Lyons | O'Neill
Structural Engineers

# 18 Grove Terrace,

**Job No. 15168**

**Basement Impact Assessment**

**REV A - October 2016**

Lyons | O'Neill
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## Contents



## Appendices

## 1. Introduction

The site address is 18 Grove Terrace, NW5 1PH. The approximate National Grid Reference of the site is TQ 28521 58992

Lyons O'Neill were appointed in August 2015 by the client, Mr Jatin Vara to produce a Basement Impact Asssessment (BIA) which would accompany the report produced by Southern Testing Report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987).

The BIA has been produced in accordance with the guidance given within the Camden planning documents defined below:

- Camden Planning Guidance Document CPG4 : Basements and Lightwells,
- Camden Geological, Hydrogeological and Hydrological Study - Guidance for subterranean development, November 2010 (Arup)
- Camden Development Policy DP27: Basements and Lightwells

The report has been written by Lyons O'Neill, Structural Engineers and is to be read in conjunction with Southern Testing's report (Ref:JD11987) which focuses on the geotechnical issues.

Written by: Franco Di Pietro MEng

Signed:

Checked by: Ian Jewison BEng CEng MIStrucE

Signed:

## 2. Existing Building and Site Constraints

### 2.1. Site

The site is referred to as No. 18 Grove Terrace, London, NW5 1PH. The site is roughly rectangular in shape and measures approximately 60m long x 4.9m wide.

The topographic map shown on Figure 10 within Appendix D shows the site area as being at approximately 45 - 50m elevation above sea level.

The approximate National Grid Reference of the site is TQ 28521 58992.

The site is located on Terrace Grove, which has a gradual slope (approximately 1-2 degrees) in the south easterly direction from Parliament Hill/Hampstead Heath to the North/Northwest of the site. Gospel Oak station is located approximately 0.4km to the South West of the site.

The existing building is 4 storey's high with a lower ground floor and is a mid-terrace residential property. The property is classified as a listed building and is not thought to have been significantly altered since it was originally built.

#### 2.1.1. Historical Maps

The site history map contained within Appendix D shows that in 1866, a road had been constructed called 'Grove Road' on the site of the current road 'Grove Terrace'. It is highly likely that the road has since been renamed to Grove Terrace. If so this map shows the current property no 18. Grove Terrace was constructed prior to 1866.

#### 2.1.2. Bomb Blast Map

The Bomb Blast Map contained within Appendix D shows that the site was not directly hit by a bomb. However, a bomb did fall, approximately 50m away from the site. It is deemed that the any construction works at 18 Terrace Grove will be unaffected by this. Prior to the main works commencing further searches should be made as this information is not exhaustive.

#### 2.1.3. London Underground Map

The map within Appendix D shows the proximity of both the Northern Underground Line and the London Overground to the site. The London Overground lines are located approximately 300m to the South West of the site, and serve Gospel Oak Station which is approximately 400m from the site.

The Northern Line is located approximately 700m from the eastern side of the site They will not be affected by the works.

### 2.2. Existing Structure

The existing structure is a 4 storey residential building with a lower ground floor. It is situated mid terrace and is classified as a listed building. The structure is thought to comprise of solid load bearing masonry walls around the perimeter of the main building. Internal walls at ground level are thought to be a mixture of masonry and studwork, with timber joist floors at each level spanning between these walls.

It is proposed to carry out localised minor repairs within the interior of the existing building and to construct a one story basement extension at the rear of the property, within the garden.

The below ground drainage to the building is thought to run out to Grove Terrace. This is to be verified using information from both Thames Water and a CCTV below ground drainage survey. The intention is to, where possible, re-use the existing connection to the main sewer.

## 3. Screening (Stage 1)

### 3.1. Introduction

As part of the pre planning application process for basements within Camden, there are 4 stages that are defined within the Camden documentation that must be worked through in order to be able to:

- demonstrate how the proposed construction will impact on the existing situation
- identification of items that need to be investigated further, further investigation of these items
- describe proposed mitigation measures.

Information required within the screening stage is contained within Sections 3.2 – 3.4 below.

### 3.2. Groundwater flow

(Please refer to Section 13 of the ST Report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987).

### 3.3. Slope Stability

(Please refer to Section 14 of the ST Report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987)

### 3.4. Surface Flow and Flooding

*Q1 Is the site within the catchment of the pond chains on Hampstead Heath?*

No. Refer to Figure 14 Hampstead Heath Surface Water Catchments and Drainage Camden within Appendix E that shows the site located approximately 0.6 km from the catchment of the ponds on Hampstead Heath.

*Q2. 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. Existing surface water on the site either flows into drainage gulley's which are then linked to the existing below ground drainage system, or soaks into the existing soft landscaping.

The extent and condition of the existing drainage will be investigated within the detailed design phase using a CCTV survey.

In the proposed condition, if the existing pipe running underneath the front vaults will be found deeper than the proposed foundation formation level then the new cavity drainage to the vaults will be connected into this pipe. Otherwise, the drainage serving the drained cavity to the vaults will be pumped up to reach the existing pipe within the front of the site and then link in with the existing drainage at this level. It is proposed that the existing connection of the combined foul and surface water to the sewer within the roadway will be maintained, where possible, based on the condition of this.

*Q3. Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?*

No. The proposed total amount of hard landscaping area to the rear garden will be kept the same as the existing condition.

*Q4. Will the proposed basement 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 is no run off in the existing condition affecting these properties. Under the new proposals this will not change - there will be no surface water being received by the adjacent properties either upstream or downstream of the development.

*Q5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream properties?*

No, as no changes are occurring to the surface water on the property, the neighbouring properties will experience no change to the surface water that they receive.

*Q6.Is the site in an area known to be at risk from surface water flooding, or is it at risk from flooding, for example, because the proposed basement is below the static water level of a nearby surface water feature?*

No. The site address has been checked against the "New Basement Development and Extensions to Existing Basement Accommodation-Guidance Note" issued by London Borough of Camden-Dec '08 and the address is not within a location of surface water flood risk.

## 4. Scoping (Stage 2)

From the screening charts, the following questions produced a "yes" or "unknown" response. Q1b. of the Groundwater section and Q13 of the Slope Stability contained within the Southern Testing Report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987).

These items will be carried forward into the scoping stage of the process.

Specific items are:

- That the proposed basement may extend beneath the water table surface (see response to Q1b, within the ST Report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987).
- The proposed basement will significantly affect the depth of foundations relative to the neighbouring properties.(see response to Q13, within the ST Report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987).

These are addressed in the text below.

### 4.1. Basement constructed below the water table.

During the site investigation groundwater was not encountered within the shallow hand excavated pits, or in the deeper boreholes, during the intrusive phase of this site investigation.

Monitoring wells were installed in two boreholes and the site was revisited on two occasions to measure the standing water levels. A summary of the readings taken from the borehole piezometers is outlined in Table 1.

| Date of Reading | 7/10/2014 | 22/10/2014 |
|---|---|---|
| Location | Standing Water Level (mBGL) | |
| WS1 | 3.00 | 2.01 |
| WS2 | 1.80 | 1.34 |

Table 1 Summary of Borehole Piezometers

From the above table it's clear the highest recorded ground water levels were 1.34m BGL

and 2.01m BGL. The presence of standing water at these levels indicates that a perched water table exists, this is due to the fact that site consists of London Clay overlain by made ground and the perched water sits within the more permeable made ground.

Any perched water encountered during the formation of the basement will be dealt with using localised sump pumps.

The hydraulic gradient of the existing water table is believed to be almost flat, meaning there will be negligible risk of any up-stream rise in water levels as a result of the basement formation.

The basement slab be will designed for a water level 1m above the slab level.

The basement formed by the underpinned walls will be a grade 3 habitable space, formed by placing an internal cavity drainage system around the perimeter of the basement.

### 4.2. Stability of neighbouring properties

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground, particularly the garden. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures.

The proposed development will also result in differential foundation depths between the site and adjacent property and as such the Party Wall Act will be used and considered during the design phase. For basement developments in densely built urban areas, the Party Wall Act (1996) will usually apply because neighbouring houses would typically lie within a defined space around the proposed building works. Specifically, the Party Wall Act applies to any excavation that is within 3m of a neighbouring structure; or that would extend deeper than that structure's foundation; or which is within 6m of the neighbouring structure and which also lies within a zone defined by a 45° line from the foundation of that structure. The Party Wall process will be followed and adhered to during this development. Refer to Section 8 for more information on this.

## 5. Site Investigation and Study (Stage 3)

Stage 3 of the process covers the site specific site investigation to determine the site specific ground conditions and groundwater level. This is described within the Southern Testing report titled "Basement Impact Assessment and Site Investigation Report" (Ref:JD11987).

### 5.1. Desk Top Study

The North Camden Geological Map shown in Figure 4 in Appendix E shows the site geology as London Clay. This ties up with copy of the British Geological Map for the North London area, in Appendix D, that shows the site as being well within the London Clay strata.

#### 5.1.1. London Clay

London Clay is a well-known stiff (high strength) blue-grey, fissured clay, which weathers to a brown colour near the surface. It contains thin layers of nodular calcareous mudstone - "claystone" - from place to place, and crystals of water clear calcium sulphate (selenite) are common. Although slopes will stand in the clay at steep angles in the short term, the long-term stable slope angle is about 7° for grassed, or cleared slopes, and a few degrees more for wooded slopes.

#### 5.1.2. Radon Risk

With reference to the BRE Guidance, no radon protection is required on this site.

### 5.2. Groundwater

Data from the Environment Agency and other information relating to controlled waters is summarised in Table 2. The groundwater vulnerability assessment is based on the most current data on the EA website.

The site is shown as being approximately 0.6km from Highgate ponds, along the western edge of Hampstead Heath. Figure 14 within Appendix E shows that the site sits well outside the catchment area of any of the Hampstead ponds.

The Highgate Ponds are located approximately 2.5km away. Local watercourses drain into and through these ponds, which turns into the River Fleet.

#### 5.2.1. Lost Rivers

The Lost Rivers of London map shown within Appendix D shows an old tributary running very close to the site, but it is thought that this, if still active, has previously been placed in a culvert as there is no evidence of this at street level.

### 5.3. Site Investigation

A ground investigation was carried out by Southern Testing Limited (ST) on the site 28th of September 2014, and is summarised below, reference should be made to Southern Testing Report titled "Site Investigation Report" (Ref:JD11987) for a detailed description of the works.

The investigation comprised of the following works:

- 2 No. window samples carried out to a depth of 6m (WS1, WS2).
- Groundwater monitoring wells were installed in both window sample boreholes for groundwater monitoring purposes

- 4 No. Hand excavated pits to establish the nature of the existing foundations to the existing building, and those to the perimeter garden boundary walls with the neighbouring properties. These also provided information on the ground conditions in these areas.

The location of these trial holes is given within the copy of the site investigation report contained in Appendix G.

Whilst detailed descriptions of the soils encountered within the borehole, together with trial pit logs are given in ST's Investigation report, a condensed summary of the soil conditions encountered is given within Table 2 below, with depth below ground level (BGL) noted.

The locations of the trial pits and windows sample are shown within Southern Testing Report titled "Site Investigation Report" (Ref:JD11987).

Trial Pit 1 was formed against the face of the brickwork boundary wall with the neighbouring property on the northern side of the site (No. 17 Terrace Grove) and against the rear porch of the subject property (No.18 Terrace Grove). TP1 showed that the footings for both the rear porch wall and the boundary wall were shallow brickwork footings, founded approximately 1m – 1.38m below ground level within the made ground

Trail Pits 2 and 3 were formed against the brickwork boundary wall along the property on the southern side of the site (No. 19 Terrace Grove). Trial Pit's 2 and 3 showed the footing to the wall is a shallow brickwork footing, founded approximately 1m – 1.38m below ground level within the made ground.

Trial Pit 4 was formed against the face of the brickwork boundary wall with the neighbouring property on the northern side of the site (No. 17 Terrace Grove) and showed the footing to the wall is a shallow brickwork footing, founded approximately 1m below ground level within the made ground.

The 2 window samples showed a consistent site geology comprising of a layer of made ground, between 1.24m and 2m thick, underlain by a layer of London Clay, becoming stiffer with depth. No groundwater was encountered during the digging of these samples. Detailed descriptions are provided in the borehole logs.

### 5.4. Bearing Capacity

Where it is necessary to construct spread foundations or bases to retaining walls/underpinned sections as part of the proposed works, all foundations will penetrate any made ground and be formed within the underlying natural High Strength Clay materials. For foundations formed on these materials, the geotechnical engineers recommend that an allowable bearing capacity of 125kPa should be adopted.

### 5.5. Heave

Due to stress relief following the removal of the existing soils to form the basement structure(s), both immediate (undrained) and long term (drained) heave displacements can be expected to occur in the underlying London Clay. The immediate (undrained) heave displacements will occur as excavation of the basement takes place and before the construction of basement elements e.g. slabs etc. Accordingly, only the long term (drained) heave displacements will need to be catered for in design, to overcome the problem of uplift pressures forming.

To cater for the heave, a compressible material will be placed to the underside of the suspended basement slab. This will compress in the event of any upwards movement from the soil. Checks will also be made to ensure that the dead load applied to foundations will be sufficient to resist uplift forces (with concrete thickness being locally increased where additional dead load is required).

| Depth to Base (m BGL) | Soil Type | Description |
|---|---|---|
| GL-1.24m/2m | Made Ground | Variable Made Ground comprising sandy gravelly clay, coarse to fine angular gravel comprised of brick and concrete. |
| 2m-6m | London Clay | Very stiff dark grey sandy fissured CLAY with scattered gypsum crystals. |

**Table 2 Summary of Borehole Logs**

## 6. Site Hydrology

### 6.1. Site Specific Groundwater Conditions

No groundwater was encountered during the formation of the trial pits or the boreholes. As part of the investigate works, groundwater level monitors were also installed within the 2 boreholes constructed.

The monitoring wells measured standing water levels of 1.34m BGL and 2.01m BGL. The presence of standing water reflects a perched groundwater table within the made ground.

On the basis of the measurements to date, groundwater ingress is not expected to be a significant problem in terms of dewatering issues etc. during construction. However, an allowance for a sump and temporary pump will be provided on an as required basis to remove any water that collects in the excavation during the construction of the basement (due to rain water / ground water ingress into the excavation).

Seepage entries from fissure flow within the clays and any perched groundwater will be

dealt with in the permanent condition using a drained cavity placed internally around the perimeter of the piled walls forming the basement. Any perched groundwater will be collected in a channel at the base of the internal drained cavity, which will then be routed to an internal manhole and pumped up to ground floor level to the existing below ground drainage system, in accordance with BS8102.

Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10-9 m/s and 1x 10-14 m/s, with an even lower vertical permeability. Accordingly, the groundwater flow rate is anticipated to be extremely low to negligible.

Any groundwater flows that will take place will likely follow the local/regional topography which in this instance comprises of local falls to the south of around 1-2º. Given the very slights fall in the local/regional topography, hence almost negligible hydraulic gradient, and the very low/impermeable nature of the underlying clay materials, there is negligible risk of the proposed basement walls causing a 'damming effect' or mounding of water on the upstream faces. On the basis of the observations/comments, it is concluded that the proposed development will not result in any specific issues relating to the hydrogeology of the site.

The proposed basement will therefore not cause any issues relating to the hydrogeology and hydrology of the site.

| Data | | |
|---|---|---|
| Aquifer Designation | Superficial Deposits | There are no superficial deposits mapped |
| | Bedrock | London Clay-Unproductive Strata. Deposits with low permeability that have negligible significance for water supply or river base flow. |
| Source Protection Zones | | The site is not located with a Source Protection Zone |
| Abstractions | | On the basis of the information on the EA website (October 2014) There is no licences for water abstraction in this area. |
| Surface Water Features | | The "Risk of Flooding from Surface Water" mapping on the Environment Agency website October 2014) shows the site to be within an area of Very Low Risk. Very Low Risk means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%). |
| | | |
| Watercourses, well (used/disused) or potential spring lines | | The nearest water course shown on the Camden Plan of Watercourses (Source Lost Rivers of London) shows the River Fleet approximately 100m to East.<br><br>According to the BGS Geology of Britain Viewer the nearest well (now abandoned) is shown 220m to the North West in the grounds of William Ellis School. We are not aware of any other active wells. Given the geology of the area (London Clay) the potential presence of spring lines are negligible. |
| Fluvial & Reservoir Flood Risk | | On the basis of the information given on the EA website (September 2015) the site is not located within an area of potential risk of flooding from reservoirs or fluvial sources. |

**Table 3:** Summary of Geology and Hydrology

The proposed basement will not result in any specific issues relating to land or slope stability. Whilst a proposed sequence of construction is outlined in Section 9, the contractor will be expected to work up his own sequence, outlining the temporary works involved and when in the construction process these will be installed.

## 7. Proposed Works

### 7.1. Introduction

Drawings **15168/P/001-REV A, 15168/P/002-REV A** and **15168/P/003** within Appendix B show the proposed structural arrangement of the building. Whilst there are other methods of construction, the form of construction for the basement is not expected to change.

#### 7.1.1. Basement

The proposed works involve the excavation of the existing floor to the front vaults and the formation of a new floor approximately 680mm lower than the existing. In order to allow the excavation, the vaults perimeter walls are proposed to be underpinned in reinforced concrete and the central wall between the 2 vaults is proposed to be underpinned in mass concrete. A new suspended RC slab cast on heave protection will span from the perimeter RC base to the central mass concrete underpinning.

At the rear of the property a new staircase will lead to the existing lower ground floor level. Part of the rear garden is proposed to be excavated down to existing lower ground floor level to allow for the new staircase. RC retaining walls are proposed to prop the soil around the new stair void in the permanent condition. These are located in board of the garden

boundary walls on either side.

The RC walls and the RC base in-between the walls are proposed to be cast in sequence.

The walls will act as cantilevers to resist the soil pressure.

RC underpinning is suitable in clay soils with a low water table level, and affords the maximum useable space for the basement. The above is proven methods of construction which will result in low movements of the existing structure.

The underpinning will be formed using reinforced concrete retaining elements, installed in a traditional hit-and-miss underpinning sequence. This involves the formation of pins maximum 1.0m wide with minimum 2 bays between working pins. This will avoid instability of the existing perimeter walls as the soil behind and masonry over will arch around local excavations. Reinforcement continuity strips will be installed on top of the inner face of the RC underpinning in order to allow the installation of the new stub RC wall cast against the perimeter vault walls. Refer to Section B-B on drawing 15168/P/003.

Reinforcement continuity strips will be placed also at the bases of the underpinning walls in order to create a structural connection with the suspended RC slab.

The underpins to the vaults will be founded within the London Clay, which is the same founding strata as the existing walls. The base and kicker to the wall will be formed first. The rear face of the excavation will be propped during the formation of the vertical stem of the pin to avoid movement of the soil behind the wall. All excavations beneath existing walls, particularly party walls, will be undertaken carefully, using low vibration tools to avoid impact on the existing structures. The use of these tools will be agreed with the contractor, prior to the works commencing.

When the underpinning is complete the contractor will start the excavation of bulk soil. This will be undertaken in a sensitive manner in order to avoid damaging the historic fabric and finishes of the building.

Although the water table has been shown to be located well below the level of the new basement, the design of the new perimeter basement walls will be designed to resist active soil pressures, surcharge forces and a conservative water pressure taken as 1m below the top of the wall. Retaining walls will transfer such loads in bending to the RC bases bearing onto London Clay.

The basement is categorised as Type 3, in line with the requirements of BS 8102. This defines the space as a dry environment, with no water penetration. In order to comply with this, a drained cavity will be placed in front of the retaining walls. This will pick up any perched water within the made ground that may have ingressed through the wall.

### 7.2. Proposed Method of Analysis

The overall construction sequence and temporary/permanent propping regime will require detailed design to ensure that potential lateral and vertical movements are kept within acceptable levels.

For the purpose of analysing the basement walls and foundations, appropriate parameters will be used for the design associated with changes in loadings on the London Clay.

A heave/settlement analysis will be carried out using commercial software packages such as RSA or VDisp to assess any possible movements.

Condition surveys of the subject building will also be undertaken prior to the commencement and at the end of the site works.

The party wall process may also require that targets are installed on this building and monitored on a regular basis throughout the duration of the works to ensure that any movements are kept within acceptable and pre-agreed levels, as described within Section 8.

## 8. Protection of Adjacent Structures

### 8.1. Party Wall Matters

The proposed development falls within the scope of the Party Wall Act 1996. Procedures under the Act will be dealt with by the Employer's Party Wall Surveyor. The Party Wall Surveyor will prepare necessary notices under the provisions of the Act and agree Party Wall Awards in the event of any disputes.

The Contractor will be required to provide the Party Wall Surveyor with appropriate drawings, method statements and all other relevant information covering the works that are notifiable under the Act, which will necessitate confirmation of existing footing profiles for each condition. The resolution of matters under the Act and provision of the Party Wall Awards will protect the interests of all owners.

The proposed works to form the basement will be designed and detailed so that any movement of the existing structure is no worse than "Category 1", defined as Very Slight within the BRE Digest 251 Table 1 and CIRIA 580 (Burland et Al).

The example calculation within Appendix F shows how this category is achieved using the anticipated movements of the RC underpins. This exact levels will be agreed as part of the party wall process, and the movement of the existing building will be monitored twice weekly during the formation of the basement using targets placed to the face of the walls. Monitoring is discussed in more detail in Section 8.3

Condition surveys of the adjoining properties will be undertaken prior to commencement of the site works. Data from monitoring stations will be regularly analysed during construction to ensure that there is no unexpected movement that may affect the adjoining properties on either side.

### 8.2. Temporary Works

The design of the temporary works and the temporary stability of any existing structure to be retained as part of the permanent works is entirely the responsibility of the contractor.

The temporary works discussed below and shown indicatively on the drawings within Appendix C outline the expected temporary works required. All of this information will be firmed up by the contractor following their appointment. The contractor is to submit an overall Method Statement a minimum of 4 weeks prior to a site start and detailed drawings and calculations a minimum of 4 weeks, which are to include an assessment of the anticipated ground movement due to the RC underpinned, this is also to cover each stage of construction, initial excavation, propping, full excavation etc.

The contractor will also be required to appoint a Temporary Works Co-ordinator for the duration of the contract in accordance with the specification.

### 8.3. Monitoring Strategy

All items of temporary works and surrounding structures are to be monitored in a manner and frequency commensurate with the construction activity taking place. As a minimum the monitoring should include a daily full visual survey of all temporary works and surrounding structures, and a twice weekly measured survey of the existing structure using fixed survey points to be agreed with the Party Wall Surveyors.

The limits of any movement may be set against the colours green, amber and red:

Green: - Settlement recorded within predicted movements.
Amber: - Settlement recorded is approaching the predicted movements.
Red: - Settlement recorded is above the predicted movements.

### 8.4. Remediation Measures should levels be exceeded

If the amber levels are exceeded, the contractor is to notify the Engineer and review the construction sequence.

If the red levels are exceeded at any point during the works, the contractor is to immediately cease the construction works and install temporary props/reinstall excavated material such as required to the face of the wall in order to prevent any further movement. These measures are to be kept in place until such time as the engineer deems them suitable to be removed.

The contractor is to ensure he has either have adequate provision in terms of props on site during the works, or be able to obtain temporary props required at short notice in order to install these in the event of the amber levels being exceeded.

### 8.5. Outline Monitoring Specification

Target locations for monitoring are to be agreed with the adjoining owners Party Wall Surveyors for inclusion on the Party Wall Award. The frequency of monitoring is to be agreed prior to execution of the works. A recommended frequency for monitoring is outlined below:

Prior to the commencement of the works: - Baseline readings are to be taken
During the installation of the underpins - Weekly readings
At the completion of each phase of the work: - Single readings taken
End of the construction stage: - Final readings taken

A stable datum must be maintained and the observed monitoring points must be an integral part of the structure. Targets are to be surveyed to an accuracy of ±1mm and read in three dimensions, i.e. the X, Y and Z axes.

Recordings should demonstrate the vertical and horizontal movements that have occurred since the previous measurements were taken.

Lateral and vertical movement limits are to be set against Green, Amber and Red limits. These limits are to be agreed by the Party Wall Engineer and the Pile Designer during the party wall process.

## 9. Impact Assessment (Stage 4)

### 9.1. Conclusion

It has been shown within this document that the proposed works will not impact on the existing geological or hydrogeological conditions, and as the ground is flat, slope stability will not be an issue.

Whilst perched groundwater within the made ground has been identified, the proposed basement design has included measures to accommodate this.

Provided the works are undertaken in a logical and safe manner the works will not have a detrimental effect on either the existing building. An assumed construction sequence is included within the report, which it is expected that the appointed contractor will use to inform his sequencing for undertaking the works.

