29<br>D16 | 3.00 | DRY | 3,4/6,6,7,7 | | | | | |
| 18.00 | D17 | | | | | | | | |
| 18.50-18.95<br>18.50-18.95 | SPT N60=31<br>D18 | 3.00 | DRY | 2,6/6,7,7,8 | | | | | |
| 19.55-20.00<br>19.55-20.00 | SPT N60=34<br>D19 | 3.00 | DRY | 3,6/7,7,8,9<br>21/08/2018:DRY | | | | | |
| | | | | | 49.60 | 20.00 | | | |

| **Remarks** | **Scale (approx)**<br>1:50 | **Logged By**<br>JD |
|---|---|---|
| | **Figure No.**<br>J18176.BH1 | |

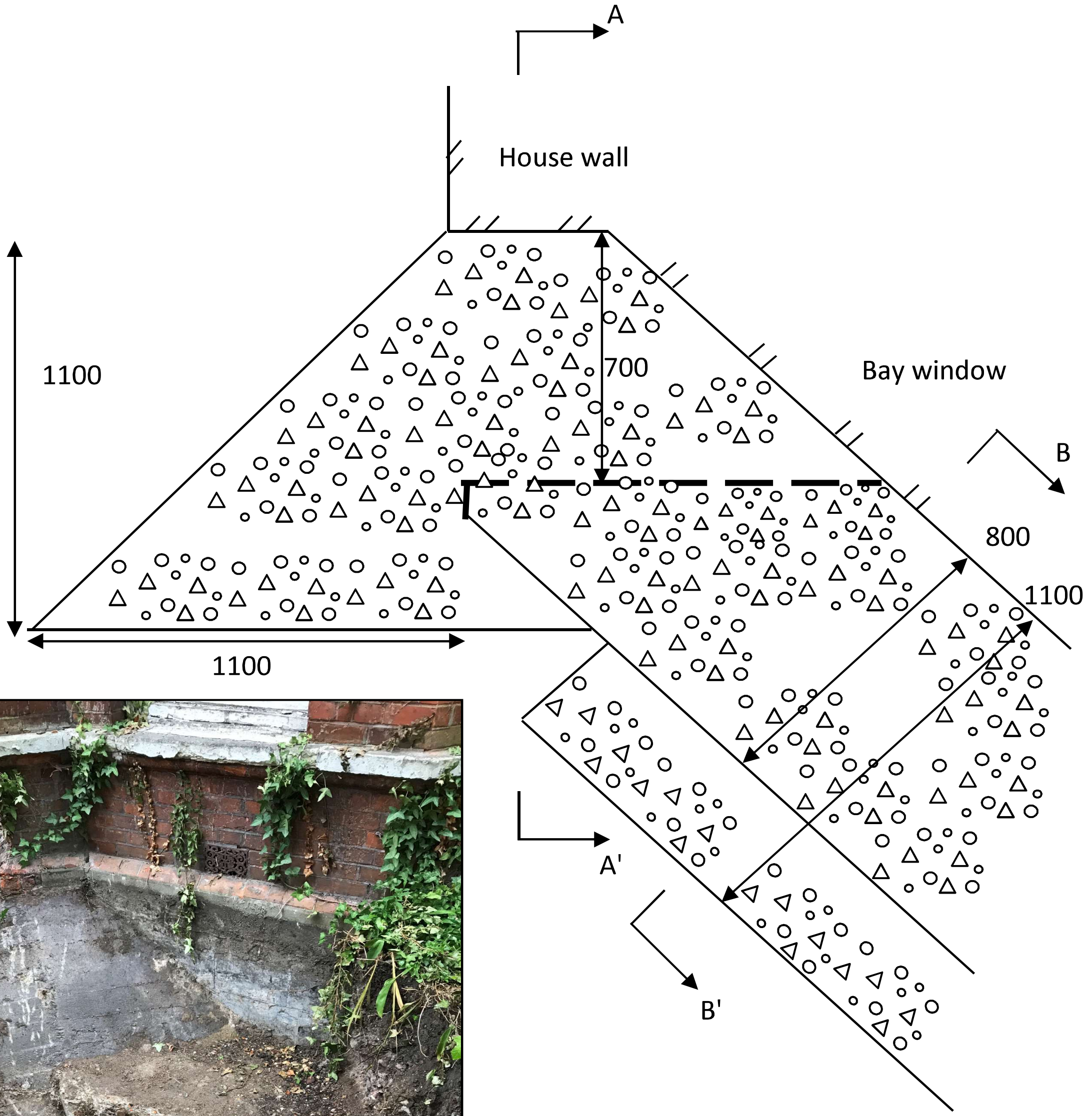
GEA

www.gea-ltd.co.uk
Herts | 01727 824666 Notts | 01509 674888

| Trial Pit No |
| --- |
| 1 |

| | |
| --- | --- |
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number** J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates** 24/08/2018 |

| Excavation Method | Dimensions | Ground Level (mOD) | Location |
| --- | --- | --- | --- |
| Mini digger | 2000 x 2000 x 1500 | | |




| | | |
| --- | --- | --- |
| Remarks: | | Scale: |
| All dimensions in millimetres | Trial pit logged from surface | 01:20 |
| Sides of trial pits remained stable | | Logged by: |
| Groundwater not encountered | | JD |