## 10. Proposed Sequence of Construction

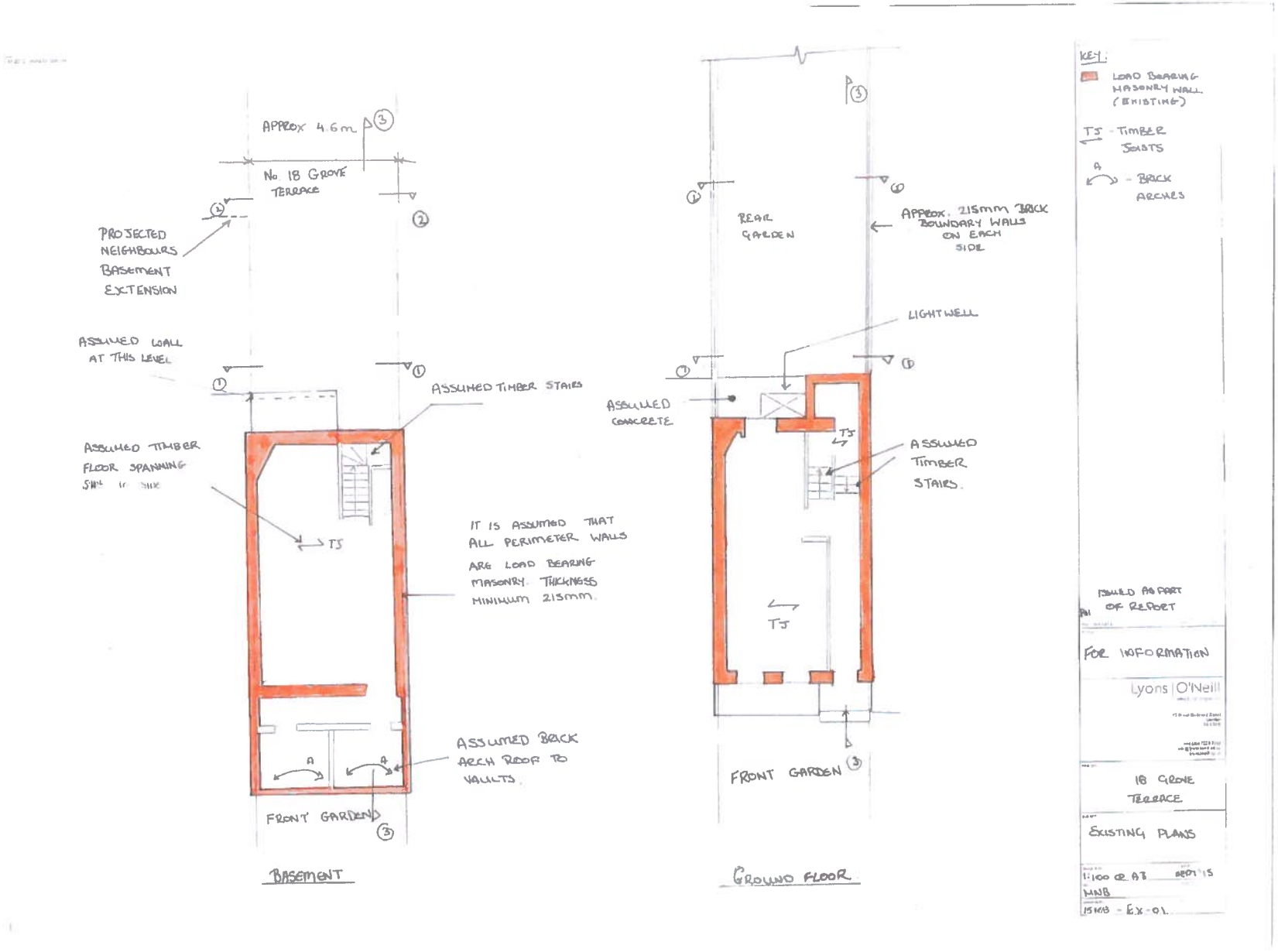
An assumed sequence of construction is described below. This summarises our initial thinking as to how the proposed works will be undertaken. but does not relieve the contractor from undertaking his own construction sequence in order to demonstrate that he has understood all of the challenges involved.

The proposed construction sequence for the new works is outlined below:

- Mobilise and set up site welfare
- Determine route of all services and cap these off as required.
- Commence underpinning of existing masonry walls, in a hit and miss sequence.
- Finish hit and miss underpinning
- Install heave protection to the underside of the basement slab.
- Place basement slab reinforcement and cast basement slab.

# Appendix A

# Existing Drawings


APPROX 4.6m
No. 18 GROVE TERRACE
PROJECTED NEIGHBOURS BASEMENT EXTENSION
ASSUMED WALL AT THIS LEVEL
ASSUMED TIMBER STAIRS
ASSUMED TIMBER FLOOR SPANNING
TJ
IT IS ASSUMED THAT ALL PERIMETER WALLS ARE LOAD BEARING MASONRY. THICKNESS MINIMUM 215mm.
ASSUMED BRICK ARCH ROOF TO VAULTS.
FRONT GARDEN
BASEMENT
REAR GARDEN
APPROX. 215mm THICK BOUNDARY WALLS ON EACH SIDE
LIGHTWELL
ASSUMED CONCRETE
ASSUMED TIMBER STAIRS.
TJ
FRONT GARDEN
GROUND FLOOR
KEY:
LOAD BEARING MASONRY WALL (EXISTING)
TJ - TIMBER JOISTS
A - BRICK ARCHES
ISSUED AS PART OF REPORT
FOR INFORMATION
Lyons | O'Neill
18 GROVE TERRACE
EXISTING PLANS
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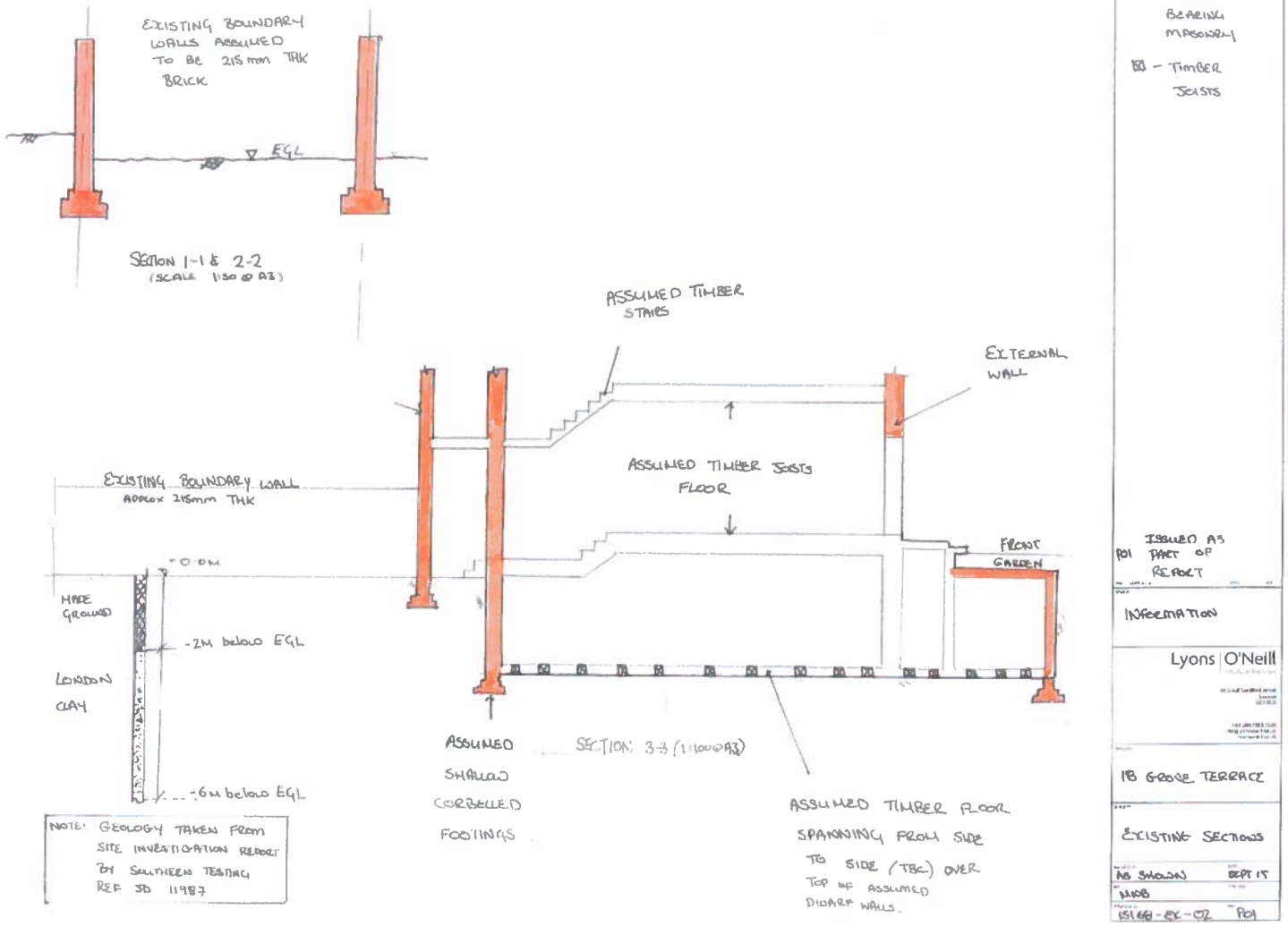
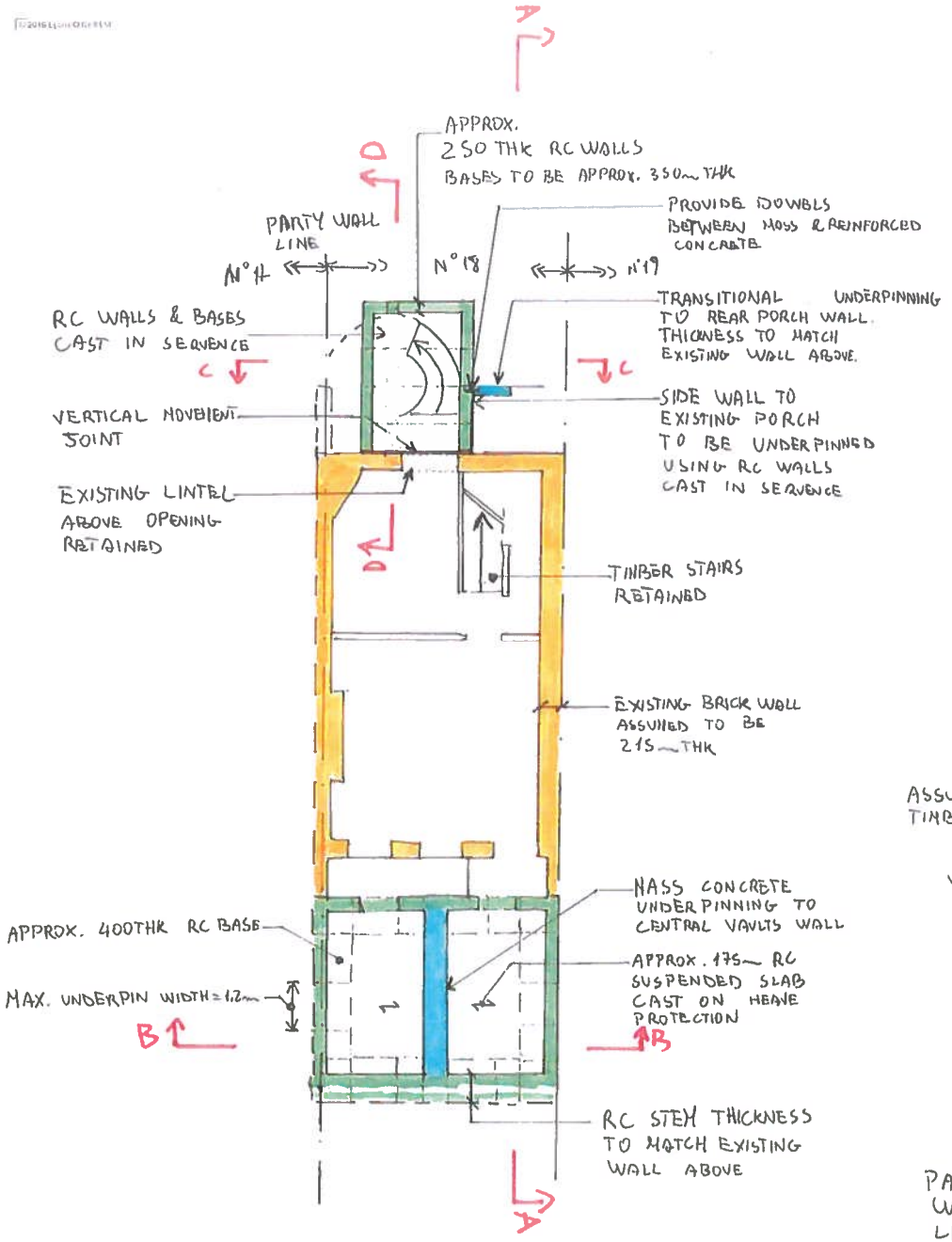
MNB
15MB - EX-01

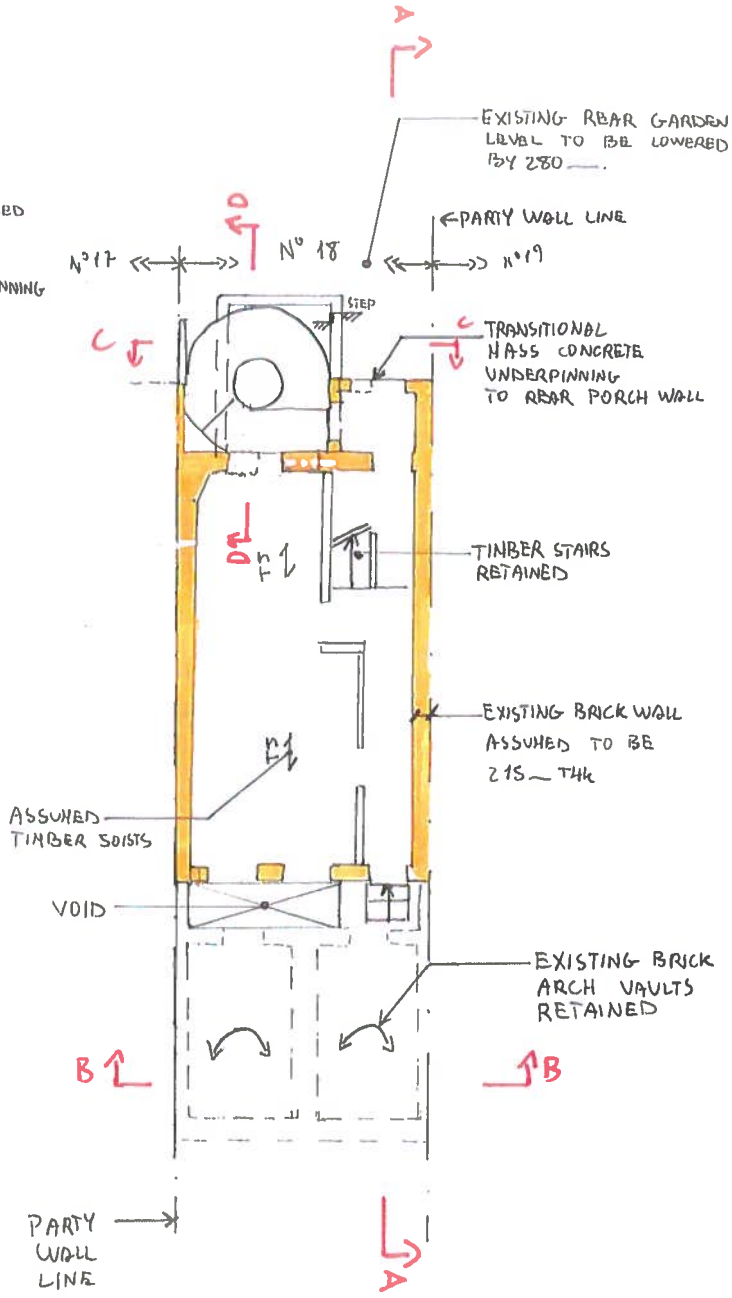

EXISTING BOUNDARY WALLS ASSUMED TO BE 215mm THK BRICK
EGL
SECTION 1-1 & 2-2
(SCALE 1:50 @ A3)
ASSUMED TIMBER STAIRS
EXTERNAL WALL
EXISTING BOUNDARY WALL
Approx 215mm THK
ASSUMED TIMBER JOISTS FLOOR
FRONT GARDEN
TOP
MADE GROUND
-2M below EGL
LONDON CLAY
-6M below EGL
NOTE: GEOLOGY TAKEN FROM SITE INVESTIGATION REPORT BY SOUTHERN TESTING REF JD 11987
ASSUMED SHALLOW CORBELLED FOOTINGS
SECTION 3-3 (1:100@A3)
ASSUMED TIMBER FLOOR SPANNING FROM SIDE TO SIDE (TBC) OVER TOP OF ASSUMED DIVIDE WALLS.
KEY:
- ASSUMED LOAD BEARING MASONRY
TJ - TIMBER JOISTS
P01 ISSUED AS PART OF REPORT
INFORMATION
Lyons | O'Neill
18 GROVE TERRACE
EXISTING SECTIONS
AS SHOWN
SEPT 15
MMB
151166-EX-02
P01

# Appendix B

# Proposed Drawings




BASEMENT




GROUND FLOOR

KEY

- RC STRUCTURE IN SECTION
- STRUCTURE UNDER
- EXISTING MASONRY IN SECTION
- MASS CONCRETE IN SECTION

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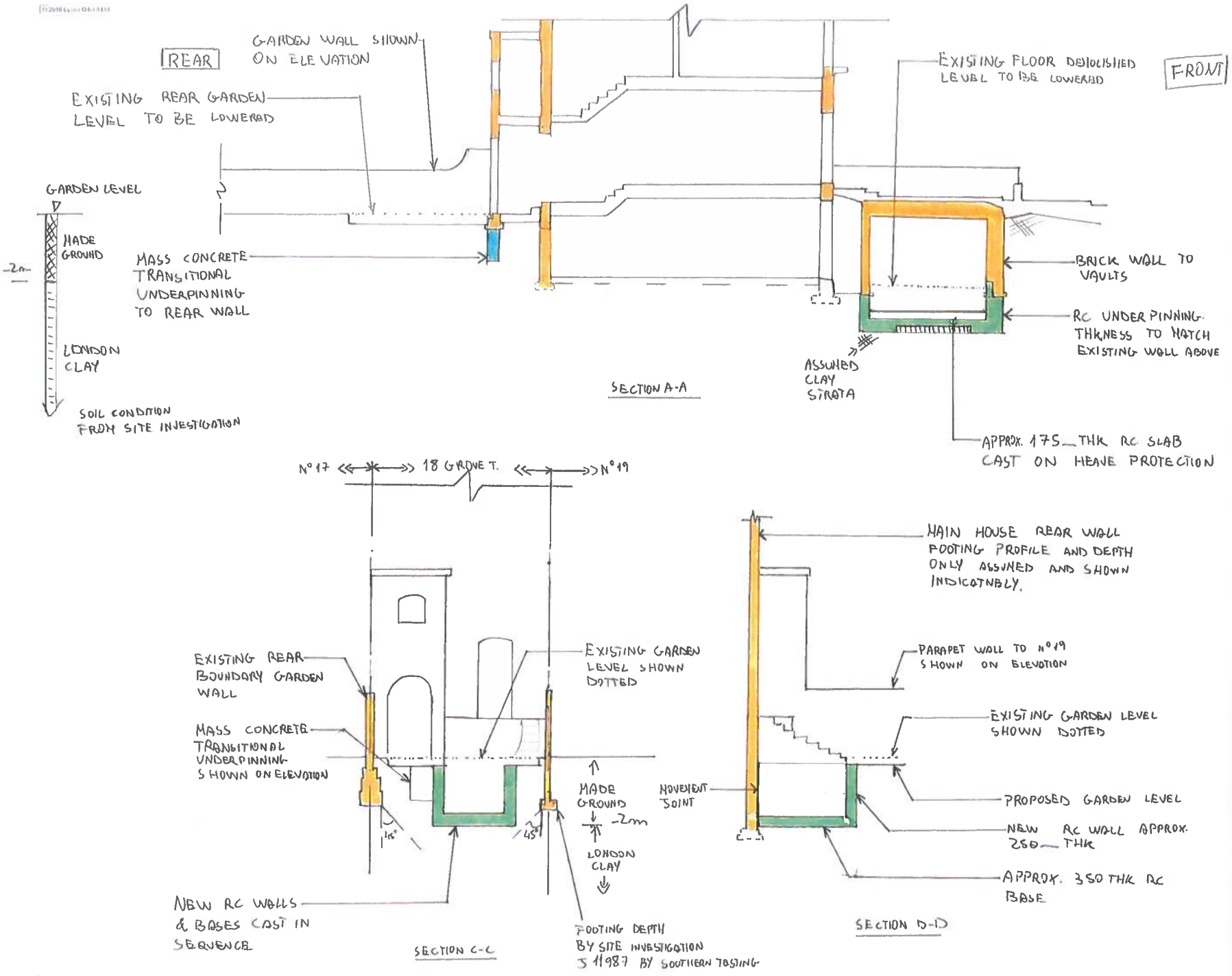
18 GROVE TERRACE

PROPOSED BASEMENT & GF PLAN

1:100 SEPT '16

FDP ES

1516B/P/001 A




Lyons | O'Neill

18 GROVE TERRACE

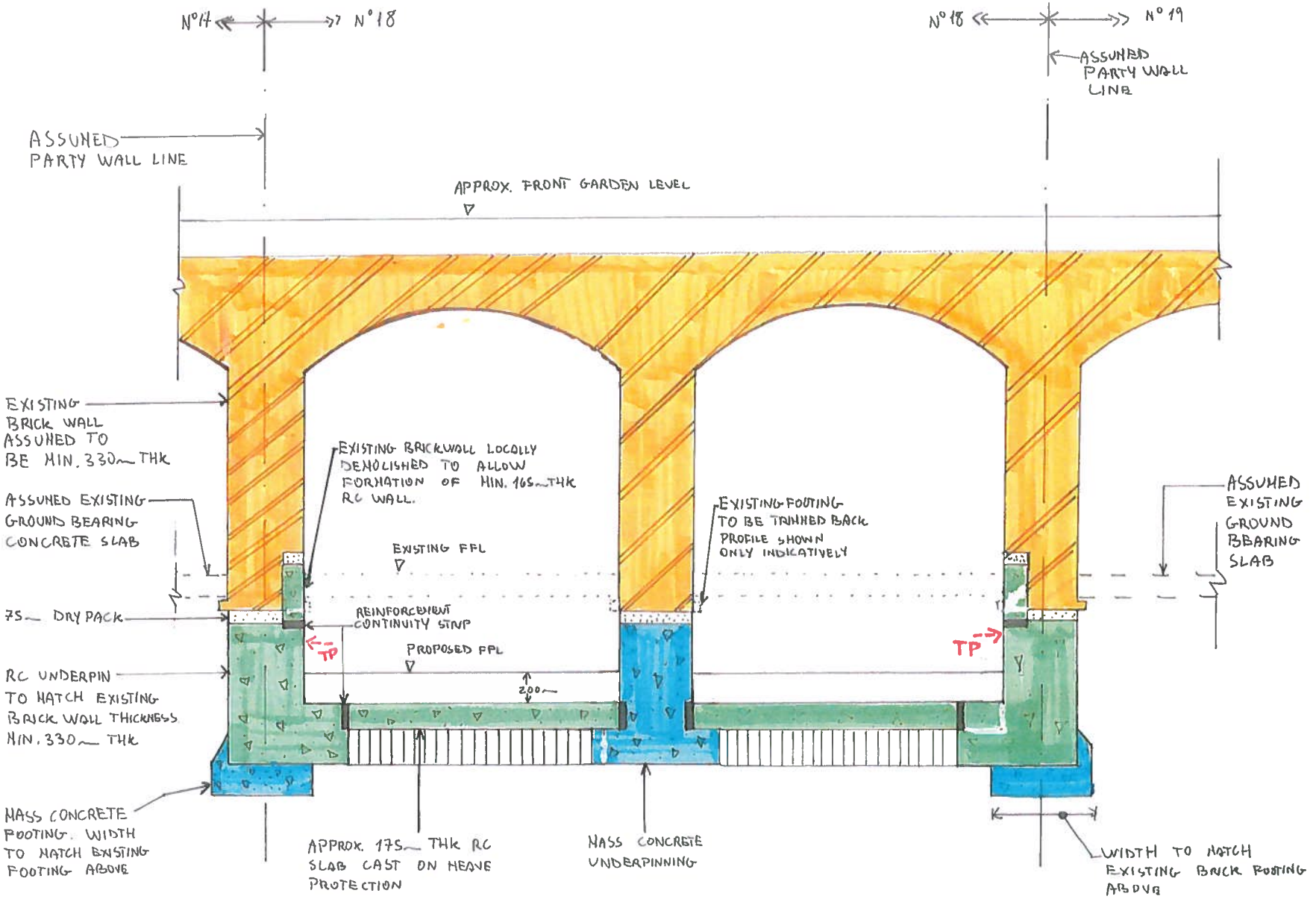
SECTION A-A, C-C & D-D

1:100 SEP'16

FDP IS

15768/P/002 A

NOTE: ALL TEMPORARY WORKS TO CONTRACTOR DETAILS




SECTION B-B

KEY

TP ← TEMPORARY PROPS

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18 GROVE TERRACE

SECTION B-B

1:25

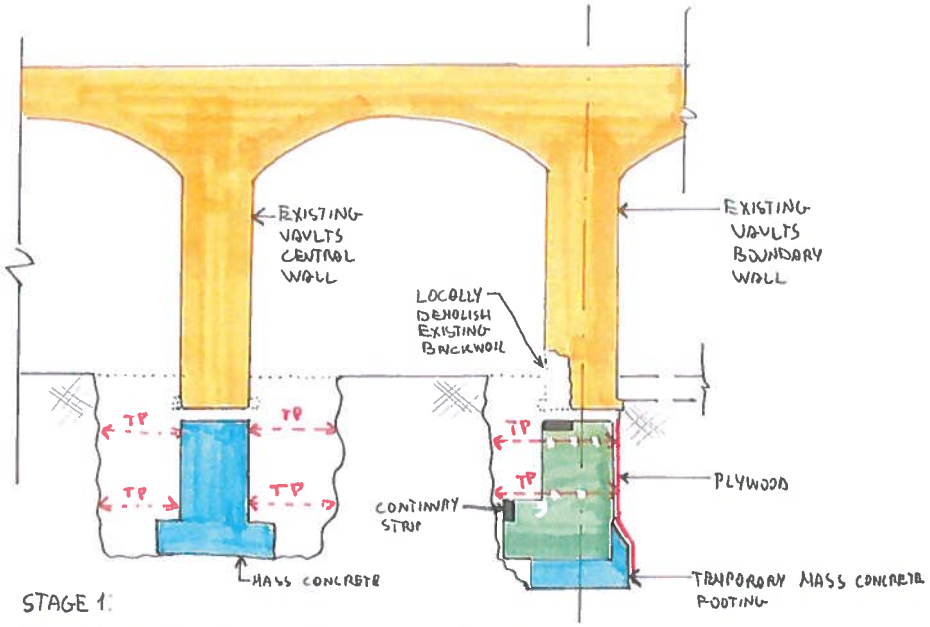
FDP

IS

15168/P/003

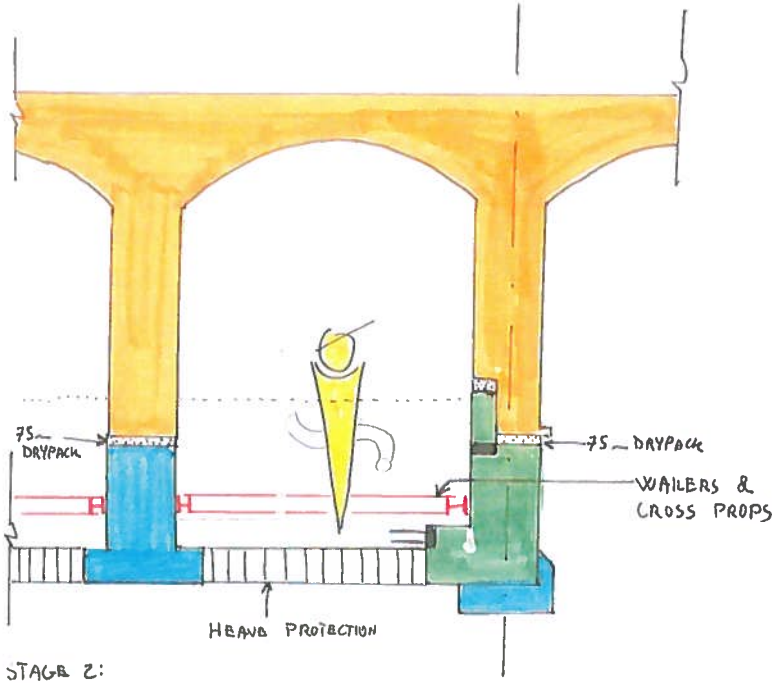
# Appendix C

## Assumed Sequence of Construction Sketches




STAGE 1:

- EXCAVATE BENEATH BOUNDARY WALL & CENTRAL WALL IN A HIT & MISS SEQUENCE. MAXIMUM EXCAVATION WIDTH = 1m.
- INSTALL PLYWOOD TO REAR FACE OF RC WALLS
- INSTALL TEMPORARY PROPS TO ALL THE EXCAVATIONS
- CAST MASS CONCRETE UNDERPINNING TO CENTRAL WALL & TEMPORARY FOOTING TO BOUNDARY WALL
- CAST RC UNDERPINNING AND PLACE CONTINUITY STRIPS TO BASE & TO TOP OF WALL




STAGE 2:

- DRYPACK WALLS
- PULL OUT CONTINUITY STRIP TO WALL HEAD & CAST 165 THK RC WALL AGAINST EXISTING BRICK WALL.
- ONCE ALL THE UNDERPINS ARE INSTALLED REMOVE PROPS & REDUCE LEVELS DOWN TO UNDERPINS BASES. INSTALL A SERIES OF WAILERS & CROSS PROPS TO THE WALLS AND EXCAVATE FURTHER DOWN. INSTALL DRAINAGE
- INSTALL HEAVE PROTECTION
- PULL OUT CONTINUITY STRIPS TO RC BASES
- PLACE REINFORCEMENT AND CAST RC SLAB ONTO HEAVE PROTECTION
- REMOVE PROPS
- WATERPROOFING INSTALLED

NOTE: A SIMILAR STRATEGY CAN BE APPLIED TO THE REAR EXCAVATION.