GEA

www.gea-ltd.co.uk

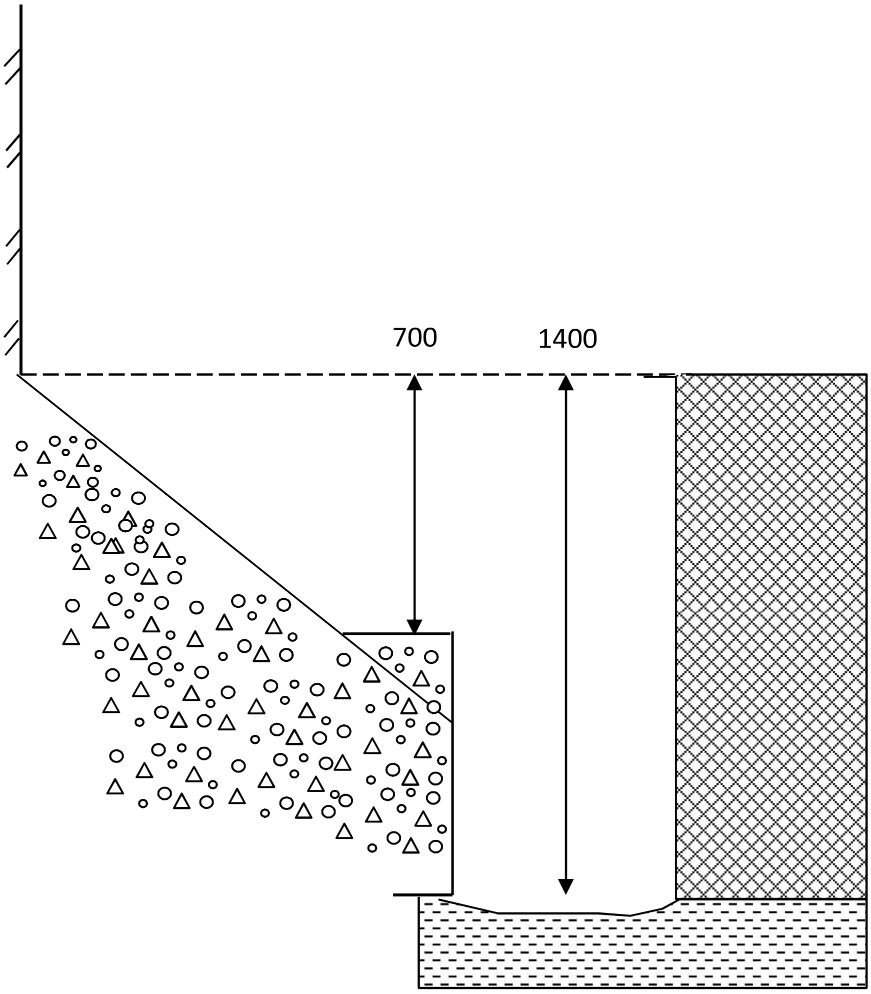
Herts | 01727 824666 Notts | 01509 674888

| Trial Pit No |
|---|
| 1 |

| | |
|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number** J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates** 24/08/2018 |

| Excavation Method | Dimensions | Ground Level (mOD) | Location |
|---|---|---|---|
| Mini digger | 2000 x 2000 x 1500 | | |

**Section A-A'**




GL to 1.4 m: Made ground (Brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery, chalk and abundant rootlets to 1.3 m

1.4 m to 1.5 m: Firm orange-brown mottled grey silty CLAY

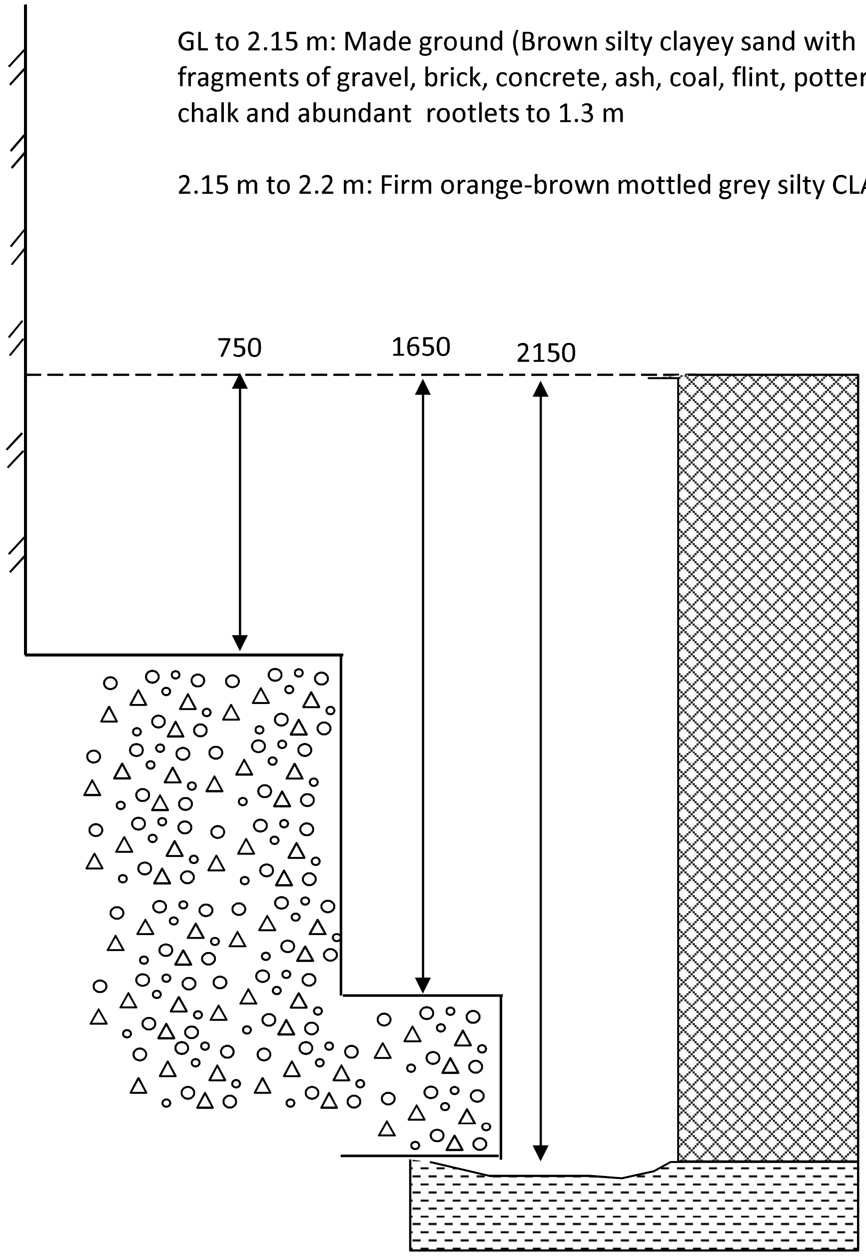
| | | |
|---|---|---|
| Remarks: | | Scale: 1:20 |
| All dimensions in millimetres | Trial pit logged from surface | |
| Sides of trial pits remained stable | | Logged by: JD |
| Groundwater not encountered | | |

| GEA | www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>1 |
|---|---|---|

| | |
|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number**<br>J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates**<br>24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 2000 x 2000 x 2200 | | |

**Section A-A'**




| Remarks: | | Scale:<br>1:20 |
|---|---|---|
| All dimensions in millimetres | Trial pit logged from surface | |
| Sides of trial pits remained stable | | Logged by:<br>JD |
| Groundwater not encountered | | |

GEA

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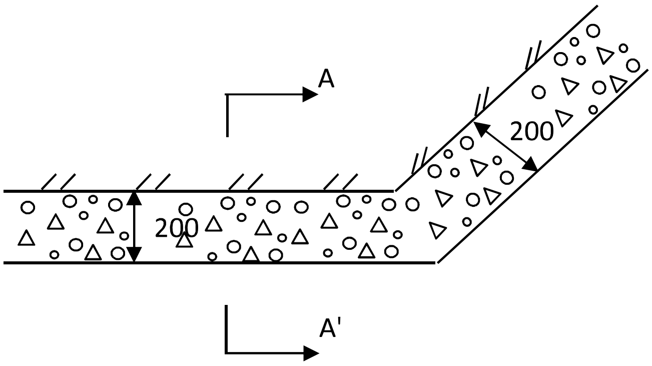
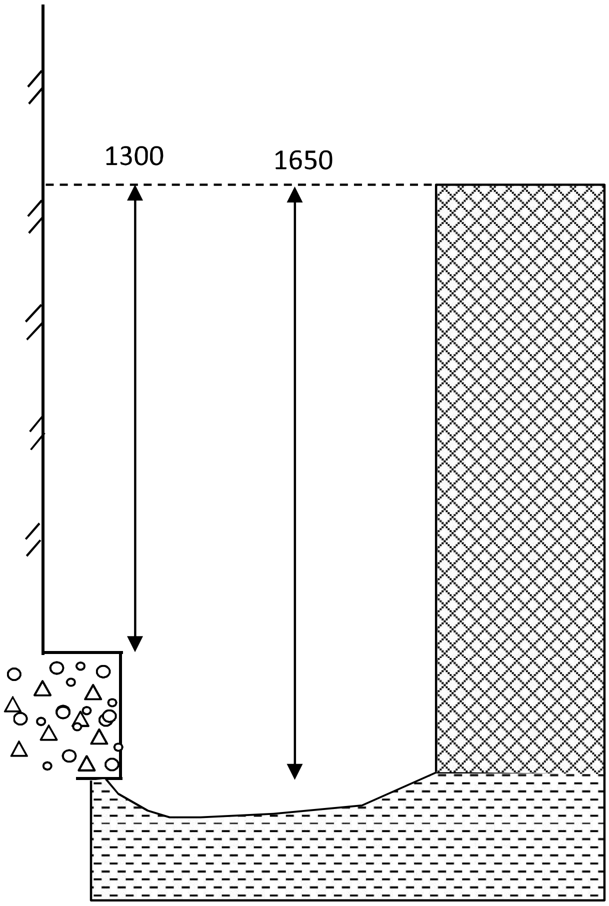
Herts | 01727 824666 Notts | 01509 674888