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PROJECT: 18 GROVE TERRACE

ASSUMED SEQUENCE SKETCH

SCALE @ A1: NTS
DATE: Oct '16
BY: FDP
CHECKED: IS
DRAWING NO: 15165/S/001
REV: A

# Appendix D

## Historical and Geological Maps

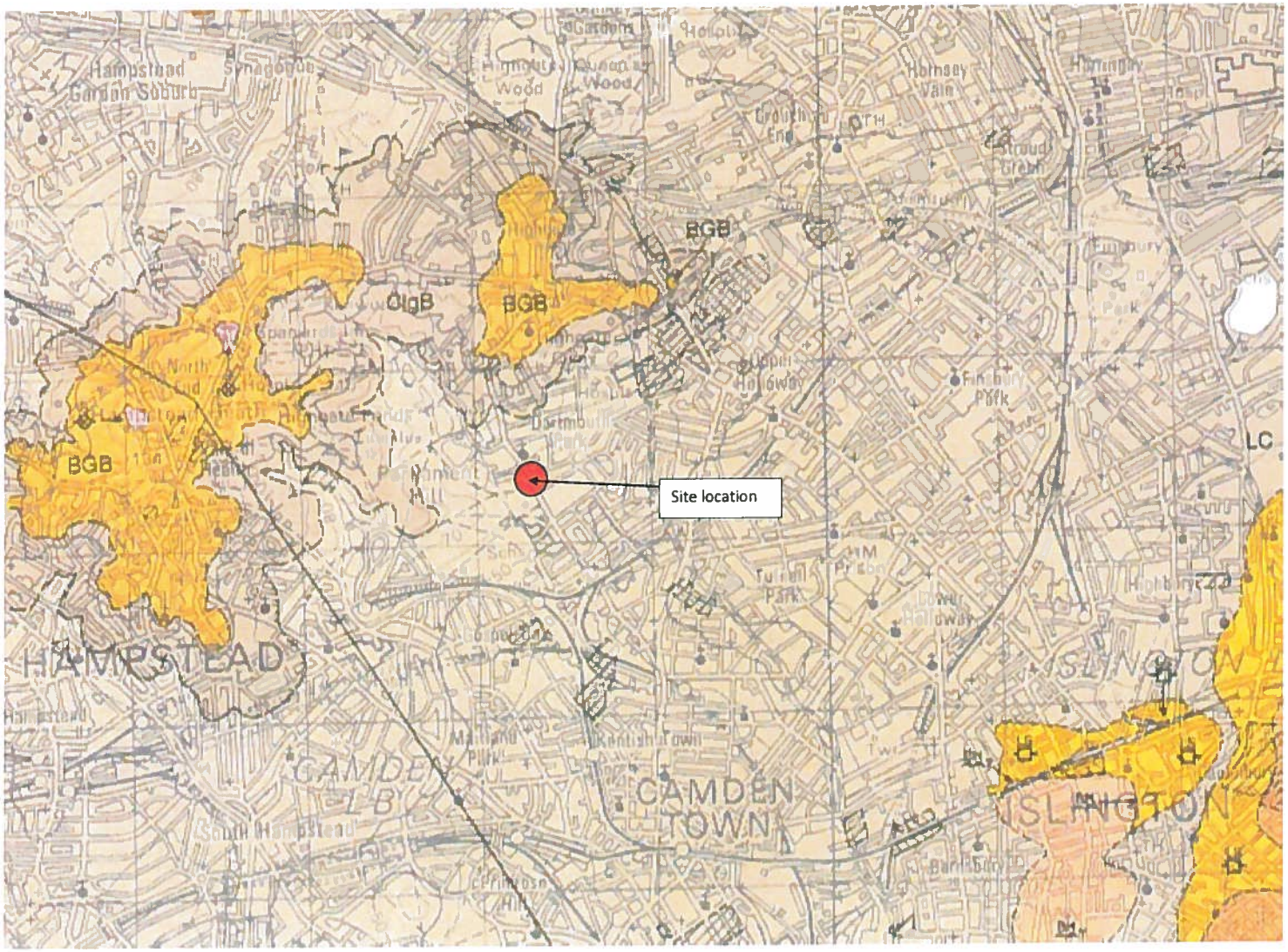



Figure 1 Topographical Map of London

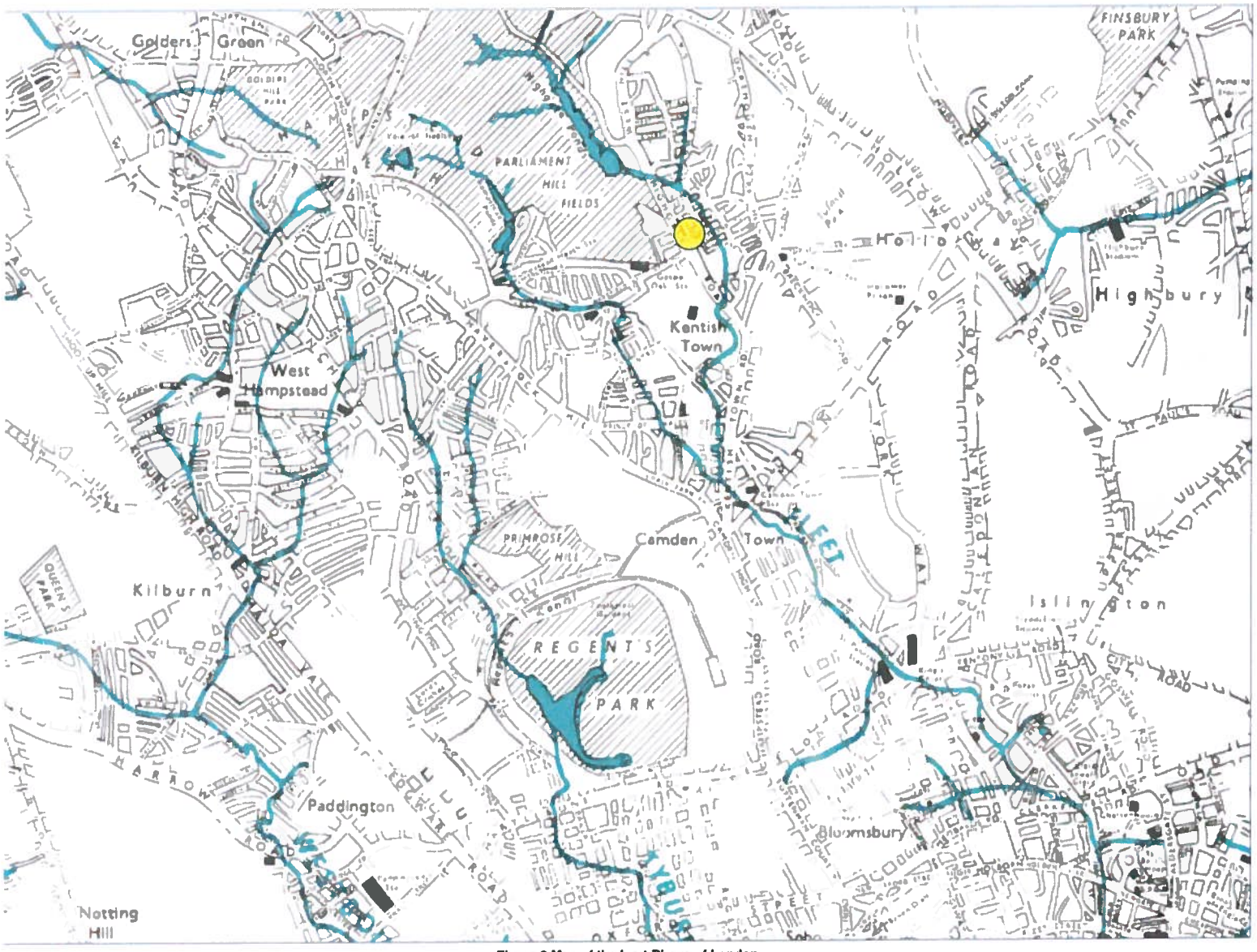



Figure 2 Map of the Lost Rivers of London


**Figure 3 Bomb Blast Map**

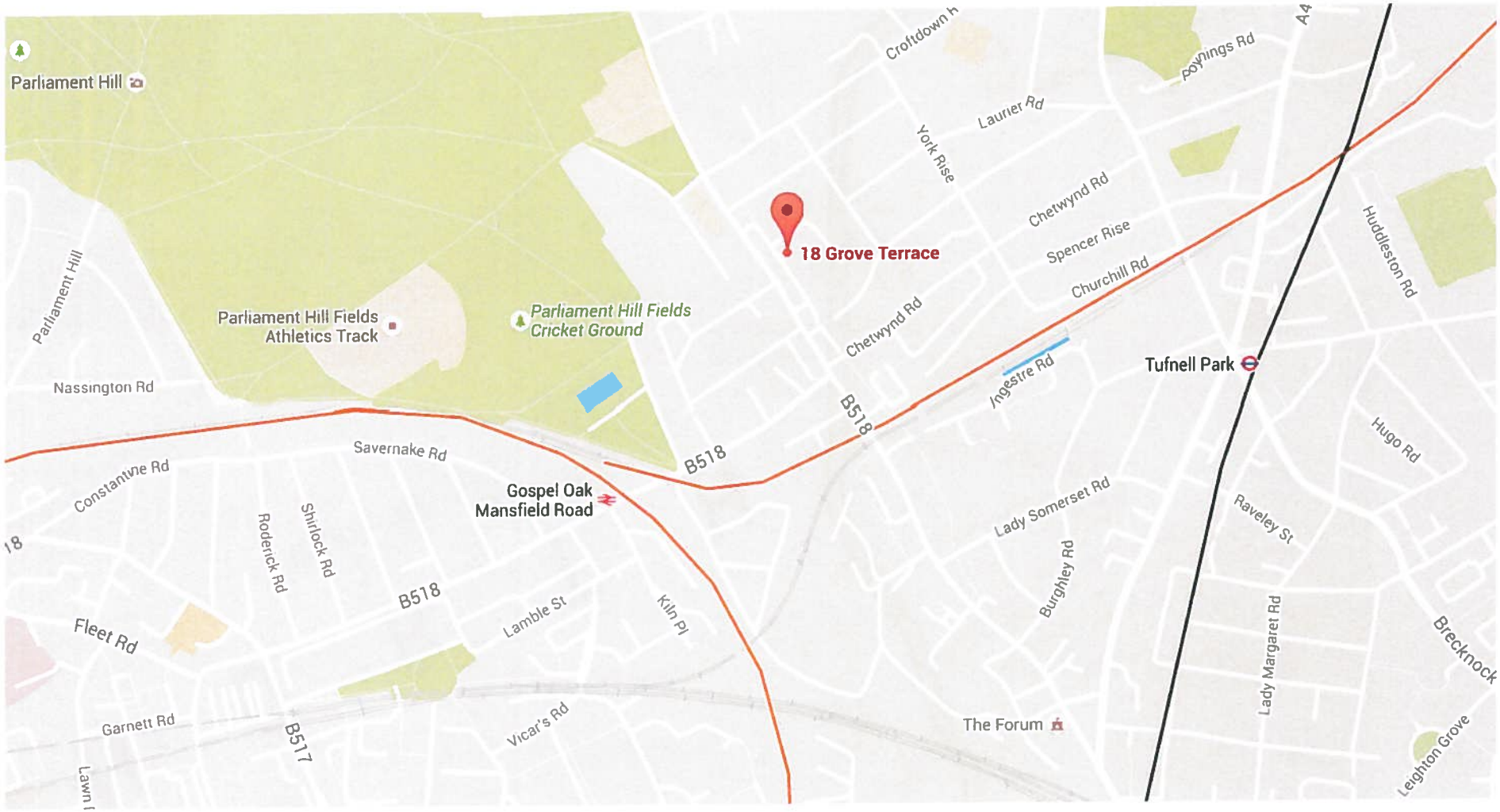



**Figure 4 Map of London Transit links near the site**

## History Maps - 1866

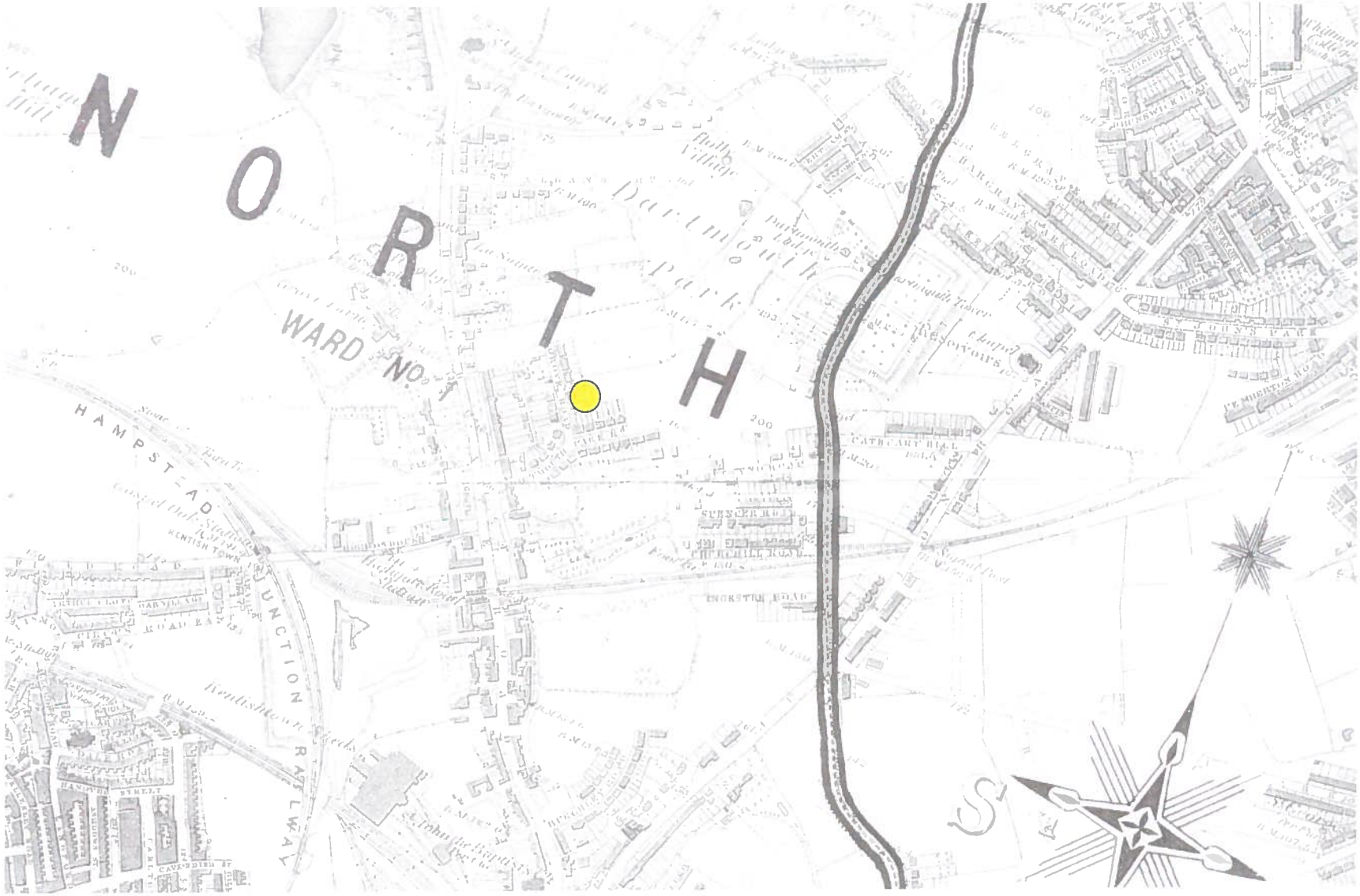



Figure 5 Historical Map of St. Pancras North from 1866

# Appendix E

## Camden Geological, Hydrogeological + Hydrological Maps

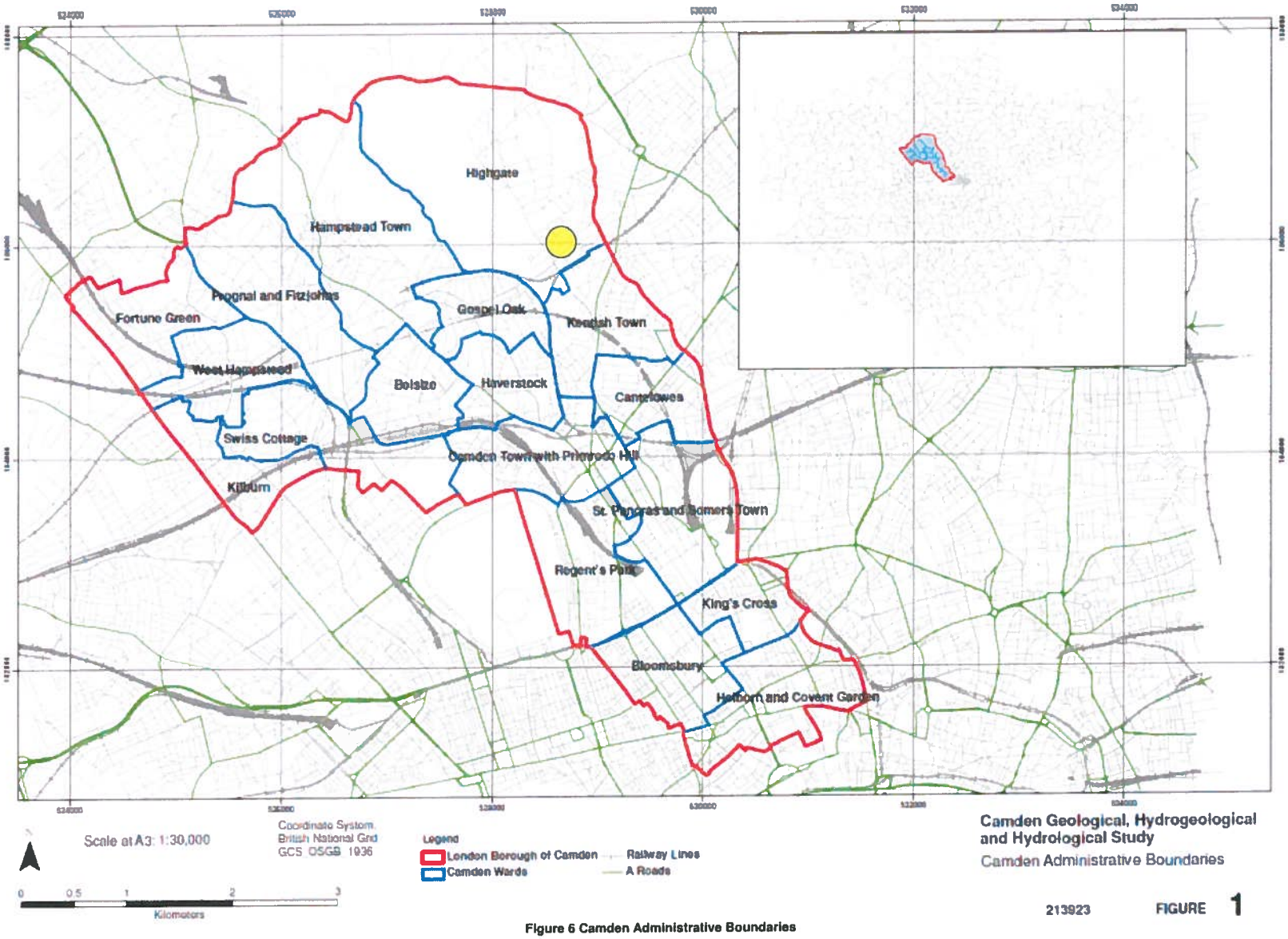



Figure 6 Camden Administrative Boundaries

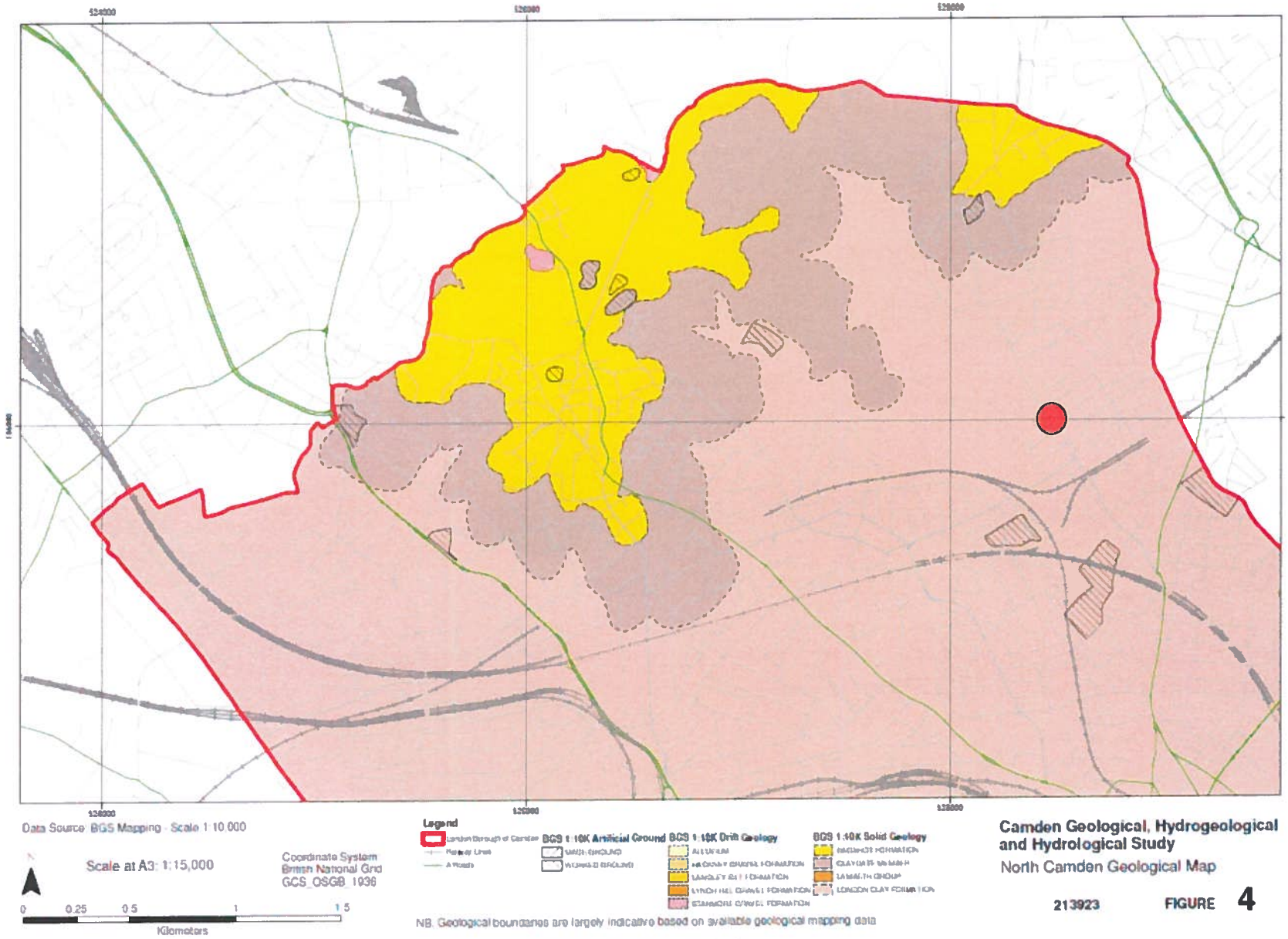



**Figure 7 North Camden Geological Map**

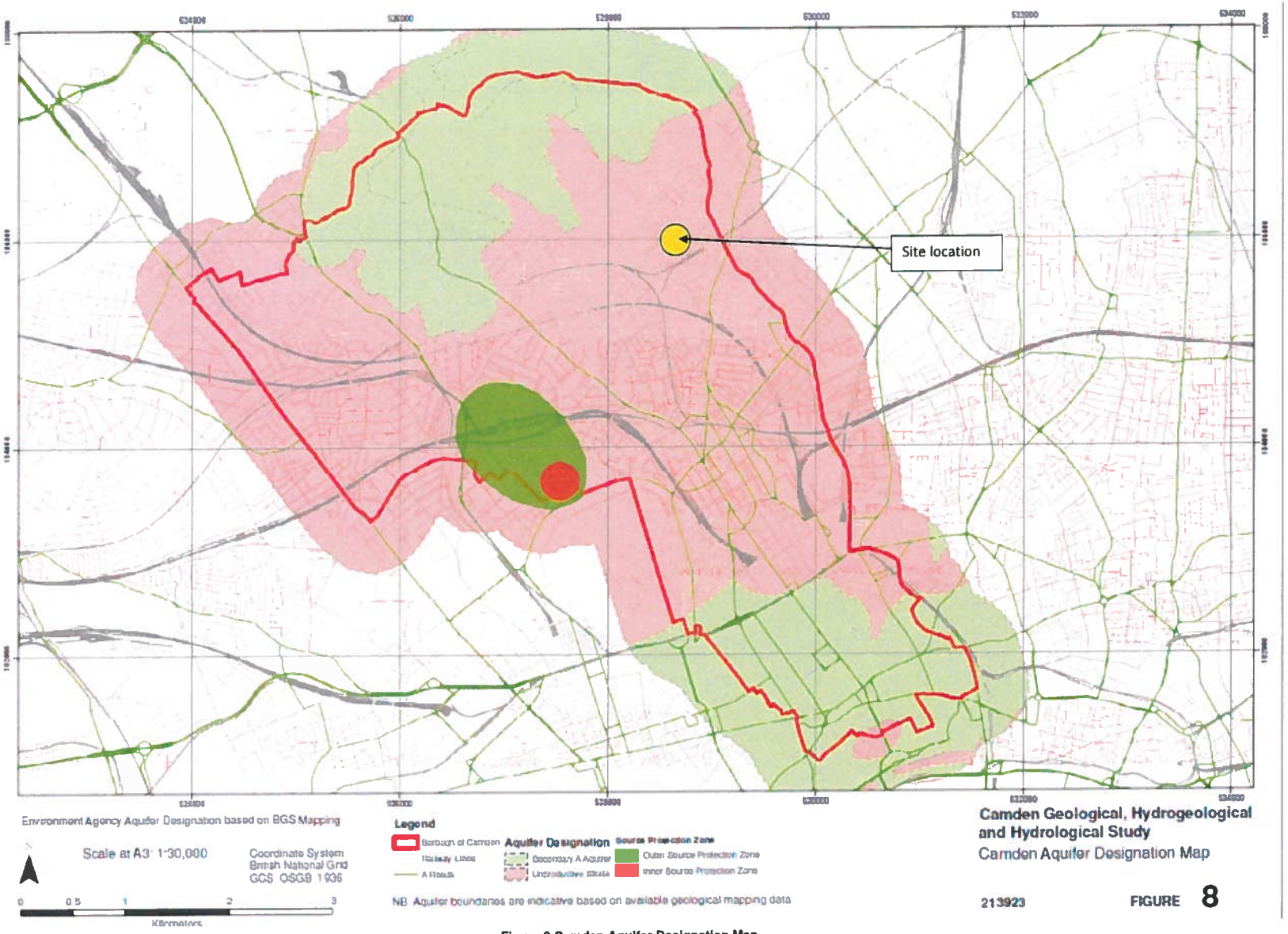



**Figure 8 Camden Aquifer Designation Map**

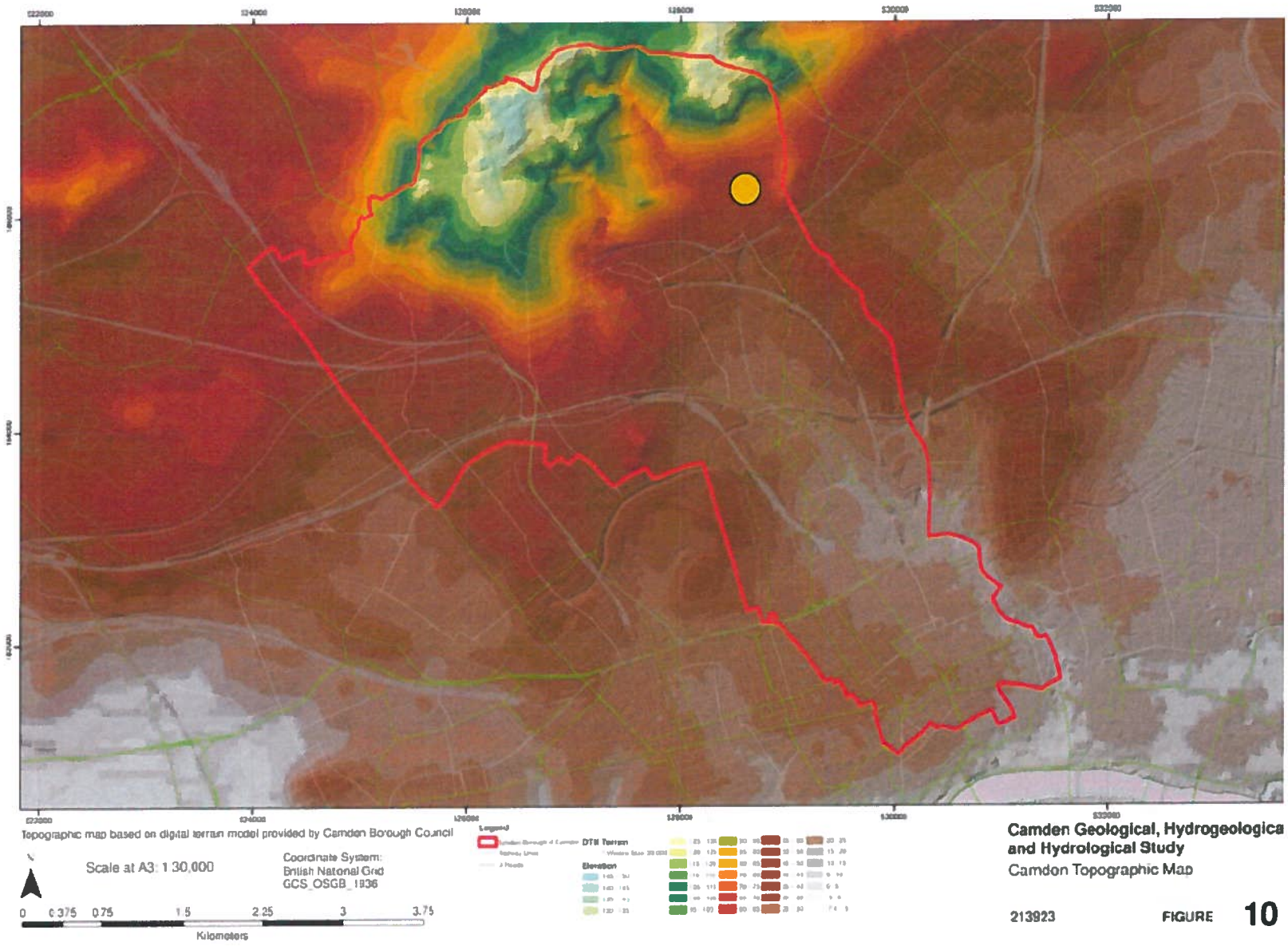



Figure 9 Camden Topographic Map

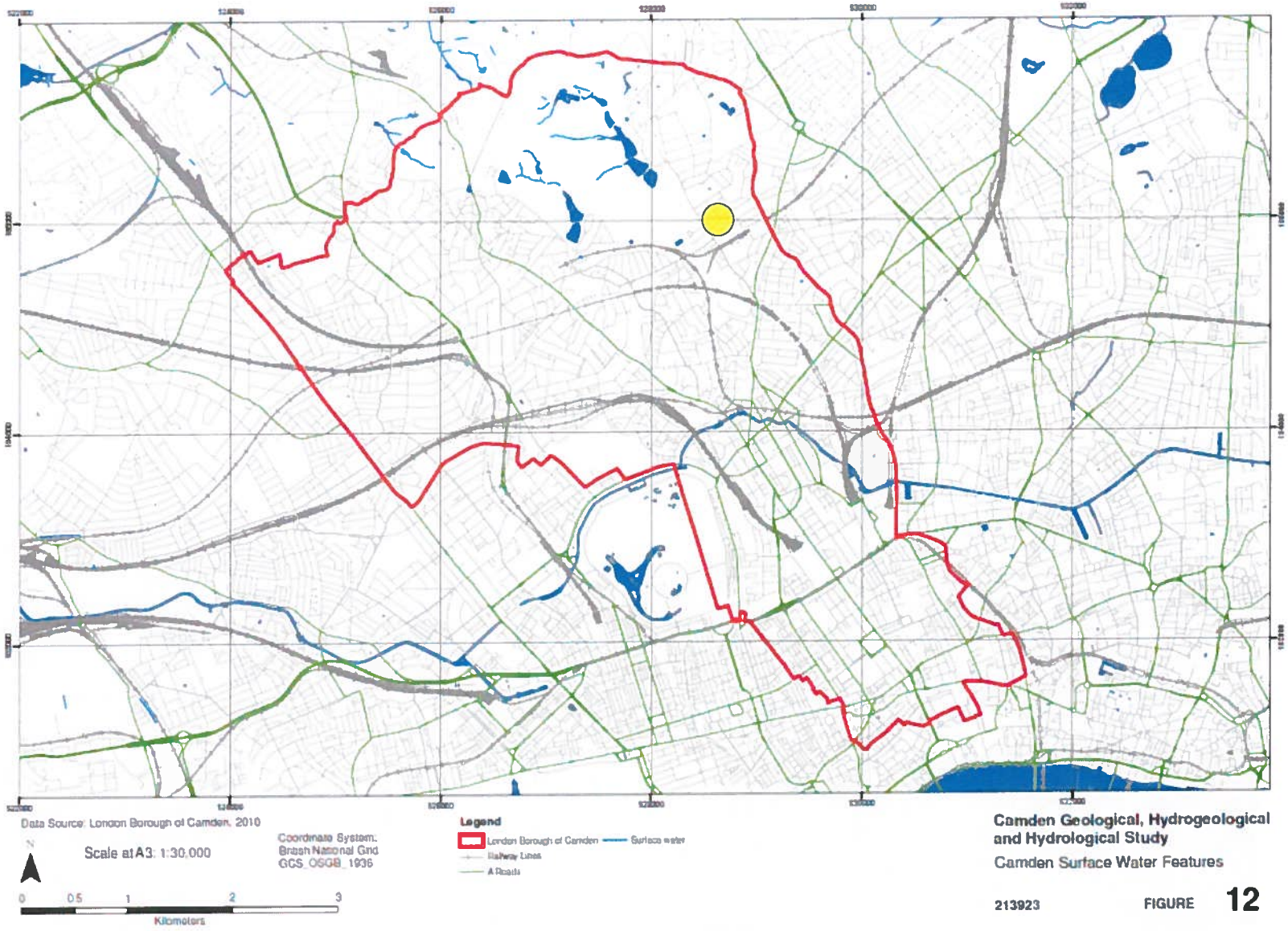



**Figure 10 Map of the Camden Surface Water Features**

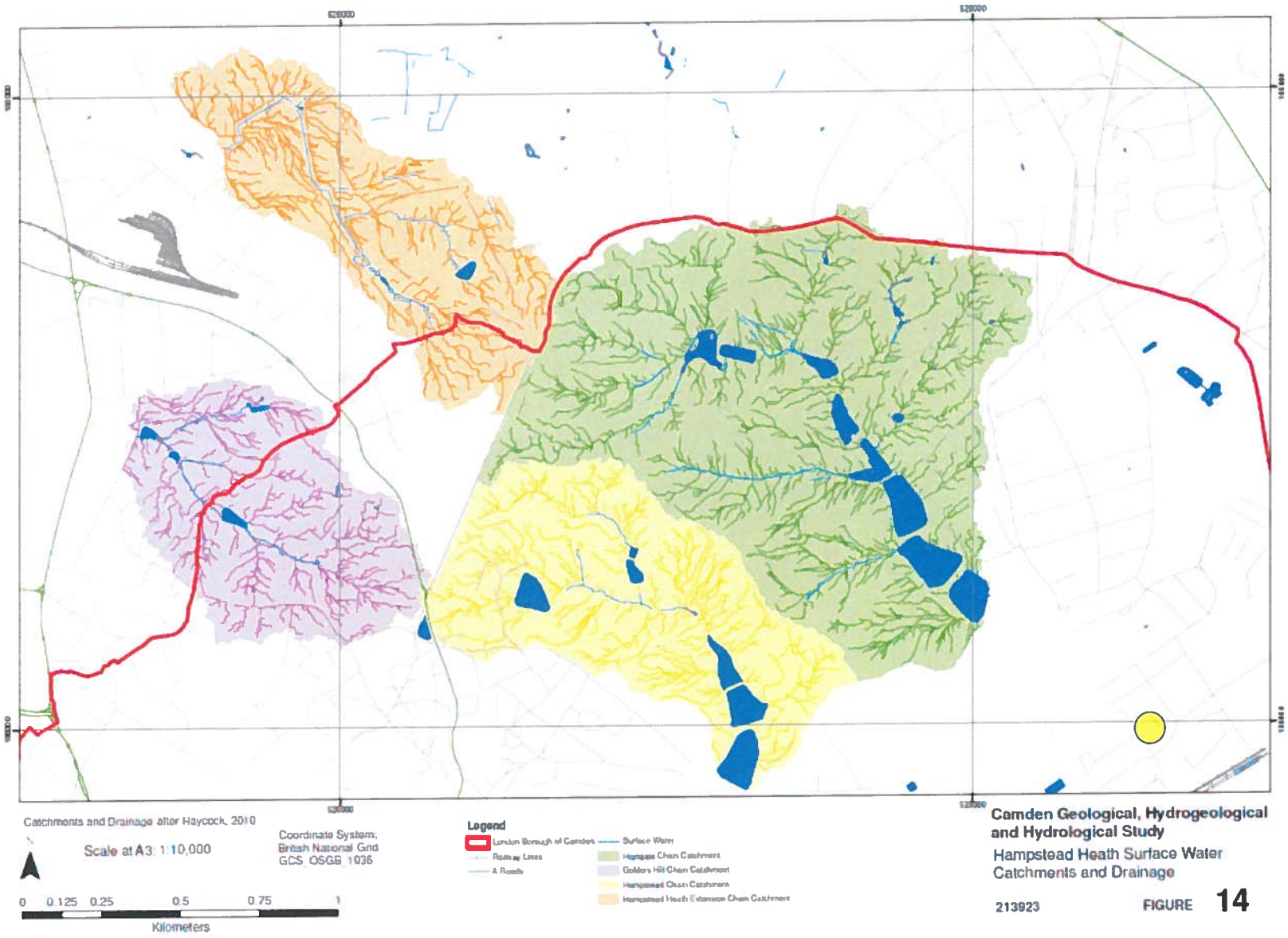



**Figure 11 Map of the Hampstead Heath Surface Water Catchments and Drainage**

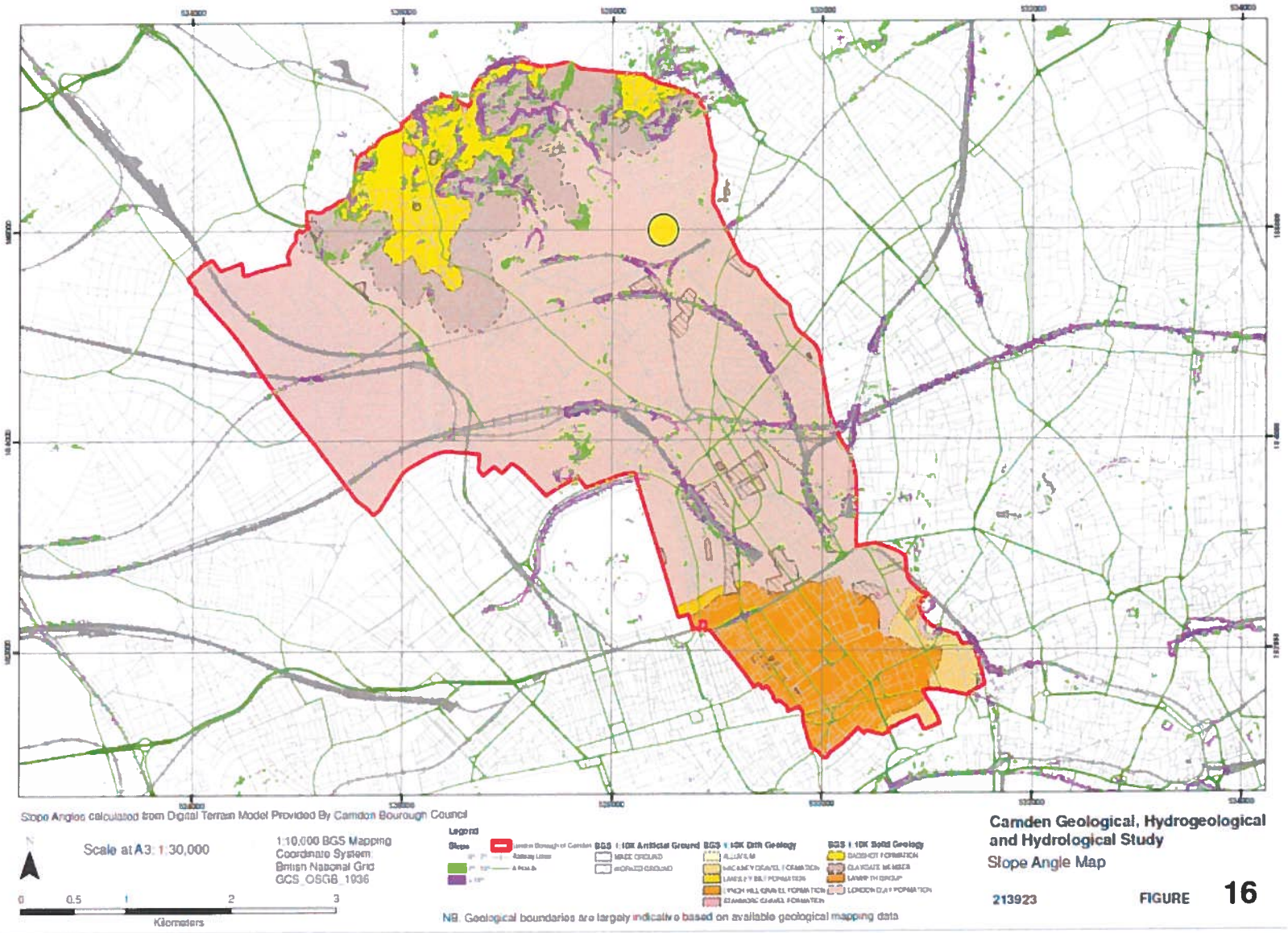



**Figure 12 Camden Slope Angle Map**

# Appendix F

## Example Damage Category Calculation

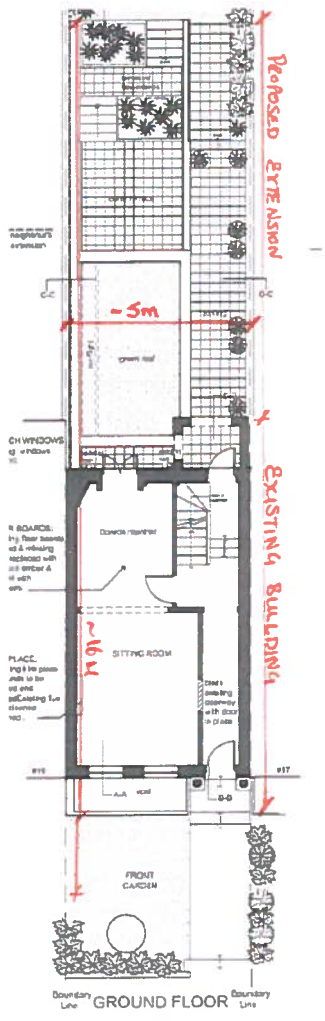



**Figure 14 Dimensions of Proposed Works**

Stage 1

Ground movements behind the retaining wall should be estimated as described in Section 2.5.2 assuming greenfield conditions, ie ignoring the presence of the building or utility and the ground above foundation level. Contours of ground surface movements should be drawn and a zone of influence established based on specified settlement and distortion criteria. All structures and utilities within the zone of influence should be identified.

Stage 2

A condition survey should be carried out on all structures and utilities within the zone of influence before starting work on site. The structure or utility should be assumed to follow the ground (ie it has negligible stiffness), so the distortions and consequently the strains in the structure or utility can be calculated. The method of damage assessment should adopt the limiting tensile strain approach as described by Burland *et al* (1977), Boscardin and Cording (1989) and Burland (2001), see Table 2.5 and Figure 2.18.

Table 2.5 *Classification of visible damage to walls (after Burland et al, 1977, Boscardin and Cording, 1989, and Burland, 2001)*

| Category of damage | Description of typical damage (ease of repair is underlined) | Approximate crack width (mm) | Limiting tensile strain $\varepsilon_{lim}$ (per cent) |
|---|---|---|---|
| 0 Negligible | Hairline cracks of less than about 0.1 mm are classed as negligible. | < 0.1 | 0.0–0.05 |
| 1 Very slight | Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection | < 1 | 0.05–0.075 |
| 2 Slight | Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly. | < 5 | 0.075–0.15 |
| 3 Moderate | The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired. | 5–15 or a number of cracks > 3 | 0.15–0.3 |
| 4 Severe | Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted. | 15–25 but also depends on number of cracks | > 0.3 |
| 5 Very severe | This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability. | usually > 25 but depends on number of cracks. | |

Notes

1. In assessing the degree of damage, account must be taken of its location in the building or structure.
2. Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

**Figure 13 Damage Categories**

Lyons O'Neill

Job 15165 - 18 Grove Terrace Date [illegible] Page 3

Title Movement Assessment By [illegible] Chkd

Aim: The following calcs will demonstrate the anticipated damage category for the proposed building works in accordance with CIRIA C580

Proposed building Dims H=13m (side wall dims refer approx.)
L1=16m
L2=5m

Estimation of visible damage to walls.
Ref CIRIA C580 TAB 2.5 & Fig 2.18

a) L/H = 5/13 = 0.38 < [illegible]
b) L/H = 16/13 = 1.23

option a is closest to the L/H=0.5 curve; shown as option b is closest to the L/H = 1 curve.