**Trial Pit No** 2

| | |
|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number** J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates** 24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 1000 x 1000 x 1700 | | |




GL to 1.65 m: Made ground (Brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery, chalk and abundant rootlets and roots to 1.3 m)

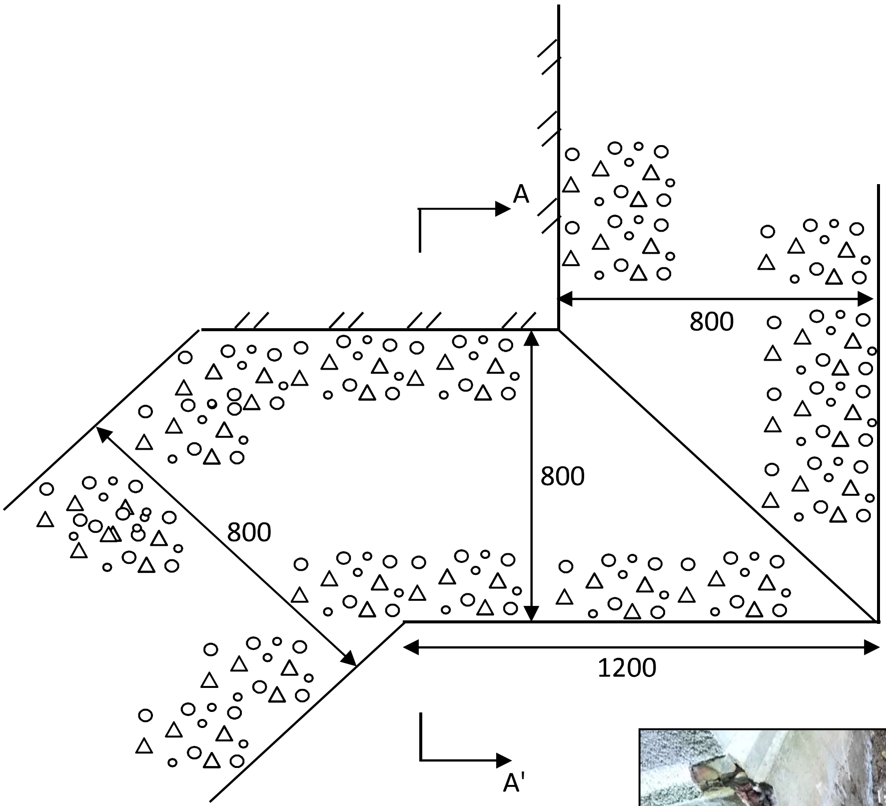
1.65 m to 1.7 m: Firm orange-brown mottled grey silty CLAY

| | |
|---|---|
| Remarks: | Scale: 1:20 |
| All dimensions in millimetres / Trial pit logged from surface | |
| Sides of trial pits remained stable | Logged by: JD |
| Groundwater not encountered | |

| GEA | www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>3 |
|---|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | | **Job Number**<br>J18148 |
| **Client** Re-Creo Developments Ltd | | **Sheet** |
| **Engineer** Elliott Wood | | **Dates**<br>24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 300 x 300 x 300 | | |