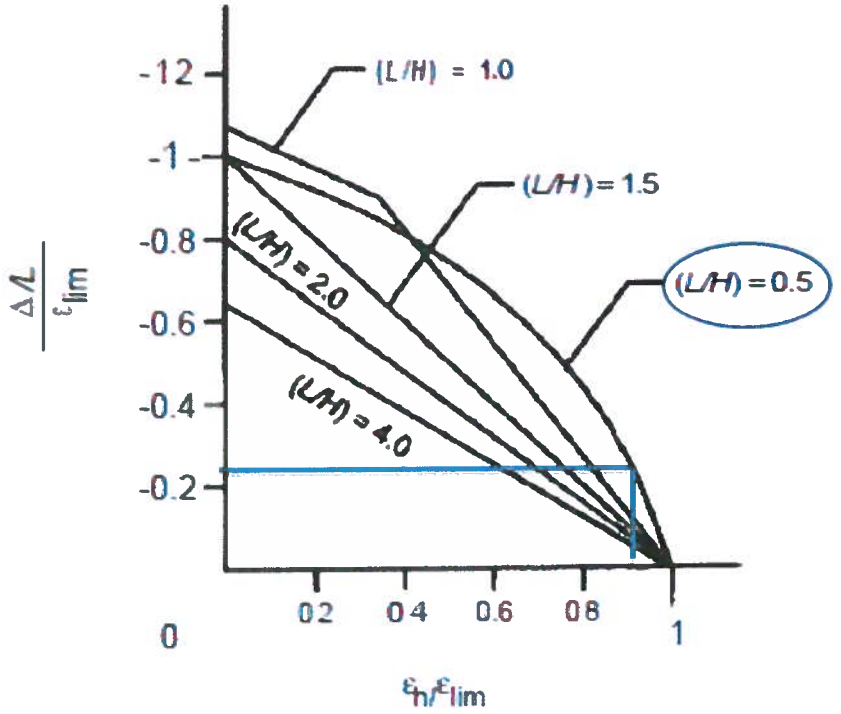
It is more conservative to take the L/H = 0.5 curve as shown over →

Expected Movement Profile
Δh = 3mm (approximately)

εv = Δv/L = 3/5000 x 100 = 0.06 %

εh = Δh/L = 4/5000 x 100 = 0.08 %

∴ Therefore this suggests the cracks will fall into Category 1




(b) Influence of horizontal strain on Δ/L / $\varepsilon_{lim}$ (after Burland. 2001)

Lyons | O'Neill

Job 15168 18 Grove Terrace Date Sep-15 Page 5

Title Monitoring and Damage Categories By MNB Chkd

**Title to Identify Wall**

Longitudinal Length, $L_l$ = 16.0 m → L/H = 0.38
Transverse Length, $L_t$ = 5.0 m
Height, H = 13.0 m

**Damage Category 0** $\varepsilon_{lim}$ = 0.050 %

| $\varepsilon_h/\varepsilon_{lim}$ | $\varepsilon_h$ (%) | $\delta_h$ (mm) | $(\Delta/L)/\varepsilon_{lim}$ | $\Delta/L$ | $\Delta$ (mm) |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 5.0E-04 | 8.0 |
| 0.2 | 0.01 | 2 | 0.91 | 4.6E-04 | 7.3 |
| 0.4 | 0.02 | 3 | 0.8 | 4.0E-04 | 6.4 |
| 0.6 | 0.03 | 5 | 0.64 | 3.2E-04 | 5.1 |
| 0.8 | 0.04 | 6 | 0.42 | 2.1E-04 | 3.4 |
| 1 | 0.05 | 8 | 0 | 0.0E+00 | 0.0 |

**Damage Category 1** $\varepsilon_{lim}$ = 0.075 %

| $\varepsilon_h/\varepsilon_{lim}$ | $\varepsilon_h$ (%) | $\delta_h$ (mm) | $(\Delta/L)/\varepsilon_{lim}$ | $\Delta/L$ | $\Delta$ (mm) |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 7.5E-04 | 12.0 |
| 0.2 | 0.015 | 2 | 0.91 | 6.8E-04 | 10.9 |
| 0.4 | 0.03 | 5 | 0.8 | 6.0E-04 | 9.6 |
| 0.6 | 0.045 | 7 | 0.64 | 4.8E-04 | 7.7 |
| 0.8 | 0.06 | 10 | 0.42 | 3.2E-04 | 5.0 |
| 1 | 0.075 | 12 | 0 | 0.0E+00 | 0.0 |

**Damage Category 2** $\varepsilon_{lim}$ = 0.150 %

| $\varepsilon_h/\varepsilon_{lim}$ | $\varepsilon_h$ (%) | $\delta_h$ (mm) | $(\Delta/L)/\varepsilon_{lim}$ | $\Delta/L$ | $\Delta$ (mm) |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1.5E-03 | 24.0 |
| 0.2 | 0.03 | 5 | 0.91 | 1.4E-03 | 21.8 |
| 0.4 | 0.06 | 10 | 0.8 | 1.2E-03 | 19.2 |
| 0.6 | 0.09 | 14 | 0.64 | 9.6E-04 | 15.4 |
| 0.8 | 0.12 | 19 | 0.42 | 6.3E-04 | 10.1 |
| 1 | 0.15 | 24 | 0 | 0.0E+00 | 0.0 |

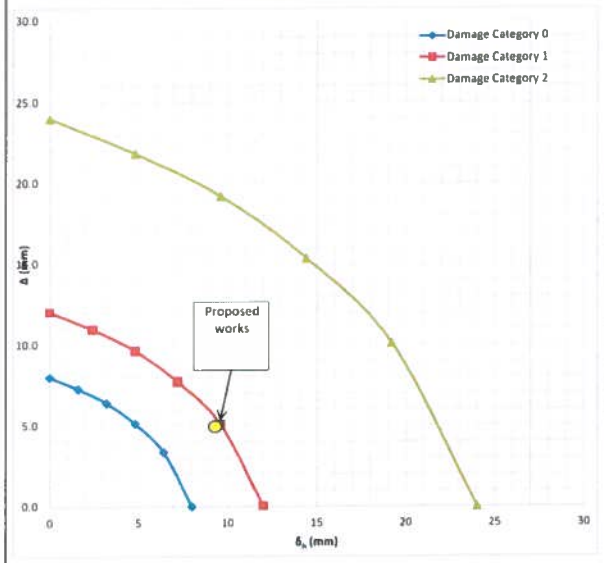
**Conclusion: Therefore this shows the proposed works fall within category 1.**

Lyons | O'Neill

Job 15168 18 Grove Terrace Date Sep-15 Page 6

Title Monitoring and Damage Categories By MNB Chkd

**Plot Showing Upper Bound Limit of Acceptable Movement**



# Appendix G

# Copy of Site Investigation Report J11987

Southern Testing
Environmental & Geotechnical

# Basement Impact Assessment & Site Investigation Report

Desk Studies | Risk Assessments | Site Investigations | Geotechnical | Contamination Investigations | Remediation Design and Validation

Site: 18 Grove Terrace, NW5 1PH

Client: Mr Jatin and Mrs Johanne Vara

Report Date: 28th October 2014

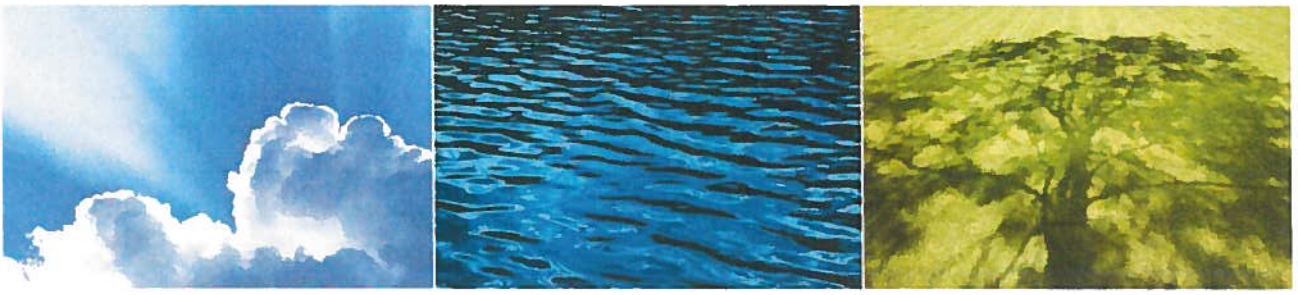
Project Reference: J11987


**Southern Testing**
Keeble House, Stuart Way
East Grinstead, West Sussex RH19 4QA

t 01342 333100 f 01342 410321
e info@southerntesting.co.uk
w southerntesting.co.uk

Southern Testing
Environmental & Geotechnical

# Basement Impact Assessment (Screen/Scoping) Report



Desk Studies | Risk Assessments | Site Investigations | Geotechnical | Contamination Investigations | Remediation Design and Validation

Site: 18 Grove Terrace, NW5 1PH

Client: Mr Jatin and Mrs Johanne Vara

Report Date: 28th October 2014

Project Reference: J11987


**Southern Testing**
Keeble House, Stuart Way
East Grinstead, West Sussex RH19 4QA

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e info@southerntesting.co.uk
w southerntesting.co.uk

## TABLE OF CONTENTS



## FIGURES

# A INTRODUCTION

## 1 Introduction

The object of this study was to produce an impact assessment for the proposed basement construction on this site in accordance with the requirements of the London Borough of Camden. Their requirements are set out within their Development Policy DP27 – Basements and Lightwells and the recent LB Camden guidance document entitled "Camden geological, hydrogeological and hydrological study – Guidance for subterranean development".

This report covers the initial desk study and screening process.

## 2 Scope

This report presents our desk study findings and our interpretation of these data.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Limited believes are reliable. Nevertheless, Southern Testing Laboratories Limited cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

This report was conducted and prepared for the sole internal use and reliance of Mr J Vara and the appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorization of Southern Testing Laboratories Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The recommendations contained in this report may not be appropriate to alternative development schemes.

# B THE SITE

## 3 Site Location

The subject site comprises an existing terraced property, No 18 Grove Terrace, London, NW5 1PH which is located approximately 0.4km north east of Gospel Oak Station. The approximate National Grid Reference of the site is TQ 285 589.

The site/subject property at No 18 Grove Terrace, comprises a five storey (including lower ground floor and roof accommodation) terraced residential building. Grove Terrace is located on the north east side of Highgate Road.

Regionally ground levels generally comprise falls in a south-easterly direction from Parliament Hill/Hampstead Heath and Highgate which are located to the northwest and north of the site.

Within the vicinity of the site ground levels locally fall from Grove Terrace towards Highgate Road with more general local falls occurring in southerly direction at about 1-2° degrees.

Existing vegetation within the rear garden area (the area of proposed construction) consists of borders containing a variety of ornamental shrubs, various fruit trees (pear and apple) and a grape vine. Vegetation within the neighbouring gardens includes maple, cherry, yew, cyprus, silver birch and various ornamentals shrubs/trees.

A site location plan is presented as Figure 1.

### 4 Proposed Development

The proposed works include the construction of a basement for a dining room and roof garden extending out from the rear lower ground floor level of the subject property into the garden area together with an open lower terrace area. Figure 2 illustrates the proposed basement/lower terrace area.

## C GROUND CONDITIONS

### 5 Published Geological Data

The British Geological Survey Map No 256 indicates that the site geology consists of London Clay.

The study site is marked on appended Figure 3 based upon the North Camden Geological Map taken from "Camden geological, hydrogeological and hydrological study – Guidance for subterranean development", which indicates the same mapped geology.

### 6 Previous Ground Investigation data

Very few publicly available records of ground investigation or historical boreholes are shown on the BGS website. The borehole information that is available does not disagree with the published information.

## D HYDROLOGY & HYDROGEOLOGY

Data from the Environment Agency and other information relating to controlled waters is summarised below. The groundwater vulnerability assessment is based on the current data on the EA website.

| Data | | Remarks |
|---|---|---|
| Aquifer Designation | Superficial Deposits | No superficial Deposits present. |
| | Bedrock | The bedrock (London Clay) is mapped as an unproductive strata |
| Groundwater Vulnerability | | Non Aquifer |

| Data | Remarks |
|---|---|
| Abstractions | On the basis of the information given on the EA website (October 2014) there are no water abstraction licenses in the area. |
| Source Protection Zones | The site is not located within a Source Protection Zone. |
| Surface Water Features | The nearest surface water features are the Hampstead Heath Pond Chain some 0.74km to the north west. The site lies outside of the catchment area to the ponds. |
| Marine/Fluvial Flood Risk | On the basis of the information given on the EA website (October 2014) the site is not located within an area at risk of flooding from fluvial sources. |
| Surface Water Flood Risk | The "Risk of Flooding from Surface Water" mapping on the Environment Agency website shows that Grove Terrace is located within an area of very low risk. Very low means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%). The Highgate Road just to the west, which is at a slightly lower level to Grove Terrace, is situated within an area of low risk. Low means that each year, this area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%). |
| Reservoir Flood Risk | On the basis of the information given on the EA website (October 2014) the site is located within an area of potential risk of flooding from Highgate Pond No 3. The estimated depth of flooding is below 0.3m |

## 7 Shallow Groundwater

As the site is directly underlain by London Clay which is an unproductive strata, there are no shallow groundwater aquifers present. (see figure 8)

## 8 Surface Water Features

No culvert, rivers and or other water bodies are known within the immediate vicinity of the site. (see figure 5)

# E UNDERGROUND STRUCTURES

## 9 Basements

From our walkover survey of the local area it appears that the neighbouring properties are of similar construction with lower ground floors like the subject property. The adjacent property (No 19) has a rear basement structure/extension with curved glass walls and a flat glass roof. The structure extends out from the lower ground floor of No 19 into the rear garden area. In plan the extension is oval shaped with curved glass walls which are approximately 1metre (at the closest point) from the shared garden wall to both properties. From a search of London Borough of Camden online planning applications, the basement to the adjacent property (No 19) was given approval in 2009.

From a further brief inspection of planning applications for basements within the immediate adjacent properties, the majority of basement applications for properties on Grove Terrace appear to be related to works to existing basements or front lightwell areas.

## 10 Transport & Other Infrastructure

No tunnels are known to be present within the immediate vicinity of the site. The nearest railway line (which runs on a viaduct) is approximately 280m to the south/south east of the site.

# F BASEMENT IMPACT ON STRUCTURAL STABILITY

## 11 Structural Stability

DP27 "Maintain the structural stability of the building and neighbouring properties".

The proposed works include the construction of a basement extending out from the rear lower ground floor level of the subject property into the garden area for a dining room and roof garden together with an open lower terrace area.

The works will entail the excavation of a basement with a founding level of approximately 2.5m below the existing ground levels to the rear garden area of the property.

All works will be carried out in accordance with the Structural Engineers design. In terms of the method of basement construction it is envisaged that conventional underpinning methods will be adopted. Appropriate propping methods and working practices will be carried out to ensure that movements associated with the works are kept within acceptable limits.

The extent and nature of the propping/works will be evaluated during the detailed design phase of the works in order to allow discussions (should they be required) with the party wall surveyor to occur.

Throughout the construction phase the party walls on both sides of the building would be monitored for both movement and vibration to make sure these are within acceptable limits.

## G SCREENING EXERCISE

DP27 "Avoid adversely affecting drainage and run-off or causing other damage to the water environment and Avoid cumulative impacts upon structural stability or the water environment in the local area" LB Camden's "guidance for subterranean development" requires that any development proposal which includes a subterranean basement should be screened in order to determine whether there is an requirement for a BIA to be carried out.

The proposed works include the construction of a basement area extending out from the rear of the subject property into the garden area together with an open lower terrace area. Therefore screening is required.

In this section, the questions in the screening flowcharts of Appendix E of the LB Camden guidance document are addressed in turn.

### 12 Surface Flow and Flooding

***Question 1: Is the site within the catchment of the pond chains on Hampstead Heath?***

*No. The site is outside the catchment of the pond chains on Hampstead Heath (see Figure 4).*

***Question 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. The current proposal is to re-use the existing storm water connections to the Thames Water Sewer, provided that this is at a sufficient level to allow this to occur through gravity, otherwise the drainage will be pumped. Subject to a more detailed condition survey of these connections, it is not envisaged that any new connections will be required.*

**Question 3: Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?**

*The existing area of construction is mainly surfaced in jointed/permeable crazy paving. The proposed basement development includes a roof garden with an open lower courtyard area. Accordingly there could be an increase in hard surfaced area. However, any surface water that needs to be dealt with from the proposed roof garden and lower courtyard area will be directed to the existing storm water connections to the Thames Water sewer. Subject to a more detailed condition survey of these connections, it is not envisaged that any new connections will be required.*

**Question 4: Will the proposed basement 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. The proposed basement will not alter surface water flows downstream as it will use existing connections to the sewer network.*

**Question 5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?**

*No. The quality of the surface water should be unaltered that is discharged to the sewer.*

**Question 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 King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?**

*No (See Figure 7). However Highgate Road just to the west, which is at a slightly lower level to Grove Terrace and also the Grove Terrace Mews, a lane leading off Grove Terrace to the north, are shown to have flooded in 1975.*

## 13 Groundwater Flow

**Question 1a: Is the site located directly above an aquifer?**

*No. The site is not located within an area designated as an aquifer. The site is underlain by London Clay designated as unproductive strata, see Figure 8.*

**Question 1b: Will the proposed basement extend beneath the water table surface?**

*Possibly. The presence of a perched groundwater table within more permeable made ground overlying the London Clay is considered possible at this stage. Subject to an intrusive investigation, allowances in construction and design could be required.*

***Question 2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?***

*No. (See figure 6). The nearest water course shown on the Camden Plan of Watercourses (Source Lost Rivers of London) shows the River Fleet approximately 100m to the east. According to the BGS Geology of Britain Viewer the nearest well (now abandoned) is shown 220m to the north west in the grounds to William Ellis School. We are not aware of any other active wells. Furthermore, given the geology of the area (London Clay) the potential presence of spring lines is negligible.*

**Question 3: Is the site within the catchment of the pond chains on Hampstead Heath?**

*No. (See Figure 4).* The Hampstead Heath Pond Chains are some 0.74km to the north west. The site lies outside of the catchment area to the ponds.

**Question 4: Will the proposed basement development result in a change in the proportion of hard surfaced /paved areas?**

*The existing area of construction is mainly surfaced in jointed/permeable crazy paving. The proposed basement development includes a roof garden with an open lower courtyard area. Accordingly there could be an increase in hard surfaced area. The current proposal is to re-use the existing storm water connections to the Thames Water sewer. Subject to a more detailed condition survey of these connections, it is not envisaged that any new connections will be required.*

**Question 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)?**

*No. All surface water will be discharged to the sewer network through existing connections, replicating the existing arrangement.*

**Question 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 (not just the pond chains on Hampstead Heath) or spring line?**

*No. There are no known local water features or spring lines in the immediate vicinity of this site.*

**14 Slope Stability**

**Question 1: Does the existing site include slopes, natural or manmade, greater than 7 degrees? (approximately 1 in 8)**

*No. (see figure 9)*

**Question 2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7 degs? (approximately 1 in 8)**

*No. (see figure 9)*

**Question 3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degs? (approximately 1 in 8)**

*No. (see figure 9)*

**Question 4: Is the site within a wider hillside setting in which the general slope is greater than 7 degrees? (approximately 1 in 8)**

*No. Regionally ground levels generally comprise falls in a south-easterly direction from Parliament Hill/Hampstead Heath and Highgate which are located to the northwest and north of the site. Within the vicinity of the site ground levels locally fall from Grove Terrace towards Highgate Road with more general local falls occurring in southerly direction at about 1-2° degrees.*

**Question 5: Is the London Clay the shallowest strata at the site?**

*Yes. (See figure 3).*

**Question 6: Will any tree/s 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? (Note that consent is required from LB Camden to undertake work to any tree/s protected by a Tree Protection Order or to tree/s in a Conservation Area if the tree is over certain dimensions).**

*With the possible exception of an immature fruit tree and some removal of ornamental shrubs no major trees are to be felled.*

**Question 7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?**

*No. We have no evidence indicating any possible shrink-swell subsidence in the local area. However the site is mapped as being underlain by London Clay which typically is classified as NHBC High Volume Change Potential. However, the site area includes a number of mainly fruit trees within the rear garden area and also a variety of trees in adjacent gardens which could give rise to shrink-swell subsidence.*

**Question 8: Is the site within 100m of a watercourse or a potential spring line?**

*No. (See Figure 6). The nearest water course shown on the Camden Plan of Watercourses (Source Lost Rivers of London) shows the River Fleet approximately 100m to the east. Given the geology of the area (London Clay) the potential presence of spring lines are negligible.*

**Question 9: Is the site within an area of previously worked ground?**

*No. The site is not within an area shown as having been worked. (See Figure 3).*

**Question 10: Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?**

*No. The site is not underlain by an aquifer. However it is common for perched groundwater to be present if made ground overlies the London Clay in which case some dewatering of the perched groundwater could be required. Minor seepage into the working area would be dealt with using sumps or other localised measures.*

**Question 11: Is the site within 50m of the Hampstead Heath ponds?**

*No. (See figure 4). The site is located approximately 0.74km south east of the Hampstead Heath Ponds.*

**Question 12: Is the site within 5m of a highway or pedestrian right of way?**

*No.*

**Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?**

*The proposed finished floor levels of the basement structure will be similar to the lower ground floor levels of the subject 1.8-2.0m below the adjacent garden areas but would be slightly deeper than the lower slab level of the basement extension structure to No 19. The exact difference in level should be confirmed by the Structural Engineer/Architect at the detailed design stage.*

**Question 14: Is the site over (or within the exclusion zone of) any tunnels, e.g. 5lines?**

*No tunnels are known to be present within the immediate vicinity of the site. The nearest railway line (which runs on a viaduct) is approximately 280m to the south/south east of the site.*

**15 Conclusions from Screening**

*On the basis of this screening exercise, it is concluded that there are a number of items that will need to be investigated further and taken into the scoping stage of the process.*

*These are as follows:*

- *A geotechnical investigation to confirm the ground conditions underlying the site.*
- *Desiccation of the underlying soils*
- *Groundwater monitoring.*
- *A series of trial pits to establish party wall foundations*

*The reader is referred to the attached report which considers the above issues.*

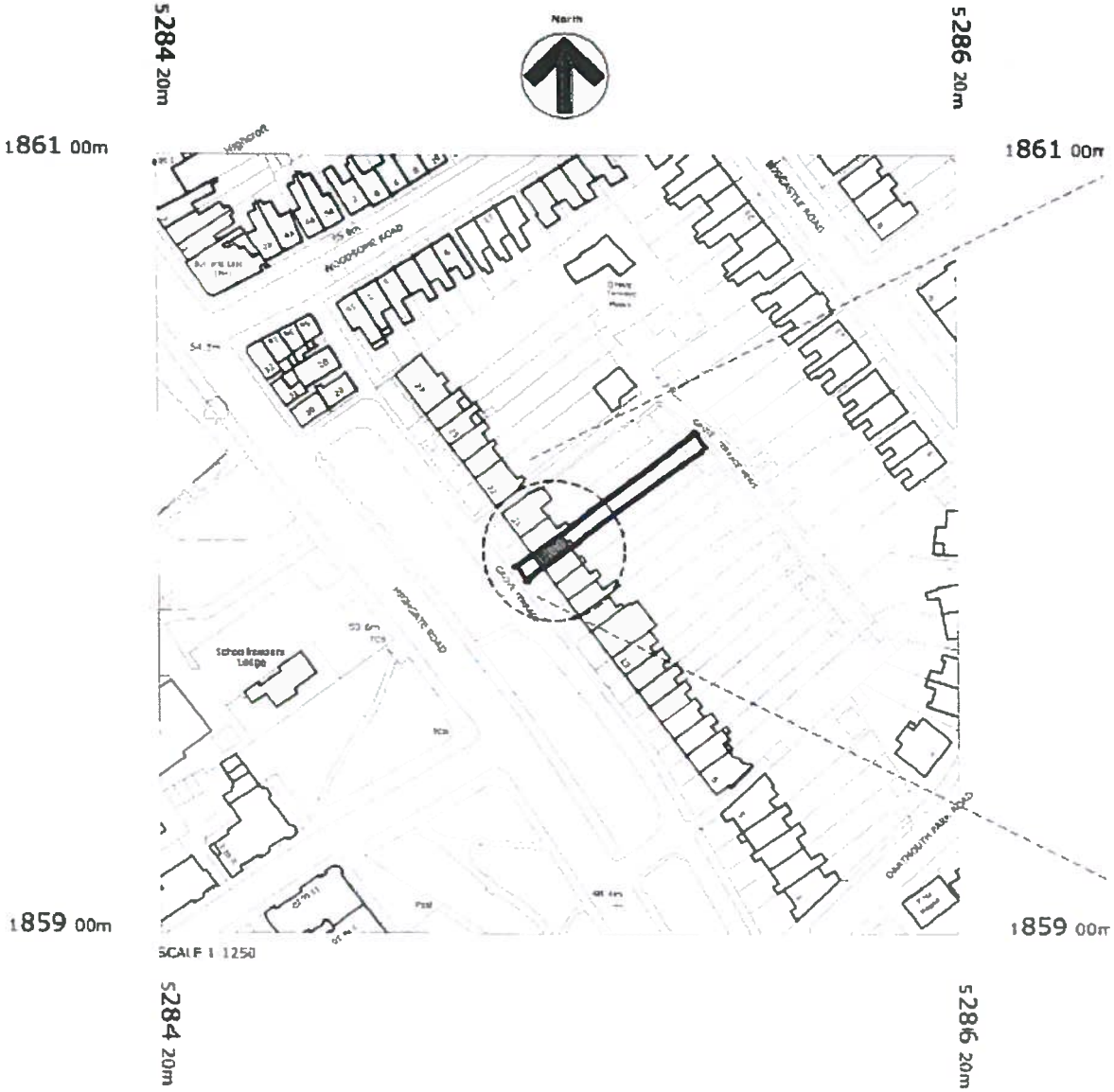
J N Race MSc CGeol
(Countersigned)

D Vooght MSc
(Signed)

For and on behalf of Southern Testing Laboratories Limited

STL: J11987
27 October 2014

# FIGURES

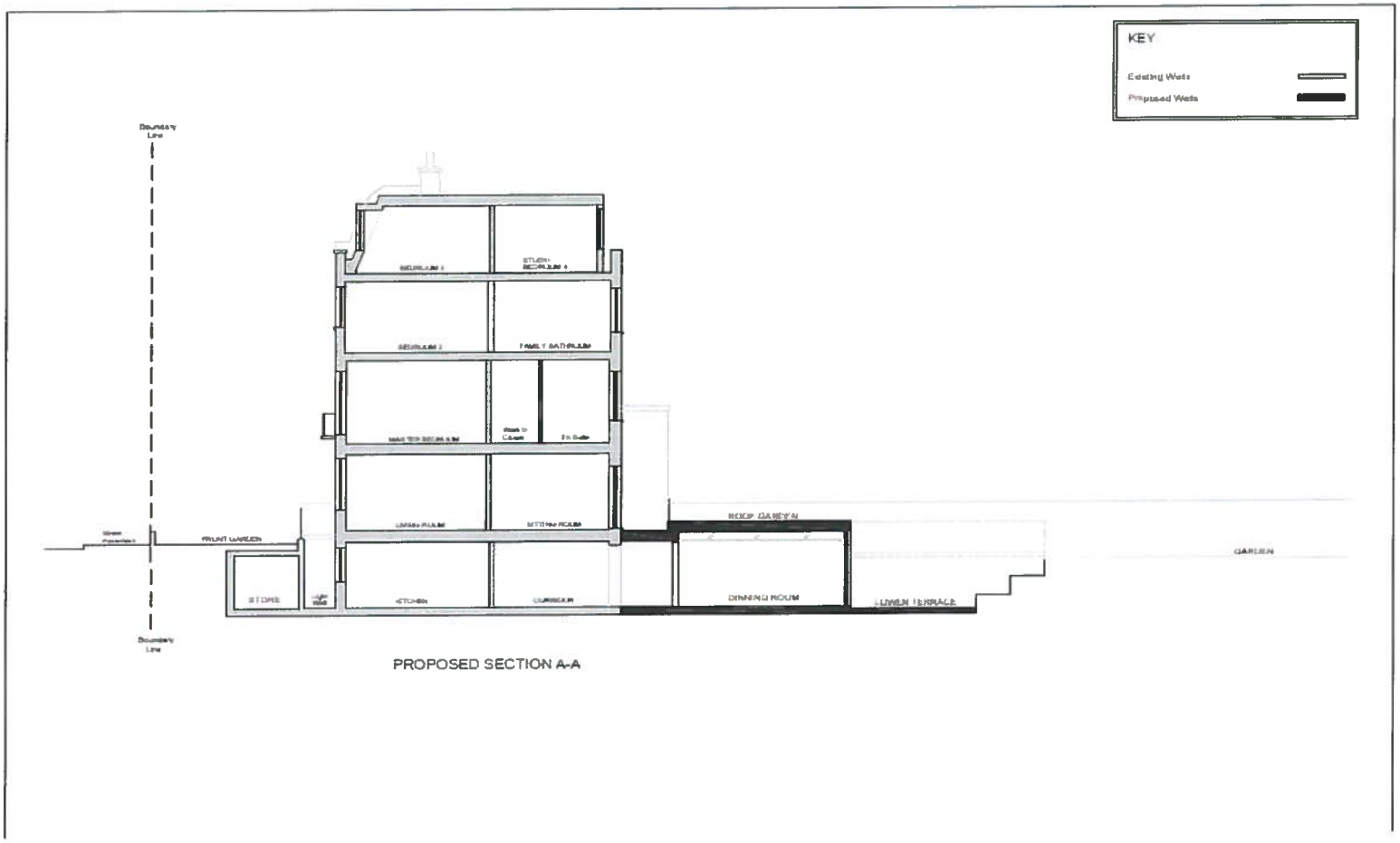



| | | | |
|---|---|---|---|
| Site: | 18 Grove Terrace, London, NW5 | STL:J11987 | Fig No: 1 |
| Date: | 24 October 2014 | Site Location | |

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult



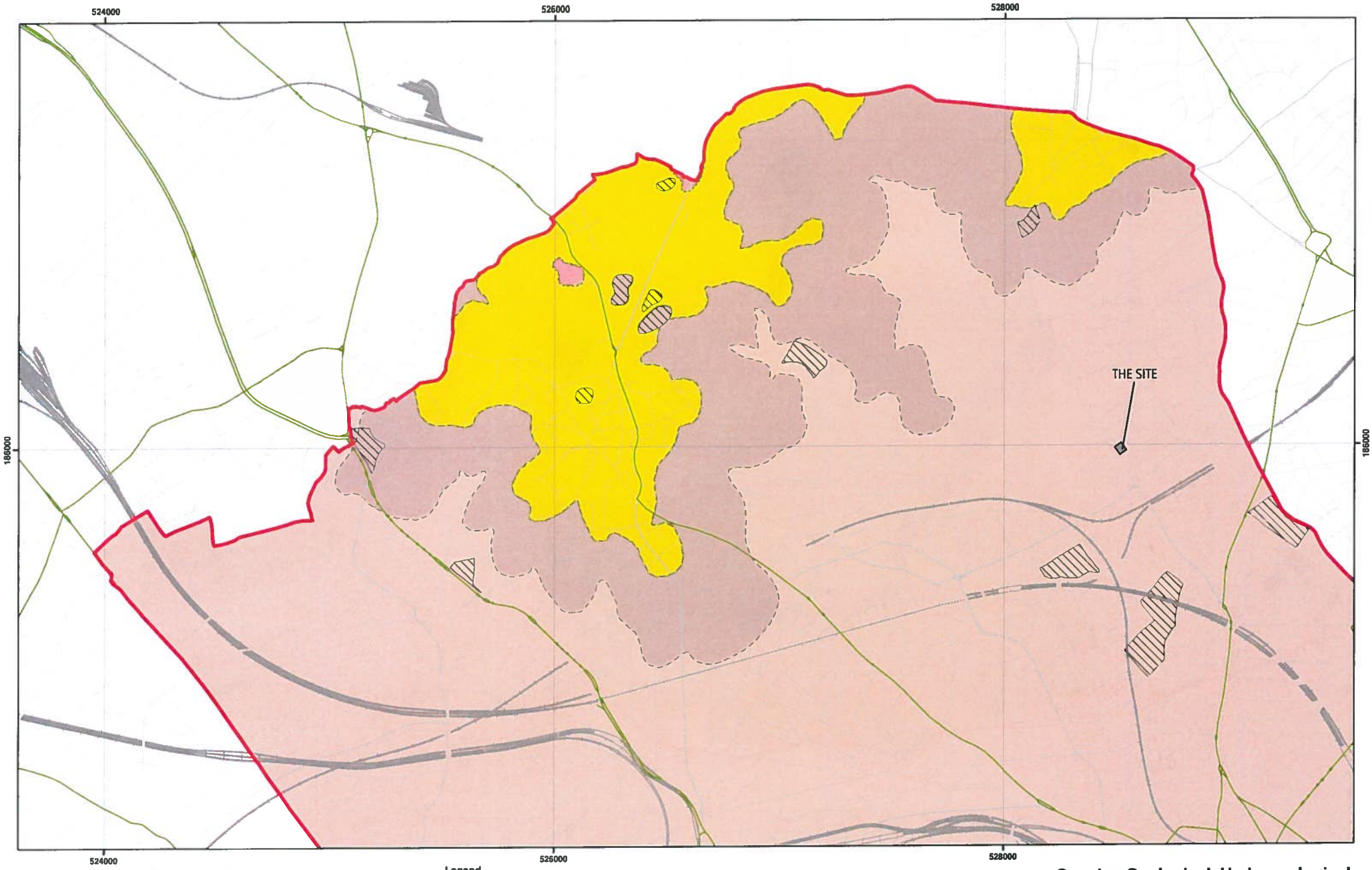

PROPOSED SECTION A-A

| | | |
|---|---|---|
| Site: 18 Grove Terrace, London NW5 | STL: J11987 | Fig No: 2 |
| Date: 24 October 2014 | Plan showing proposals | |

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult




Data Source: BGS Mapping - Scale 1:10,000

N

Scale at A3: 1:15,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.25 0.5 1 1.5
Kilometers

**Legend**

- London Borough of Camden
- Railway Lines
- A Roads

**BGS 1:10K Artificial Ground**

- MADE GROUND
- WORKED GROUND

**BGS 1:10K Drift Geology**

- ALLUVIUM
- HACKNEY GRAVEL FORMATION
- LANGLEY SILT FORMATION
- LYNCH HILL GRAVEL FORMATION
- STANMORE GRAVEL FORMATION

**BGS 1:10K Solid Geology**

- BAGSHOT FORMATION
- CLAYGATE MEMBER
- LAMBETH GROUP
- LONDON CLAY FORMATION

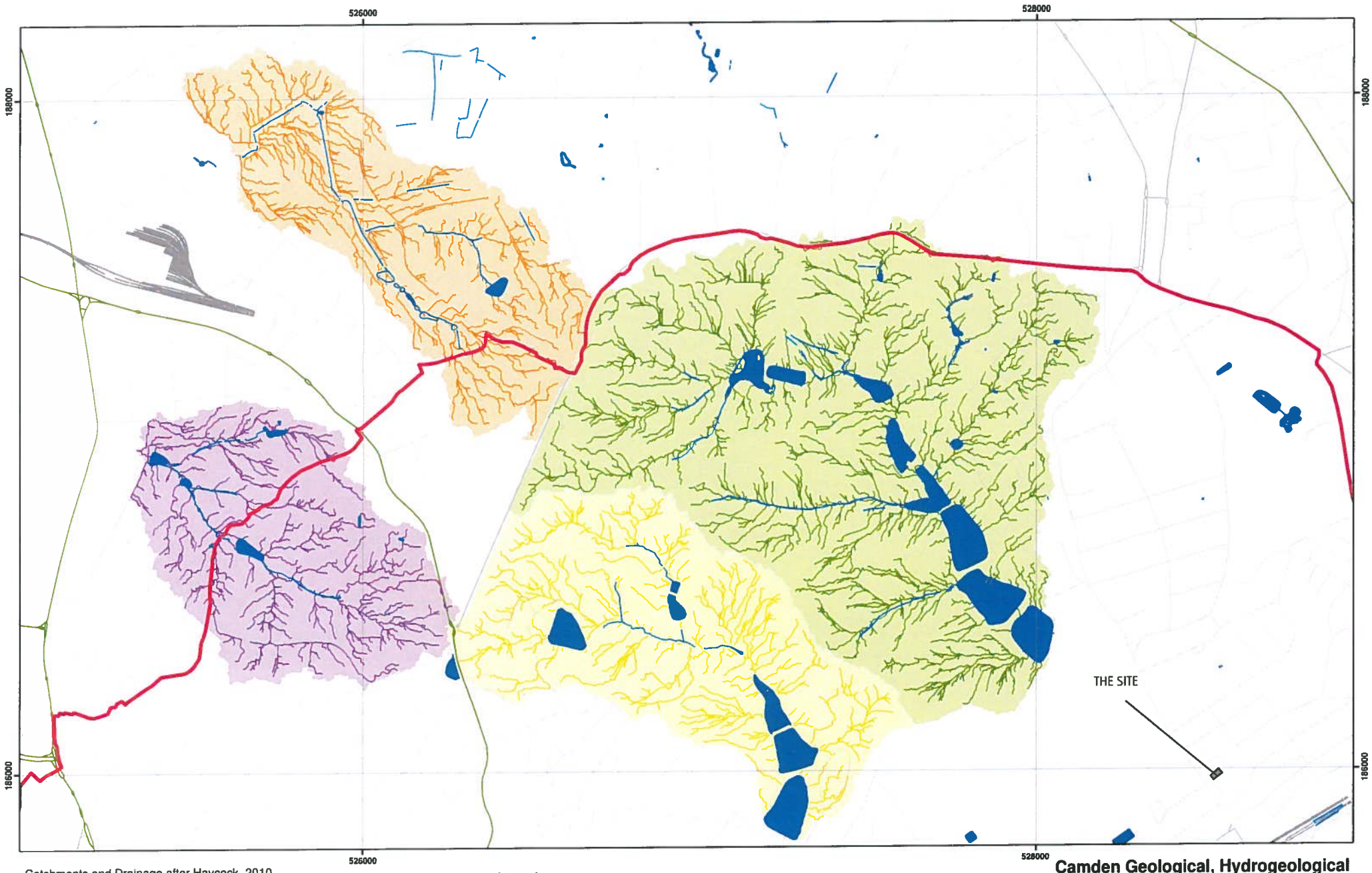
NB. Geological boundaries are largely indicative based on available geological mapping data

**Camden Geological, Hydrogeological and Hydrological Study**

North Camden Geological Map

Report: J11987

Site: 18 Grove Terrace, London NW5 Figure: 3




Catchments and Drainage after Haycock, 2010

N

Scale at A3: 1:10,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.125 0.25 0.5 0.75 1
Kilometers

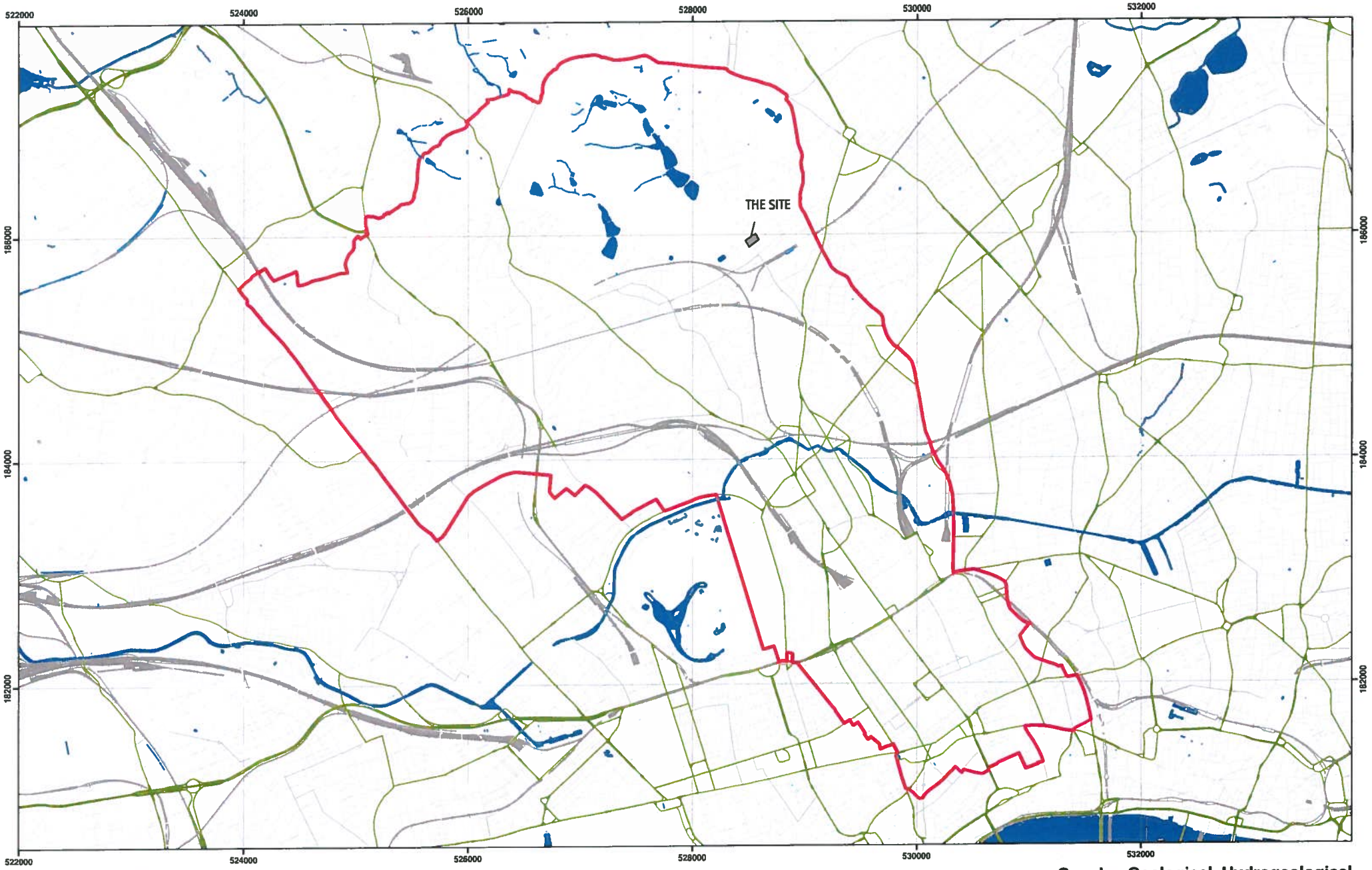
**Legend**

- London Borough of Camden
- Railway Lines
- A Roads
- Surface Water
- Highgate Chain Catchment
- Golders Hill Chain Catchment
- Hampstead Chain Catchment
- Hampstead Heath Extension Chain Catchment

**Camden Geological, Hydrogeological and Hydrological Study**

Hampstead Heath Surface Water Catchments and Drainage

Report: J11987 Site: 18 Grove Terrace, London NW5 Figure: 4




Data Source: London Borough of Camden, 2010

N

Scale at A3: 1:30,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.5 1 2 3
Kilometers