**Plan**

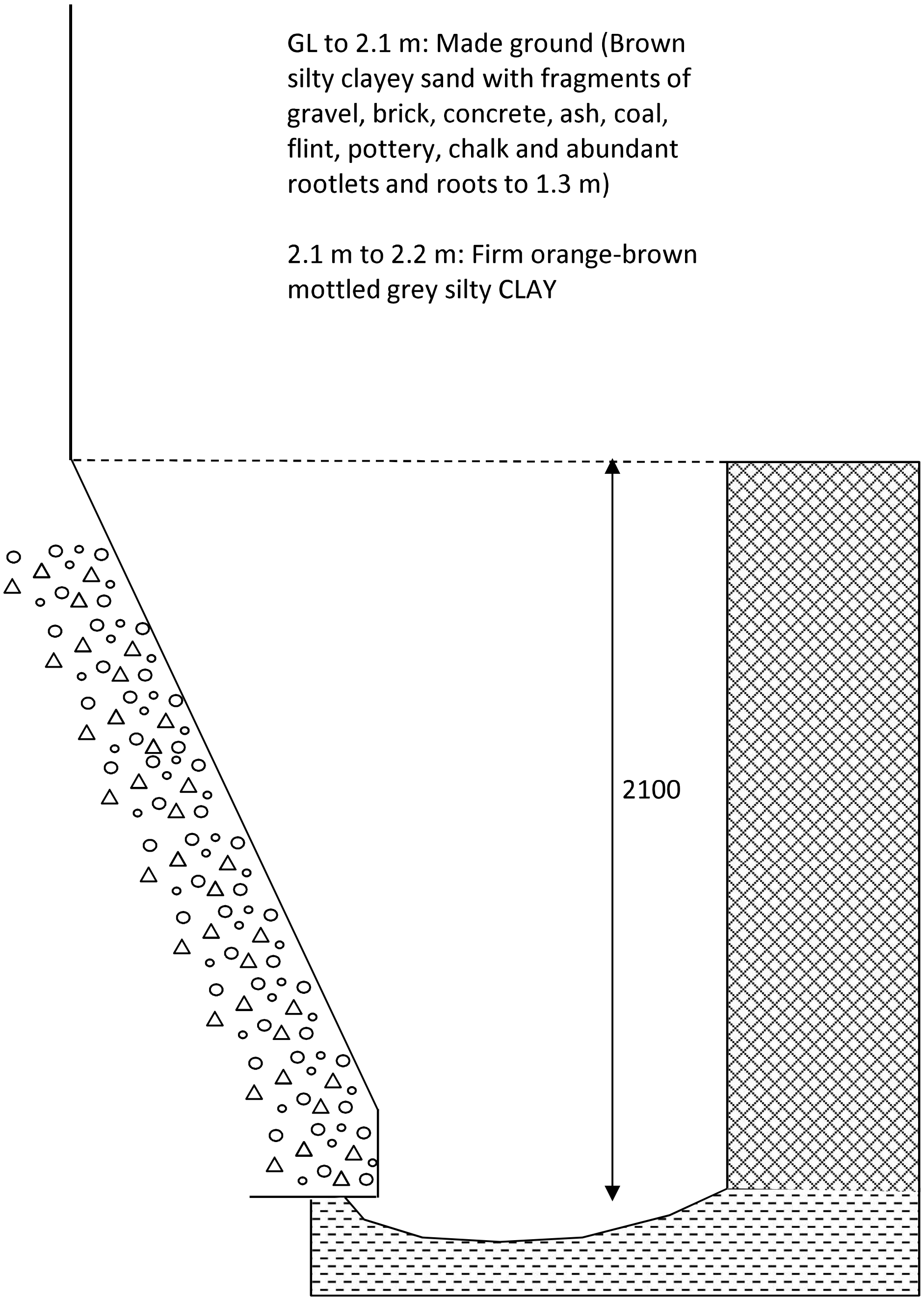



| Remarks: | | Scale:<br>1:20 |
|---|---|---|
| All dimensions in millimetres | Trial pit logged from surface | |
| Sides of trial pits remained stable | | Logged by: |
| Groundwater not encountered | | JD |

| | |
|---|---|
| GEA — www.gea-ltd.co.uk — Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No** 3 |
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number** J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates** 24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 300 x 300 x 300 | | |

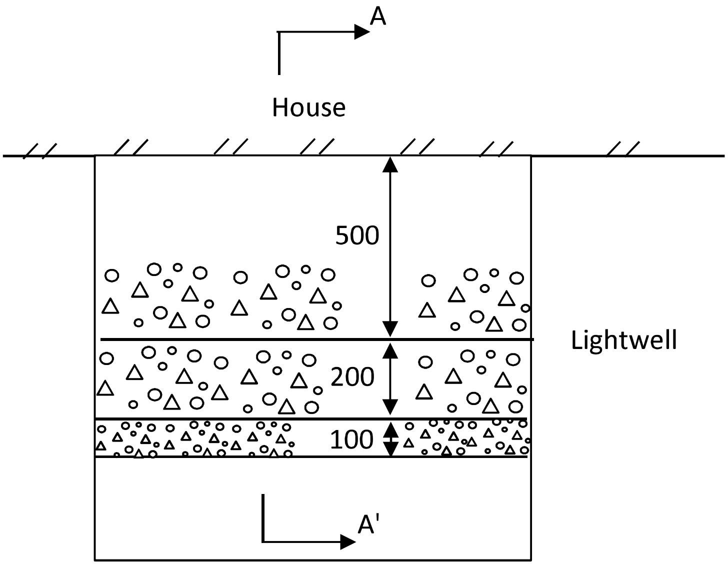
**Section A- A'**




| | | |
|---|---|---|
| Remarks:<br>Groundwater not encountered, although leaking pipe from nearby bathroom did fill pit to 1.6 m. This was pumped and drained on site. | Trial pit logged from surface<br>Sides of trial pits remained stable<br>All dimensions in millimetres | Scale: 1:20<br>Logged by: JD |

| | | |
|---|---|---|
| GEA | www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>4 |
| **Site** 13 Netherhall Gardens, London, NW3 5RN | | **Job Number**<br>J18148 |
| **Client** Re-Creo Developments Ltd | | **Sheet** |
| **Engineer** Elliott Wood | | **Dates**<br>24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 1000 x 1000 x 2100 | | |

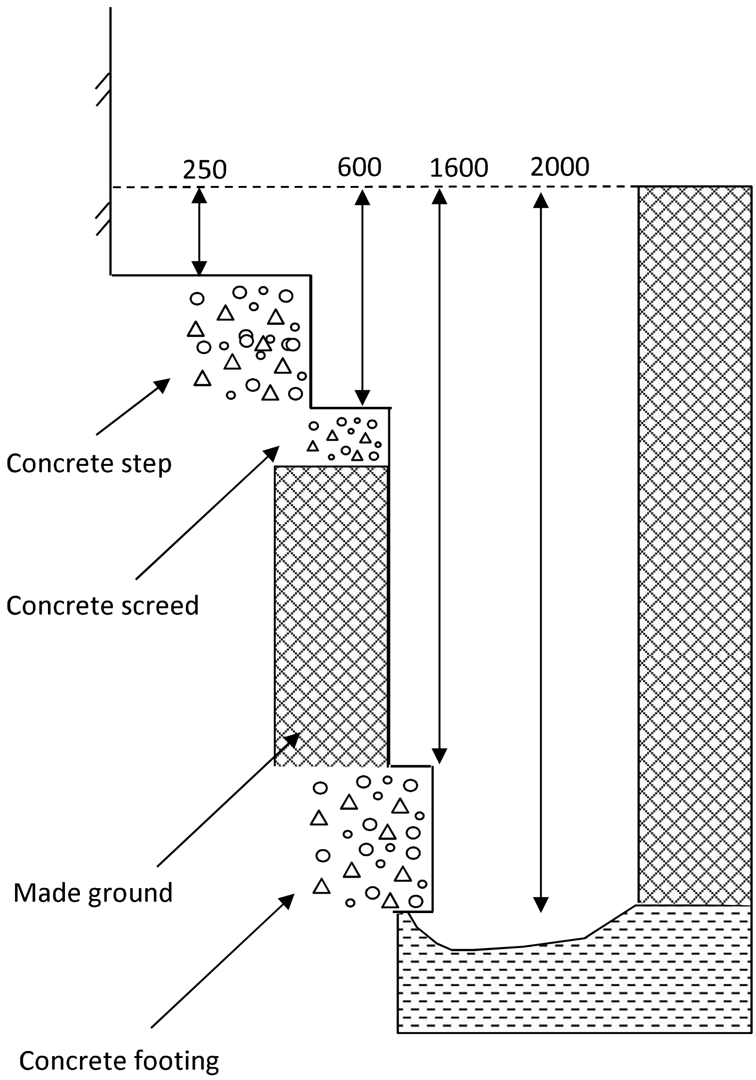



| | | |
|---|---|---|
| Remarks: | | Scale: |
| All dimensions in millimetres | Trial pit logged from surface | 1:20 |
| Sides of trial pits remained stable | | Logged by: |
| Groundwater not encountered | | JD |

| | | |
|---|---|---|
| GEA | www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>4 |
| **Site** 13 Netherhall Gardens, London, NW3 5RN | | **Job Number**<br>J18148 |
| **Client** Re-Creo Developments Ltd | | **Sheet** |
| **Engineer** Elliott Wood | | **Dates**<br>24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 1000 x 1000 x 2100 | | |

**Section A -A'**




GL to 2.0 m: Made ground (Brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery, chalk and abundant rootlets and roots to 1.5 m)