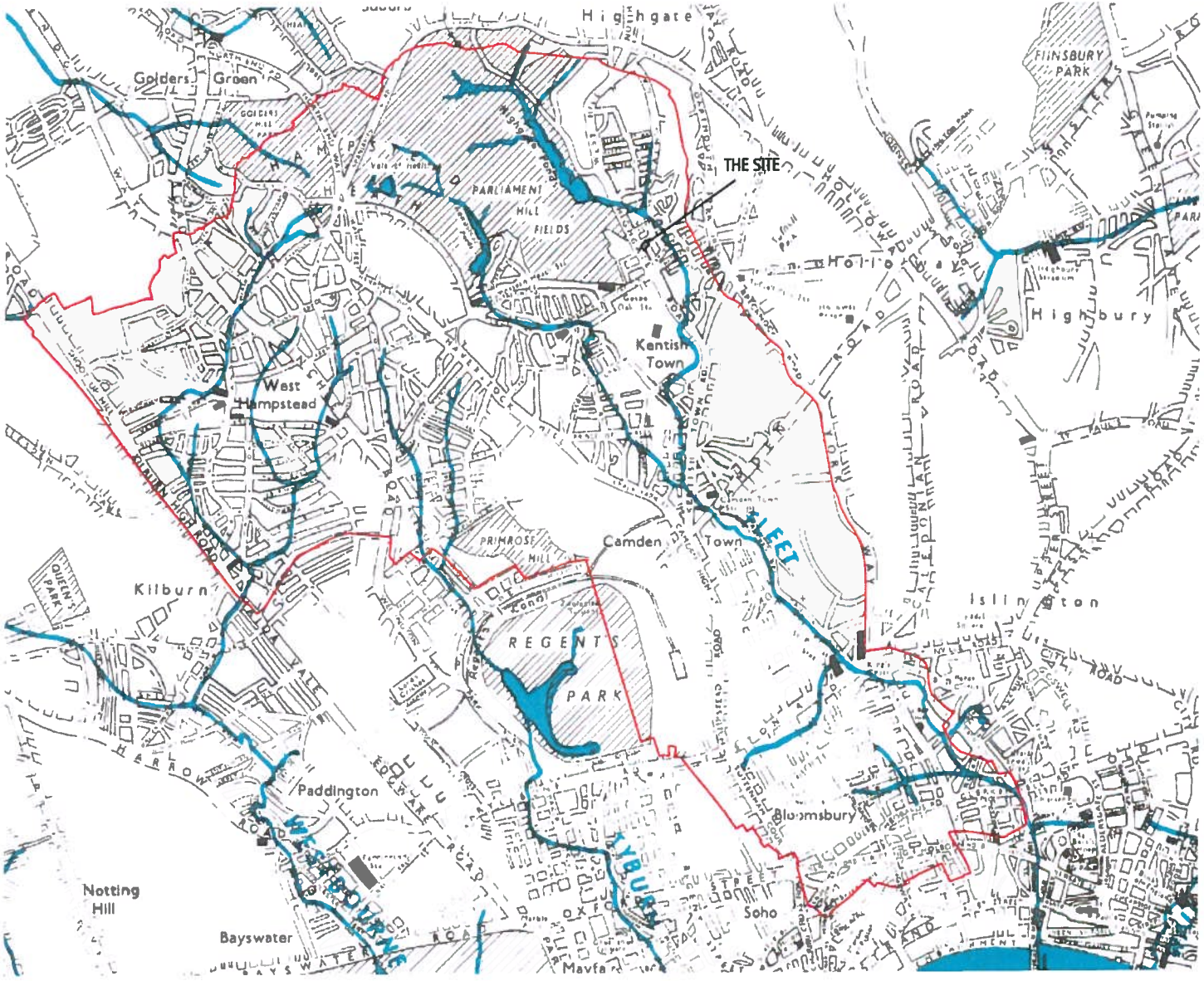
**Legend**

- London Borough of Camden
- Surface water
- Railway Lines
- A Roads

**Camden Geological, Hydrogeological and Hydrological Study**

Camden Surface Water Features

Report: J11987 Site: 18 Grove Terrace, NW5 Figure: 5




**Camden Geological, Hydrogeological and Hydrological Study**
Watercourses

Source – Barton, Lost Rivers of London

Report: J11987 Site: 18 Grove Terrace, London NW5 Figure: 6

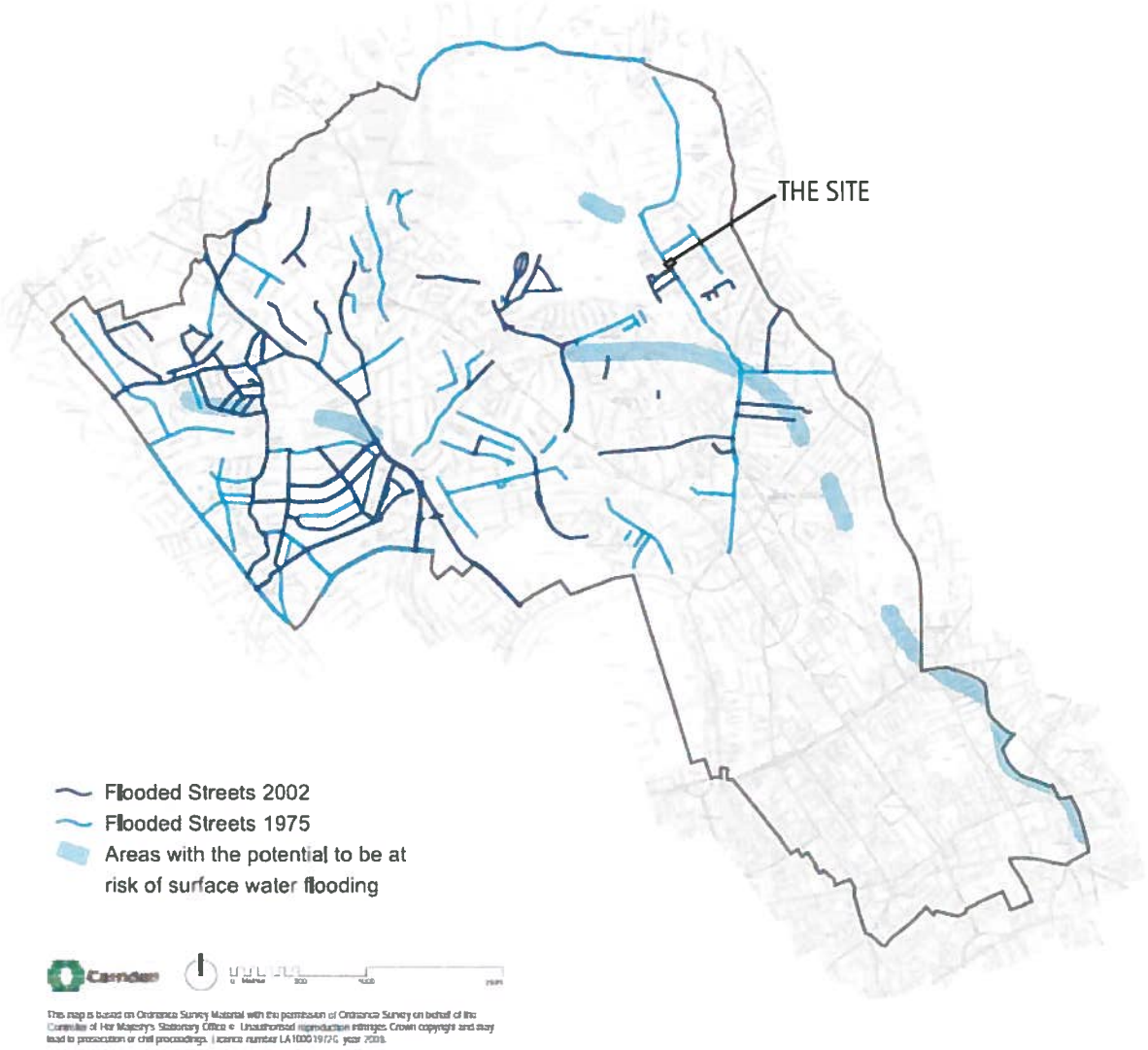
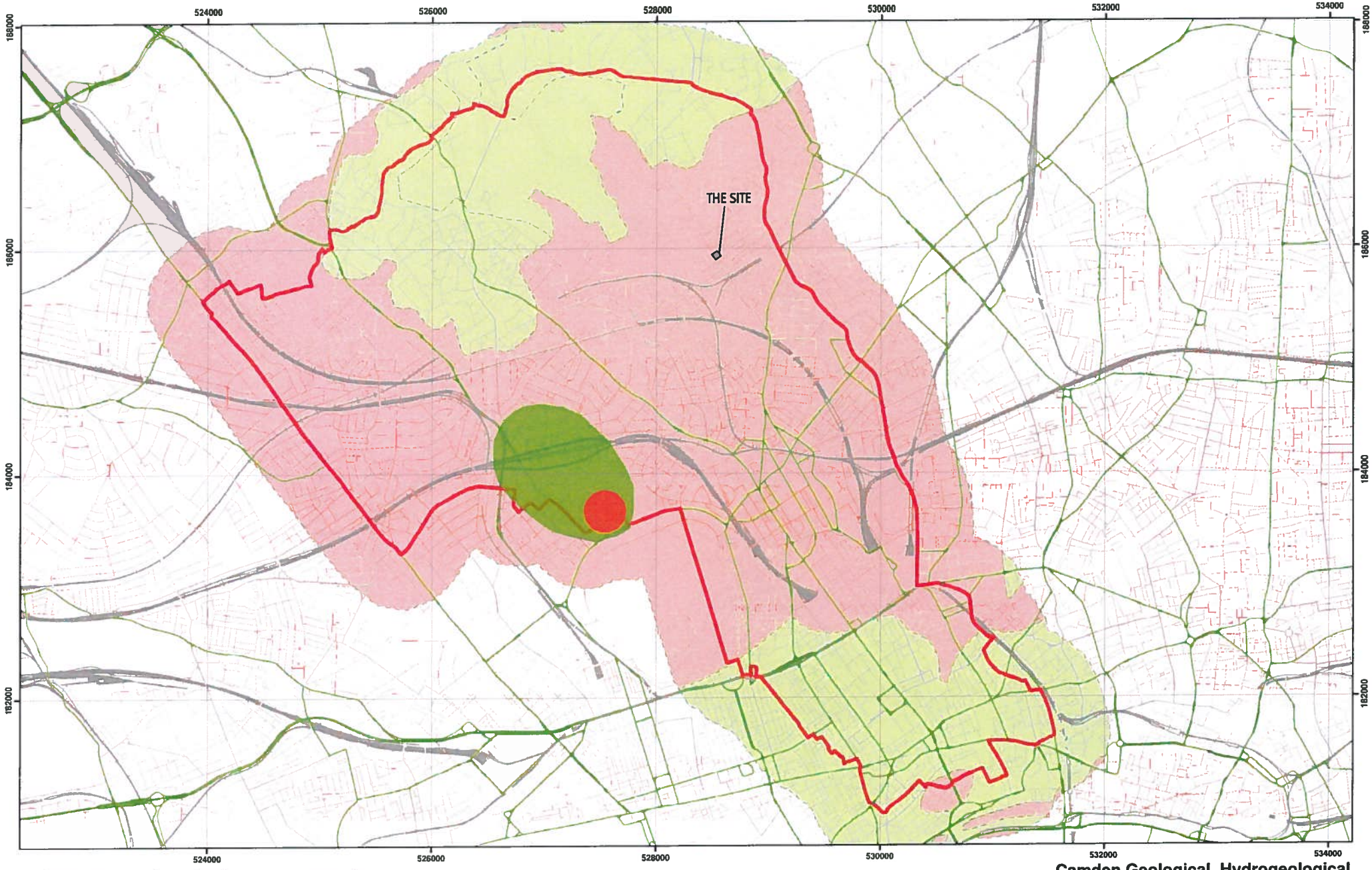



Figure 5 from Core Strategy, London Borough of Camden

**Camden Geological, Hydrogeological and Hydrological Study**
Flood Map

J11987 Site: 18 Grove Terrace, London NW5 Figure 7




Environment Agency Aquifer Designation based on BGS Mapping

N

Scale at A3: 1:30,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.5 1 2 3
Kilometers

**Legend**

Borough of Camden
Railway Lines
A Roads

**Aquifer Designation**
Secondary A Aquifer
Unproductive Strata

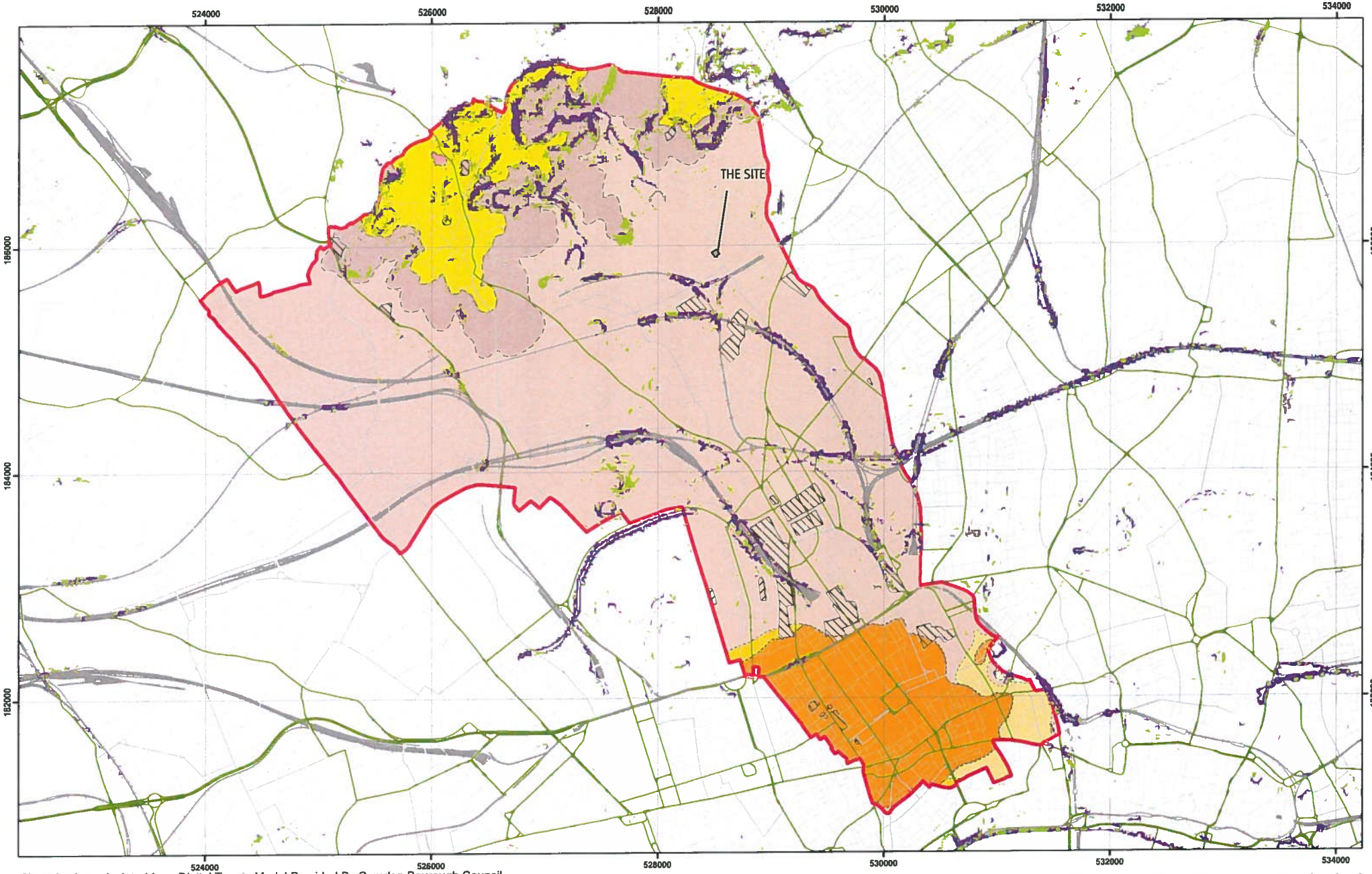
**Source Protection Zone**
Outer Source Protection Zone
Inner Source Protection Zone

NB. Aquifer boundaries are indicative based on available geological mapping data

**Camden Geological, Hydrogeological and Hydrological Study**

Camden Aquifer Designation Map

Report: J11987 Site: 18 Grove Terrace, London NW5 Figure: 8




Slope Angles calculated from Digital Terrain Model Provided By Camden Bourough Council

N

Scale at A3: 1:30,000

1:10,000 BGS Mapping
Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.5 1 2 3
Kilometers

**Legend**

Slope
- 0° - 7°
- 7° - 10°
- > 10°

London Borough of Camden
Railway Lines
A Roads

**BGS 1:10K Artificial Ground**
- MADE GROUND
- WORKED GROUND

**BGS 1:10K Drift Geology**
- ALLUVIUM
- HACKNEY GRAVEL FORMATION
- LANGLEY SILT FORMATION
- LYNCH HILL GRAVEL FORMATION
- STANMORE GRAVEL FORMATION

**BGS 1:10K Solid Geology**
- BAGSHOT FORMATION
- CLAYGATE MEMBER
- LAMBETH GROUP
- LONDON CLAY FORMATION

NB. Geological boundaries are largely indicative based on available geological mapping

**Camden Geological, Hydrogeological and Hydrological Study**

Slope Angle Map

Report: J11987 Site: 18 Grove Terrace, London NW5 Figure: 9

Southern Testing
Environmental & Geotechnical

# Site Investigation Report

Desk Studies | Risk Assessments | Site Investigations | Geotechnical | Contamination Investigations | Remediation Design and Validation

## Site: 18 Grove Terrace, NW5 1PH

## Client: Mr Jatin and Mrs Johanne Vara

## Report Date: 28th October 2014

## Project Reference: J11987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# SUMMARY

The site comprises an existing terraced property, No 18 Grove Terrace, London, NW5 1PH, located approximately 0.4km to the north-east of Gospel Oak Station. The proposed works include the construction of a basement for a dining room and roof garden, extending out from the rear lower ground floor level of the subject property into the garden area, together with an open lower terrace area.

A desk study and formal contamination investigation were outside the requested scope of works.

Geological records indicate the site to be underlain by London Clay.

The soils encountered comprised made ground, overlying weathered London Clay.

To date, the highest standing water levels of 1.34 and 2.01m BGL, have been measured within the monitoring wells installed.

Precautions for BRE Class DS-2 sulphate are recommended for subsurface concrete with an ACEC classification of AC-1s.

NHBC High Volume Change Potential precautions will apply for the weathered London Clay soils.

The development includes a basement structure which we assume will be constructed using conventional underpinning methods. Parameters for retaining wall design are given.

The design of the new basement foundation system should take account the nature of the existing/adjacent foundations and their condition.

The results of the contamination testing, which were mainly carried out for waste classification purposes, are also included. Although a wider contamination investigation was outside the requested scope of works, soil analysis has indicated that the Made Ground and underlying natural soils tested were largely free from significant contamination, other than some minor lead impact of the Made Ground and, to a lesser extent, the natural soil. This is fairly typical in London. The results should be sent to the tip and the groundworks contractor and prospective tip, for their appraisal.

A discovery strategy should be put in place to deal with any significant contamination that comes to light during the development work. Such a discovery could alter the waste classification, site practices and mean that a remediation strategy is required.



J N Race MSc CGeol
(Countersigned)

D Vooght MSc
(Signed)

For and on behalf of Southern Testing Laboratories Limited

STL: J11987
27 October 2014

# TABLE OF CONTENTS

# A INTRODUCTION

## 1 Authority

Our authority for carrying out this work was given in an email dated 3rd September 2014 from Masoud Parvardin of Archetype Associates Limited acting, on behalf of the client Mr J Vara.

## 2 Location

The subject site comprises an existing terraced property, at No 18 Grove Terrace, London, NW5 1PH, located approximately 0.4km to the north-east of Gospel Oak Station. The approximate National Grid Reference of the site is TQ 285 589.

## 3 Proposed Construction

The proposed works include the construction of a basement extending out from the rear lower ground floor level of the subject property into the garden area, together with an open lower terrace area. It is envisaged that the works will be carried out using a form of conventional underpinning methods.

## 4 Object

The object of the investigation was to assess ground and groundwater conditions, foundation bearing and other soil parameters relevant to the proposed development.

A series of contamination tests were also carried out to assist with the waste classification of the soils to be removed from site as part of the basement excavation. This does not, however, constitute a detailed contamination investigation. A desk study was also outside the requested scope of works.

For the purposes of the contamination risk assessment, the proposed development land use is classified as **Residential with plant uptake, (CLEA model[1]/C4SL report[2]). The gas sensitivity of the site is rated as High (CIRIA C665[3]).**

## 5 Scope

This report presents our, exploratory hole logs and test results and our interpretation of these data.

A desk study and formal contamination investigation were outside the requested scope of works.

As with any site there may be differences in soil conditions between exploratory hole positions.

[1] Environment Agency Publication SC050021/SR3 'Updated technical background to the CLEA Model' (2009).
[2] SP1010 Development of Category 4 Screening Levels DEFRA (2014)
[3] CIRIA C665 (2006) Assessing risks posed by hazardous ground gases to buildings.

This report is not an engineering design and the figures and calculations contained in the report should be used by the Engineer, taking note that variations will apply, according to variations in design loading, in techniques used, and in site conditions. Our figures therefore should not supersede the Engineer's design.

The findings and opinions conveyed via this Site Investigation Report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Limited believes is reliable. Nevertheless, Southern Testing Laboratories Limited cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

The site investigation was conducted and this report has been prepared for the sole internal use and reliance of Mr J Vara and the appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorization of Southern Testing Laboratories Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The recommendations contained in this report may not be appropriate to alternative development schemes.

# B THE SITE

## 6 Geology

The British Geological Survey Map at 1:50,000 indicates that the site geology consists of London Clay.

### London Clay

London Clay is a well-known stiff (high strength) blue-grey, fissured clay, which weathers to a brown colour near the surface. It contains thin layers of nodular calcareous mudstone - "claystone" - from place to place, and crystals of water clear calcium sulphate (selenite) are common.

## 7 Hydrology and Hydrogeology

Data from the Environment Agency and other information relating to controlled waters is summarised below. The groundwater vulnerability assessment is based on the current data on the EA website.

| Data | | |
|---|---|---|
| Aquifer Designation | Superficial Deposits | There are no superficial deposits mapped. |
| | Bedrock | Unproductive Strata (London Clay) - deposits with low permeability that have negligible significance for water supply or river base flow. |
| Source Protection Zones | | The site is not located within a Source Protection Zone. |

| Data | |
|---|---|
| Abstractions | On the basis of the information given on the EA website (October 2014) there are no licenses for water abstraction in the area. |
| Surface Water Features | The nearest surface water features are the Hampstead Heath Pond Chain some 0.74km to the north west. The site lies outside of the catchment area to the ponds. |
| Watercourses, well (used/disused) or potential spring lines | The nearest water course shown on the Camden Plan of Watercourses (Source Lost Rivers of London) shows the River Fleet approximately 100m to the east. According to the BGS Geology of Britain Viewer the nearest well (now abandoned) is shown 220m to the north west in the grounds to William Ellis School. We are not aware of any other active wells. Given the geology of the area (London Clay) the potential presence of spring lines are negligible. |
| Fluvial Flood Risk | On the basis of the information given on the EA website (October 2014) the site is not located within an area at risk of flooding from fluvial sources. |
| Surface Water Flood Risk | The "Risk of Flooding from Surface Water" mapping on the Environment Agency website shows that Grove Terrace is located within an area of very low risk. Very low means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%). The Highgate Road just to the west, which is at a slightly lower level to Grove Terrace, is situated within an area of low risk. Low means that each year, this area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%). |
| Reservoir Flood Risk | On the basis of the information given on the EA website (October 2014) the site is located within an area of potential risk of flooding from Highgate Pond No 3. The estimated depth of flooding is below 0.3m |

## 8 Radon Risk

With reference to BRE guidance, no radon protection is required on this site.

## 9 Bomb Map

The published bomb map for the area, taken from the London County Council Bomb Damage Maps (1939-1945), shows that the site, along with the adjacent properties on Grove Terrace, did not suffer any bomb damage during WWII. The map does show, however, that No 4 Grove Terrace along with the adjacent No 5, which are located at the more southern end of Grove Terrace, did suffer some damage (refer Figure 2-Appendix D).

## 10 Site Location

The subject site comprises an existing terraced property, at No 18 Grove Terrace, London, NW5 1PH, located approximately 0.4km to the north-east of Gospel Oak Station.

### 11 General Description

The site/subject property at No 18 Grove Terrace, comprises a five storey (including lower ground floor and roof accommodation) terraced residential building. Grove Terrace is located on the north-east side of Highgate Road.

An inspection of historical maps freely available on the internet was carried out. The earliest map available, 1850-1851, does not show any of the existing properties on Grove Terrace, but does shows the basic road lines including Grove Terrace and Grove Terrace Mews; the latter runs along the rear boundaries of the properties on Grove Terrace. The next map dated 1873 shows the subject building, along with the other terraced properties on Grove Terrace. The later editions do not show any changes to the current properties on Grove Terrace.

The existing building is of masonry brick construction and comprises a detached 5-storey property (including a lower ground floor and roof accommodation). The properties, along with the rest of the buildings on Grove Terrace, have front lightwells. On its rear elevation the subject property has a small lightwell to the lower ground floor with a grill at ground level. From the rear of the house, a proportion of the garden is surfaced with crazy paving, whilst the remainder is grassed. Brick boundary walls separate the rear garden area from the adjacent gardens on its more northern and southern sides. A garage is situated at the end of the garden with access onto Grove Terrace Mews, an unmade lane that passes along the rear boundaries to the properties that front onto Grove Terrace and Boscastle Road to the north-east.

The adjacent detached properties all have lower ground floors and are of similar age and construction to that of the subject building. Of note, the adjacent property No19 Grove Terrace has a basement structure which extends out from rear of the property (at lower ground floor level) together with an upper glass roof/wall structure. In plan, the basement to No 19 curves away from the shared boundary wall to both properties.

Regionally ground levels generally comprise falls in a south-easterly direction from Parliament Hill/Hampstead Heath and Highgate, which are located to the north-west and north of the site. Within the vicinity of the site, ground levels locally fall from Grove Terrace towards Highgate Road with more general local falls occurring in a southerly direction, at about 1-2° degrees.

Existing vegetation within the rear garden area consists of borders containing a variety of ornamental shrubs, various fruit trees (pear and apple) and a grape vine. Vegetation within the neighbouring gardens includes maple, cherry, yew, cyprus, silver birch and various ornamentals shrubs/trees.

## C SITE INVESTIGATION

### 11 Method

The strategy adopted for the intrusive investigation comprised the following:

- 2 No window sample holes were drilled to a depth of 6m.
- Groundwater monitoring wells were installed in both window sample boreholes for groundwater monitoring purposes.

- A series of 4 No test pits were hand excavated to establish foundation conditions to the boundary walls and rear porch to the building.

The exploratory borehole and trial pit locations are shown in Figure 1 in Appendix A.

The fieldwork was carried out on the 23rd September 2014, at which time the weather was dry.

## 12 Soils as Found

The soils encountered within the two window sample holes and hand-dug trial pits are described in detail in the attached exploratory hole logs (Appendix A).

A brief summary of the soils encountered is also given below.

| Depth to Base (m BGL) | Soil Type | Description |
|---|---|---|
| 1.24-2.0 | MADE GROUND | Variable dark grey to brown silty sandy CLAY with occasional brick, ceramic, concrete fragments, ash, glass, and rootlets etc. |
| 6.0+ | WEATHERED LONDON CLAY | Firm to stiff, medium to high strength CLAY with occasional selenite crystals and silty patches. |

A series of hand excavated pits were carried out to establish the rear porch foundations and the adjacent boundary walls. Cross sections showing our findings are given in Appendix A.

## 13 Groundwater Observations

A summary of the water level observations made during site works on the 23rd September 2014 is given below.

| Test Location | Water Strikes/Observations |
|---|---|
| WS1 | Dry on completion to 6.0mBGL |
| WS2 | Dry on completion to 6.0mBGL |
| TP1 | Dry to base of hole (1.4mBGL) on completion |
| TP2 | Dry to base of hole (1.47mBGL) on completion |

| | |
|---|---|
| TP3 | Dry to base of hole (1.1mBGL) on completion |
| TP4 | Dry to base of hole (1.3mBGL) on completion |

### 14 Groundwater Monitoring

Following the initial fieldworks the site was re-visited on two separate occasions, to monitor the wells installed. The results are presented in the table below.

| Date of Reading | 7/10/2014 | 22/10/2014 |
|---|---|---|
| Location | Standing Water Level (mBGL) | |
| WS1 | 3.00 | 2.01 |
| WS2 | 1.80 | 1.34 |

## D FIELD TESTING AND SAMPLING

The following in-situ tests and sampling methods were employed. Descriptions are given in Appendix B.

- Disturbed Samples
- Hand Penetrometer Tests

## E GEOTECHNICAL LABORATORY TESTS

The following tests were carried out on selected samples. Test method references and results are given in Appendix C.

- Moisture Content
- Atterberg Limit Tests
- Soluble Sulphate and pH

# F DISCUSSION OF GEOTECHNICAL TEST RESULTS AND RECOMMENDATIONS

## 15 Soil Classification and Properties

| Soil Type | Depth | Compressibility | VCP | Permeability | Frost Susceptible | CBR | Remarks |
|---|---|---|---|---|---|---|---|
| Made Ground | GL to 1.24/2.0m | N/A | N/A | Low but seepages from more permeable horizons are anticipated | Yes | N/A | Not suitable for foundations |
| Weathered London Clay | 6.0m+ | Medium | High | Very low/impermeable, but seepages from fissures can occur | No | Poor | |

## 16 Swelling and Shrinkage

The results of the Atterberg Limit Tests on selected samples of the Weathered London Clay soils recorded plasticity indices in the range of 28% to 50%, which indicate that the clay soils are classified as NHBC Medium to High Volume Change Potential. On balance, we would recommend that NHBC High Volume Change Potential precautions are adopted.

It is noted that a number of fruit trees are present within the rear garden, with one of these being located approximately 2.0m from trial hole WS 2. Given this information, the presence of soil desiccation was investigated.

### 16.1.1 (Soil Desiccation)

Various methods are available in the appraisal of soil desiccation. We have listed below the methods used in our assessment:-

- Water content/Atterberg limit
- Shear Strength using hand penetrometer methods

### 16.1.2 Water Content/Atterberg Limit Test

Information from the Atterberg Limit test can sometimes be used to give an indication of desiccation that is present at the time of the investigation. It should be noted that they are only crude guides and therefore any conclusions drawn should be used in conjunction with other available data. The criterions used in our estimate of desiccation are as follows:

(i) The soils within the upper weathered zone will generally be at plastic limit + 2 to 4% where unaffected by trees.

(ii) The soils at depth below the very highly weathered zone are generally close to their plastic limit.

(iii) Where clays are desiccated by trees, they will be at significantly lower water contents than those given in (i) and (ii).

(iv) If soils are at a moisture content of less than 0.5 x liquid limit, they can be considered desiccated. Experience shows that rigid application of this criterion results in an overestimate of the depth of desiccation. As a consequence, this criterion has not been considered further.

(v) If soils are below a moisture content of 0.4 x liquid limit, then significant desiccation could be present and, depending on foundation loading, is likely to give rise to heave on removal of trees and structural damage.

Figure MC1 (Appendix C) shows a plot of moisture content versus depth for both test locations. Figure MC2 and MC3 (Appendix C) has been plotted with respect to the above criterion.

Referring to figure MC1, and within the upper 3.2m, the moisture contents in WS2 are typically lower than those recorded within WS1.

Below a depth of 3.2m, the moisture contents within WS1 are lower than those recorded within WS2. It is noted that WS1 is more remote from the adjacent vegetation than WS2 and therefore below 3.2m the results are somewhat contradictory. The moisture content profiles within both holes converge at a depth of 6.0m

Referring to Figures MC2 and MC3, and using the above desiccation criterion, in our opinion, there is no conclusive sign of significant desiccation within the upper 3.0m in either borehole. The tests indicate possible signs of desiccation within WS1 between 3.0-4.2m. As noted above, WS1 is located in an area which was more remote from the trees within the garden than WS2, and therefore, in this instance, the use of the criteria is not definitive proof of desiccation being present at depth in WS1.

### 16.1.3 Shear Strength

Pugh et al [4] used shear strength in their method of evaluating desiccation depths of London Clay, as they considered it offered a rapid, low cost technique.

The method basically consists of the use of simple hand penetrometer measurements of shear strength. By comparing the test results with that of a range of typical values for London Clay soils in a non-desiccated state, an assessment of soil desiccation can be made. The results of the hand penetrometer measurements are given in Figure HP1 (Appendix C).

[4] "A rapid and reliable on-site method of assessing desiccation in clay soils"
by R S Pugh, P G Parnell, and R D Parkes, Proc. Instn Civ. Engrs. Geotech. Engng. 1995, 113 pp. 25-30.

Referring to Figure HP1 there is no signs of soil desiccation indicated within test location WS1. Within WS2, again, there is no sign of desiccation within the upper 3m, although the possible presence of soil desiccation is indicated between 3.0-4.0m.