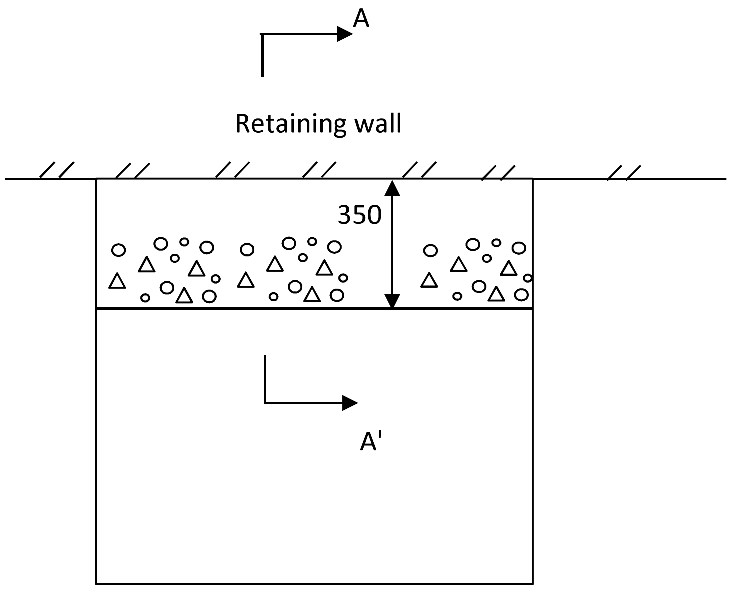
2.0 m to 2.1 m: Firm orange-brown mottled grey silty CLAY

| | | |
|---|---|---|
| Remarks: | | Scale: |
| All dimensions in millimetres | Trial pit logged from surface | 1:20 |
| Sides of trial pits remained stable | | Logged by: |
| Groundwater not encountered | | JD |

| GEA | www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>5 |
|---|---|---|

| | |
|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number**<br>J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates**<br>24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 1000 x 1000 x 3300 | | |

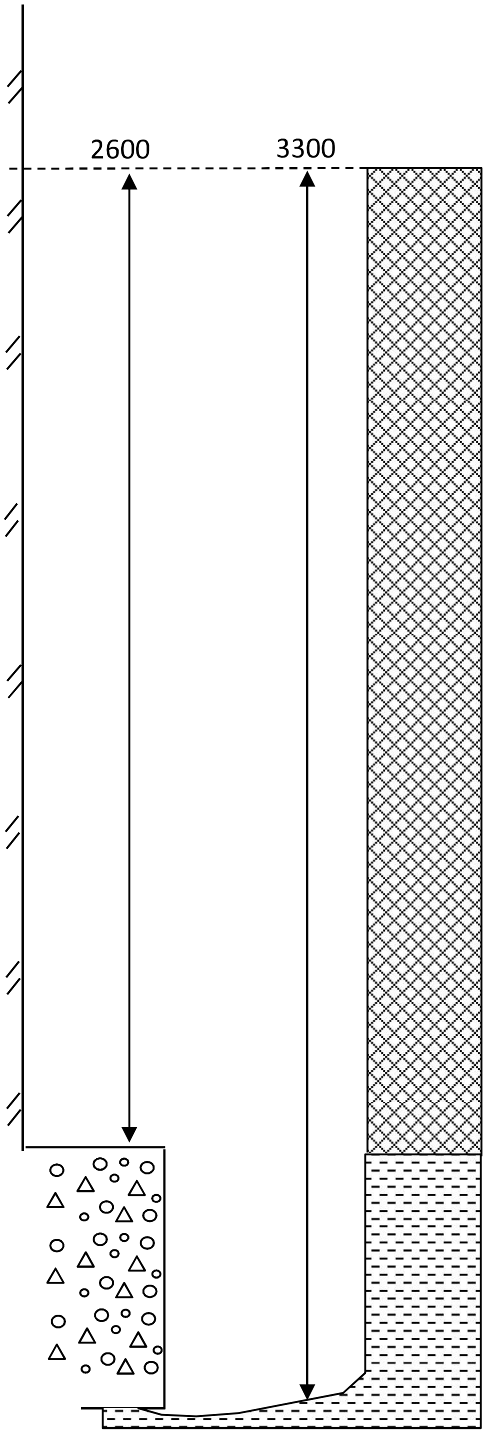



| | | |
|---|---|---|
| Remarks: | Trial pit logged from surface | Scale: |
| All dimensions in millimetres | Dimensions derived from TP6 and as described by digger driver | 1:20 |
| Sides of trial pits remained stable | | Logged by: |
| Groundwater not encountered, although heavy rainfall caused pit sides to collapse, obscuring footing | | JD |

| GEA www.gea-ltd.co.uk Herts \| 01727 824666 Notts \| 01509 674888 | Trial Pit No 5 |
|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number** J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates** 24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 1000 x 1000 x 3300 | | |

**Section A -A'**




GL to 2.6 m: Made ground (Brown silty clayey sand with fragments of gravel, brick, concrete, ash, coal, flint, pottery, chalk and abundant rootlets and roots to 1.5 m)

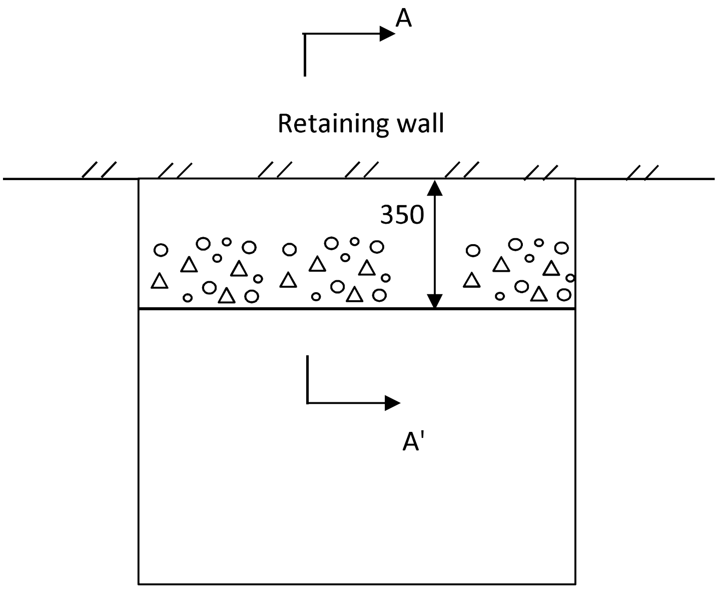
2.6 m to 3.3 m: Firm orange-brown mottled grey silty CLAY

| Remarks: | Trial pit logged from surface | Scale: 1:20 |
|---|---|---|
| All dimensions in millimetres | Dimensions derived from TP6 and as described by digger driver | |
| Sides of trial pits remained stable | | Logged by: JD |
| Groundwater not encountered, although heavy rainfall caused pit sides to collapse, obscuring footing | | |

| www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>6 |
|---|---|

| | |
|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | **Job Number**<br>J18148 |
| **Client** Re-Creo Developments Ltd | **Sheet** |
| **Engineer** Elliott Wood | **Dates**<br>24/08/2018 |

| **Excavation Method** | **Dimensions** | **Ground Level (mOD)** | **Location** |
|---|---|---|---|
| Mini digger | 1000 x 1000 x 3300 | | |




| Remarks: | | Scale:<br>1:20 |
|---|---|---|
| All dimensions in millimetres | Trial pit logged from surface | |
| Sides of trial pits remained stable | | Logged by:<br>JD |
| Groundwater not encountered | | |

| GEA | www.gea-ltd.co.uk<br>Herts \| 01727 824666 Notts \| 01509 674888 | **Trial Pit No**<br>6 |
|---|---|---|
| **Site** 13 Netherhall Gardens, London, NW3 5RN | | **Job Number**<br>J18148 |
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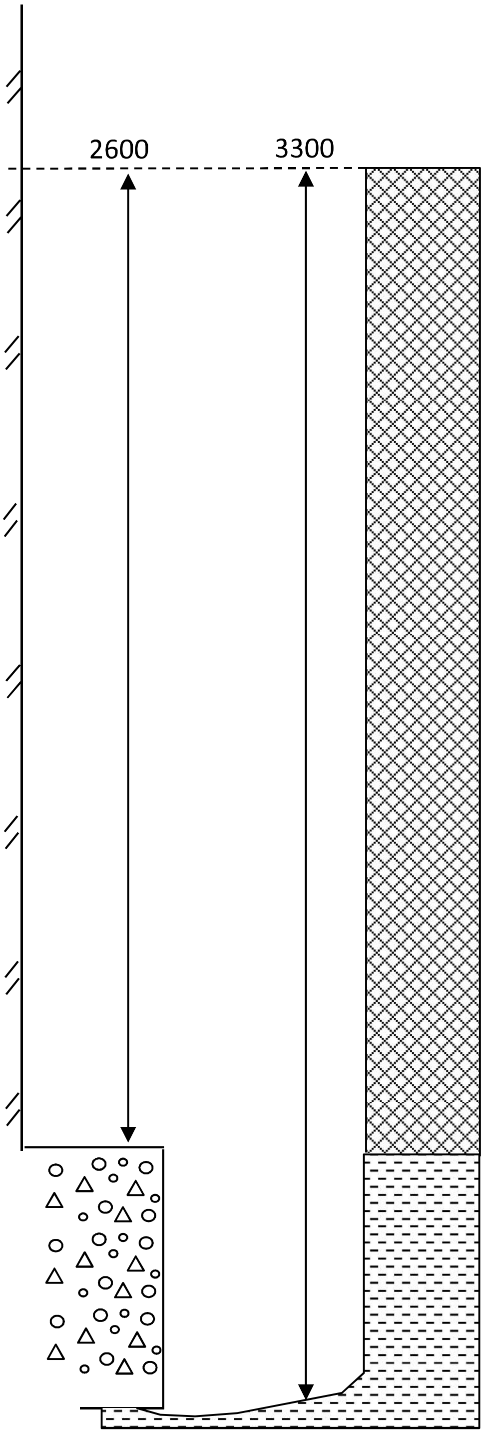
**Section A -A'**

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|---|---|---|
| All dimensions in millimetres | Trial pit logged from surface | |
| Sides of trial pits remained stable | | Logged by:<br>JD |
| Groundwater not encountered | | |