### 16.1.4 Summary on Desiccation

The above tests to determine desiccation are somewhat contradictory and not entirely consistent. Furthermore, given the tree types present (fruit trees of moderate water demand) we do not consider that the results of the tests are entirely conclusive and it is very unlikely that desiccation is present in either test hole below 3.0m.

Therefore, in terms of the proposed construction, we would recommend that the basement construction is designed using standard NHBC High Volume Change precautions.

## 17 Groundwater Levels

It should be noted that ground water levels vary considerably from season to season and year to year, often rising close to the ground surface in wet or winter weather, and falling in periods of drought. Long term monitoring is required to assess the ground water regime and this was not possible during the course of this site investigation.

While siteworks were in progress, no groundwater entries were noted within the made ground or underlying Weathered London Clay.

To date, the highest groundwater levels measured within the monitoring wells installed have measured standing water levels of 1.34m BGL and 2.01m BGL. The presence of a standing water level reflects a perched groundwater table within the made ground.

On the basis of the measurements to date, groundwater ingress is not expected to be a significant problem in terms of dewatering issues etc during construction. Allowances for some dewatering, however, should be made from perched sources e.g. within the made ground, in the form of intermittent pumping from strategically placed collector sumps.

For the longer term condition, seepage entries from fissure flow within the clays and any perched water from within the overlying made ground should be allowed for in the design of the basement area e.g. provision of waterproofing measures, and also for hydrostatic uplift of the basement floor slab.

Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x $10^{-9}$ m/s and 1x $10^{-14}$ m/s, with an even lower vertical permeability. Accordingly, the groundwater flow rate is anticipated to be extremely low to negligible.

Any groundwater flows that take place will likely follow the local/regional topography which in this instance comprises local falls to the south of around 1-2°. Given the very slight falls in the local/regional topography, hence almost negligible hydraulic gradient, and the very low/impermeable nature of the underlying clay materials, there is negligible risk of the proposed basement walls causing a "damming effect" or mounding of water on the upstream faces.

On the basis of the observations/comments, it is concluded that the proposed development will not result in any specific issues relating to the hydrogeology of the site.

In terms of the potential cumulative effects on the groundwater environment in the local area, i.e. the effects on the adjacent basement to No 19 Grove Terrace, and should other future basements be granted beneath adjacent properties, the combination of the overall regional and local topographic falls of the area (hence negligible to low hydraulic gradients), and the very low/impermeable nature of the underlying London Clay, any resulting increases in groundwater levels within the area (locally or regionally) will be negligible.

## 18 Sulphates and Acidity

The measured pH of the two made ground samples analysed was 8.1, indicating slightly alkaline conditions. The measured pH of the natural Weathered London Clay soils analysed ranged between 7.1 and 8.3 and therefore they were neutral to slightly alkaline in reaction.

Within the made ground materials, soluble sulphate levels of 40 and 50mg/l were measured in the samples tested. Within the underlying natural Weathered London Clay soils analysed, soluble sulphate levels of between 50 and 941mg/l were measured. The characteristic value for the five tests carried out on the Weathered London Clay soils was 720mg/l.

On the basis of the above measurements, we would recommend that BRE Class DS-2 precautions are adopted for subsurface concrete, together with an ACEC Class of AC-1s.

## 19 Bearing Capacity

Where it is necessary to construct spread foundations or bases to retaining walls as part of the proposed works, all foundations should clearly penetrate any made ground and be formed on the underlying natural Medium to High Strength Clay materials. For foundations formed on these materials, an allowable bearing capacity of 125kPa may be adopted.

## 20 Heave

Due to stress relief following the removal of the existing soils to form the basement structure, both immediate (undrained) and long term (drained) heave displacements can be expected to occur in the underlying London Clay.

The immediate (undrained) heave displacements will more or less occur as excavation of the basement takes place and before the construction of basement elements e.g. slabs etc. Accordingly, only the long term (drained) heave displacements will need to be catered for in design, to overcome the problem of uplift pressures forming. This is normally overcome by installing appropriate void forming materials beneath the basement elements.

For the analysis of heave movements, the following stiffness parameters after Burland and Kalra (1986)[5] are suggested for the London Clay:

[5] Burland J.B. and Kalra J.C. (1986) Queen Elizabeth Conference Centre: geotechnical aspects, Proc. Inst. Civ. Engnrs, Part 1,80,1479-1503

Undrained Young's Modulus ($E_u$) = (10+5.2z) ($MN/m^2$)

Undrained Poisson Ratio ($\nu_u$) =0.5

Drained Young's Modulus ($E_d$) = (7.5+3.9z) ($MN/m^2$)

Drained Poisson Ratio ($\nu_d$) =0.2

Where z (m) is taken from the surface of the London Clay

Assuming a basement/excavation formation depth of about 2.5m beneath the existing ground levels, an analysis of heave displacements has been carried out using PDisp and the above parameters (Appendix E). For the purpose of the analysis we have assumed an unload pressure of 50kPa across the full area of the proposed basement structure and lower courtyard area.

Figure U1 relates to the immediate (undrained-end of construction stage) heave displacements and Figure V1 to the total long term (drained) heave displacements (which includes the end of construction displacements). The maximum undrained heave displacement, i.e. end of construction stage, occurs beneath the approximate central point of the proposed basement excavation area and is 7mm. The total long term drained heave movement (which includes the initial undrained heave movement) occurs at the same point and is 12mm.

We note that the proposed basement structure also includes a roof structure and therefore this could result in a reduction in net unloading assumed and hence heave displacements.

## 21 Basement Construction

Based on the findings of the boreholes and the soil types encountered, the following soil parameters are suggested for design of retaining walls:

| Soil Type | Bulk density $\gamma_b$ ($kN/m^3$) | Undrained Shear Strength (Temporary Condition) | Long Term Drained Condition | |
|---|---|---|---|---|
| | | | c' ($kN/m^2$) | $\varphi^o$ |
| Made Ground | 19 | N/A | 0 | 25 |
| Weathered London Clay | 20 | Cu=50kPa@2m depth (surface of London Clay) increasing linearly with depth to 100kPa @6.0m depth | 0 | 25 |

## 22 Excavations and Trenching

Statutory lateral earth support will be required in all excavations where men must work. Instability of the sides of any excavations carried out must be expected. Accordingly, measures should be taken at all times to ensure that excavations are adequately supported. Given the presence of the existing adjacent foundations (boundary walls and properties), close attention in design of temporary and permanent propping is required at all times, to prevent settlement or excessive lateral yielding of the excavation/foundations.

# G LAND QUALITY

## 23 Analytical Framework

There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

The CLEA model[6] provides a methodology for quantitative assessment of the long term risks posed to human health by exposure to contaminated soils. Toxicological data is used to calculate a Soil Guideline Value (SGV) for an individual contaminant, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

In the absence of any published SGVs for certain substances, Southern Testing have derived or adopted Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH[7] and CL:AIRE[8] generic assessment criteria. In addition, in March 2014, DEFRA[9] published the results of a research programme to develop screening values to assist decision making under Part 2A of the Environmental Protection Act. Category 4 screening levels were published for 6 substances, with reference to human health risk only. This guidance includes revisions of the CLEA exposure parameters, presenting parameters for public open space land use scenarios, and also of the toxicological approach. The screening levels represent a low risk scenario, based on a 'Low Level of Toxicological Concern' rather than the 'Minimal Risk' of CLEA, and the analytical results of this investigation may be considered relative to these levels.

Site-specific assessments are undertaken wherever possible and/or applicable.

CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

Whilst a formal contamination investigation was outside the requested scope of works (the intrusive investigation did not include a desk study or a conceptual model, for example), some

[6] Environment Agency Publication SC050021/SR3 'Updated technical background to the CLEA Model' (2009).
[7] The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment 2nd Edn. (2009).
[8] The EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment (2009).
[9] SP1010 Development of Category 4 Screening Levels foe Assessment of Land Affected by Contamination. DEFRA, 2014.

basic contamination testing was undertaken to help assess the risk to site workers, as well as providing data to assist with the waste classification of any material taken off-site.

## 24 Site Investigation – Soil

### 24.1 Sampling Regime

The number of sample locations was to provide reasonable coverage of the area of the proposed works.

### 24.2 Testing

As there was no evidence of significant contamination noted during the site work, the following tests were undertaken to allow a general assessment of the contamination and waste classification.

| Test Suite | Number of Samples | Soil Tested |
|---|---|---|
| STL Key Contaminant Suite and Asbestos Screen | 2 | Made Ground |
| STL Key Contaminant Suite | 1 | Natural Soils |

The test results are presented in full in Appendix F. A summary and discussion of the significance of the results and identified contamination sources is given below.

### 24.3 Test Results and Identified contamination sources

#### 24.3.1 General Contaminants

The results of the key contaminant tests have been analysed in accordance with the CLEA methodology. The samples have been grouped into two populations comprising made ground and natural soils although, as only two sample of the made ground and one sample of the natural London Clay soil was analysed, a statistical assessment was not possible. The test results are presented below, along with the screening values (to allow a basic assessment).

***Soil Type: Made Ground***

| Contaminant | Unit | Measured Range (mg/kg) | Screening value |
|---|---|---|---|
| | | | Residential with Plant Uptake |
| Arsenic | mg/kg | 15-22 | 32 |
| Cadmium | mg/kg | 0.1 | 10 |
| Total Chromium | mg/kg | 23-27 | 627 |
| Lead | mg/kg | **450-540** | 200 |
| Mercury | mg/kg | 1.1-3.7 | 7 |
| Selenium | mg/kg | <3 | 350 |
| Nickel | mg/kg | 22 | 130 |
| Copper | mg/kg | 66-250 | 2300 |

| Contaminant | Unit | Measured Range (mg/kg) | Screening value |
|---|---|---|---|
| | | | Residential with Plant Uptake |
| Zinc | mg/kg | 110-150 | 3700 |
| Phenol | mg/kg | <1 | 184-420 |
| Benzo(a)pyrene | mg/kg | <0.1 | 0.8 |
| Naphthalene | mg/kg | <0.1 | 1.5 |
| Total Cyanide | mg/kg | <1 | - |

The made ground material analysed was generally free from significant contamination, with the exception of some fairly minor lead impact. In our experience, however, the lead concentrations reported are fairly typical of made ground material in London and is not considered significant in terms of the development proposals and the likely risk to the site workers (assuming basic health and safety measures are adopted) and the end users.

***Soil Type: Natural Soils (Weathered London Clay)***

| Contaminant | Unit | Measured Range (mg/kg) | Screening value |
|---|---|---|---|
| | | | Residential with Plant Uptake |
| Arsenic | mg/kg | 15 | 32 |
| Cadmium | mg/kg | <0.1 | 10 |
| Total Chromium | mg/kg | 49 | 627 |
| Lead | mg/kg | **210** | 200 |
| Mercury | mg/kg | <1 | 7 |
| Selenium | mg/kg | <3 | 350 |
| Nickel | mg/kg | 58 | 130 |
| Copper | mg/kg | 97 | 2300 |
| Zinc | mg/kg | 130 | 3700 |
| Phenol | mg/kg | <1 | 184-420 |
| Benzo(a)pyrene | mg/kg | <0.1 | 0.8 |
| Naphthalene | mg/kg | <0.1 | 1.5 |
| Total Cyanide | mg/kg | <1 | - |

The contamination results for the natural soil analysed, with the exception of lead, were all less than their corresponding screening values. This concurs with the observations made on site and the results for the overlying fill material analysed. In most instances, the concentrations for corresponding contaminants were much lower in the natural soil analysed (even in the case of lead, for example), which suggests minimal leaching and a low risk to the aquifer.

Whilst no asbestos containing materials were detected in the samples of made ground and natural soil analysed, and none were observed in the exploratory holes, it should be noted that the exploratory hole was of small diameter/size, so the samples obtained may not reflect the full composition of the soils on the site. Therefore, there is always the potential for pockets of asbestos or for asbestos containing materials to be present, which have not been detected in the sampling.

It is also our experience that asbestos containing materials are quite often encountered in buried pockets and beneath slabs (sometimes adhering to the concrete). It is, therefore, advised that further examination is carried out, when suitable access is available.

All of the results should be forwarded to the tip for their appraisal and comments. Given that the made ground material is slightly impacted with lead, it would be prudent to separate the fill material from the natural arisings during construction. The tip might require that WAC testing is carried out.

Encountering more significant contamination, during the development works, could change the waste classification and the health and safety practices required on site.

### 25 Summary of Identified Contamination

Although a wider contamination investigation was outside the requested scope of works, soil analysis of two samples of the made ground and one sample of the natural Weathered London Clay has indicated that the Made Ground and underlying natural soils tested is largely free from significant contamination. Some minor impact with lead was reported in the Made Ground samples analysed, however, although less so in the natural soil sample tested. In our experience, this is typical of Made Ground in London and not considered significant in terms of the proposed development.

### 26 Recommendations

It is anticipated that the made ground soils and natural soils on site will be removed, as part of the basement construction in particular, and deposited at an appropriate waste management facility. No remediation is considered necessary at this stage.

The contamination results should be forwarded to this facility for confirmation of the waste classification, particularly whether the slight lead impact of the fill, will results in something other than an inert classification. The tip might require that WAC testing is carried out.

On the basis of these results, it appears that good general site practice, such as appropriate PPE and basic hygiene measures, will be sufficient to mitigate any minor risk to the ground workers. As with the waste management facility, these results should be provided to the ground workers for their appraisal.

A careful watch should be kept for any more significant contamination that comes to light during the construction works, as part of a discovery strategy. This will need inspection, sampling and analysis; depending on the results, this may alter the remediation strategy, the waste classification and, possibly, site practices.

## H CONSIDERATIONS FOR IMPLEMENTATION AND VALIDATION OF REMEDIATION

### 27 General Guidance

It may be that specific local requirements apply to this site, of which we are not aware at this time.

In general terms, the workforce and general public should be protected from contact with contaminated material. There is a range of relevant documents published by the Health and Safety Executive, and organisations such as CIRIA, and the BRE.

Some soils will require removal from site and disposal to suitably licensed landfills. Different guidelines and charges will apply to different waste classification. As waste producers, the Developer holds responsibilities under the various governing regulations, the key elements of which are:-

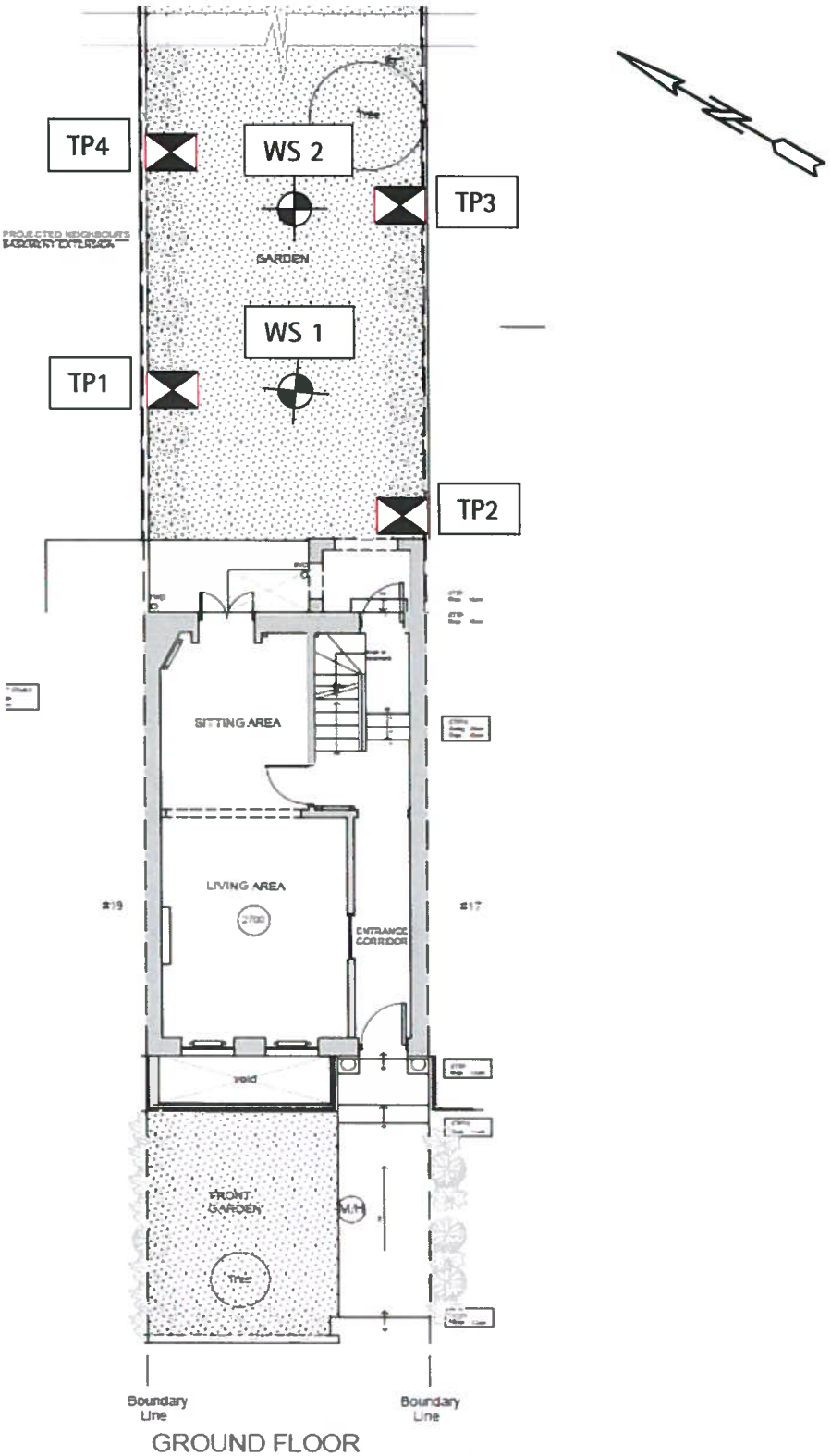
- Ensuring that waste is characterised in accordance with Technical Guidance WM2.
- Ensuring that waste is disposed of at a facility appropriately licensed to receive the waste as classified.
- Keeping accurate records of all waste classification, transfer and a disposal log including information such as:
    - Date, Waste Classification, Carrier's Registration Number, Transfer Note Number, Ultimate Destination.
- Submitting full copies of those records for inclusion in validation/closure reports.
- Maintaining those records for potential future regulatory inspection.

All hazardous and non-hazardous soils leaving site will need to be pre-treated.

Many water supply companies now require higher specification pipe on contaminated sites, even following remediation.

# APPENDIX A

Site Plans and Exploratory Hole Logs and Photographs




| | | | |
|---|---|---|---|
| NB: | Positions of Boreholes and/or Trial Pits are only indicative unless dimensioned | | |
| Site: | 18 Grove Terrace, London NW5 | STL: J11987 | Fig No: 1 |
| Date: | 06 October 2014 | Trial Pit and Borehole Location Plan | |

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

Southern Testing | ST Consult — Environmental & Geotechnical — Tel: 01342 333100

| Project No. | Hole Type | Borehole No |
|---|---|---|
| J11987 | WS | WS1 Sheet 1 of 1 |

Project Name: 18 Grove Terrace ( London NW5 )

Dates: 23/09/2014

Location: London NW5

NGR: -

Client: Archetype Associates Limited

Level: -

Logged By: SM

| Well | Water Strikes | Samples & In Situ Testing: Depth (m) | Type | Results | Level (m AOD) | Thickness | Legend | Depth (m) | Stratum Description |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.06 | | 0.06 | Crazy Paving |
| | | 0.50 | ES | | | 0.59 | | | MADE GROUND composed of grey brown, slightly silty/sandy, CLAY, with frequent fine to coarse, sub-angular fragments of brick, ceramic, concrete and occasional medium to coarse, sub-rounded flint gravel. |
| | | 1.00 | D | | | 0.45 | | 0.65 | MADE GROUND composed of grey CLAY, with frequent fine brick fragments and occasional ash and concrete fragments. |
| | | 1.50 | | UCS = 90 | | 0.90 | | 1.10 | MADE GROUND composed of grey brown, slightly silty, CLAY, with occasional medium to coarse, brick fragments. |
| | | 1.50 | D | | | | | | 1.50m - 2.00m: Occasional fine to medium, sub-rounded flint gravel. |
| | | 1.75 | | UCS = 120 | | | | | |
| | | 2.00 | | UCS = 80 | | | | 2.00 | Firm to stiff, medium to high strength, grey brown, CLAY, with occasional silty patches and selenite crystals. |
| | | 2.00 | D | | | | | | |
| | | 2.00 | ES | | | | | | |
| | | 2.25 | | UCS = 110 | | | | | |
| | | 2.50 | | UCS = 160 | | | | | |
| | | 2.50 | D | | | | | | |
| | | 2.75 | | UCS = 160 | | | | | |
| | | 3.00 | | UCS = 190 | | | | | |
| | | 3.00 | D | | | | | | |
| | | 3.25 | | UCS = 230 | | | | | |
| | | 3.50 | | UCS = 180 | | | | | |
| | | 3.50 | D | | | | | | |
| | | 3.75 | | UCS = 220 | | | | | |
| | | 4.00 | | UCS = 320 | | 4.00 | | | |
| | | 4.00 | D | | | | | | |
| | | 4.25 | | UCS = 200 | | | | | |
| | | 4.50 | | UCS = 250 | | | | | |
| | | 4.50 | D | | | | | | |
| | | 4.75 | | UCS = 250 | | | | | |
| | | 5.00 | | UCS = 270 | | | | | |
| | | 5.00 | D | | | | | | |
| | | 5.25 | | UCS = 320 | | | | | |
| | | 5.50 | | UCS = 280 | | | | | |
| | | 5.50 | D | | | | | | |
| | | 5.75 | | UCS = 320 | | | | | |
| | | 6.00 | | UCS = 380 | | | | 6.00 | End of Borehole at 6.00 m |
| | | 6.00 | D | | | | | | |

| Type | Results |
|---|---|

## Borehole Details

| Casing Depth m bgl | Hole Depth m bgl | Casing Diameter mm |
|---|---|---|
| | | |

## Water Strikes

| Date | Water (m) | Casing (m) | Time (mins) | Rose to (m) | Sealed (m) |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks:

Hole dry on completion.

Southern Testing | ST Consult — Environmental & Geotechnical — Tel: 01342 333100

| Project No. | Hole Type | Borehole No |
|---|---|---|
| J11987 | WS | WS2 Sheet 1 of 1 |

Project Name: 18 Grove Terrace ( London NW5 )

Dates: 23/09/2014

Location: London NW5

NGR: -

Client: Archetype Associates Limited

Level: -

Logged By: SM

| Well | Water Strikes | Samples & In Situ Testing Depth (m) | Type | Results | Level (m AOD) | Thickness | Legend | Depth (m) | Stratum Description |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.06 | | 0.06 | Crazy Paving (Concrete Slab) |
| | | | | | | 0.56 | | | MADE GROUND composed of grey brown to yellow, slightly clayey, silty, SAND, with frequent fragments of fine to medium brick and ash. |
| | | 0.50 | ES | | | | | 0.62 | |
| | | 0.70 | D | | | | | | MADE GROUND composed of grey brown, slightly sandy, CLAY, with frequent fine, sub-angular brick fragments and occasional rootlets. |
| | | 1.00 | D | | | 0.78 | | | |
| | | | | | | | | 1.40 | |
| | | 1.50 | | UCS = 150 | | | | | Firm, medium to high strength, grey blue, silty, CLAY. |
| | | 1.50 | D | | | | | | |
| | | 1.60 | ES | | | | | | |
| | | 1.75 | | UCS = 170 | | 0.70 | | | |
| | | 2.00 | | UCS = 210 | | | | | |
| | | 2.00 | D | | | | | 2.10 | |
| | | 2.25 | | UCS = 200 | | | | | Firm to stiff, medium to high strength, orangey brown, silty, CLAY, with occasional fine to medium, sub-rounded flint gravel, selenite crystals and sandy lenses/patches. |
| | | 2.50 | | UCS = 260 | | | | | |
| | | 2.50 | D | | | | | | |
| | | 2.75 | | UCS = 310 | | | | | |
| | | 3.00 | | UCS = 310 | | | | | |
| | | 3.00 | D | | | | | | |
| | | 3.25 | | UCS = 400 | | | | | |
| | | 3.50 | | UCS = 410 | | | | | |
| | | 3.50 | D | | | | | | |
| | | 3.75 | | UCS = 380 | | | | | |
| | | 4.00 | | UCS = 370 | | 3.90 | | | |
| | | 4.00 | D | | | | | | |
| | | 4.50 | | UCS = 120 | | | | | |
| | | 4.50 | D | | | | | | |
| | | 4.75 | | UCS = 300 | | | | | |
| | | 5.00 | | UCS = 260 | | | | | |
| | | 5.00 | D | | | | | | |
| | | 5.25 | | UCS = 340 | | | | | |
| | | 5.50 | | UCS = 320 | | | | | |
| | | 5.50 | D | | | | | | |
| | | 5.75 | | UCS = 380 | | | | | |
| | | 6.00 | | UCS = 300 | | | | 6.00 | |
| | | 6.00 | D | | | | | | End of Borehole at 6.00 m |

| | Type | Results |
|---|---|---|

## Borehole Details

| Casing Depth m bgl | Hole Depth m bgl | Casing Diameter mm |
|---|---|---|
| | | |

## Water Strikes

| Date | Water (m) | Casing (m) | Time (mins) | Rose to (m) | Sealed (m) |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks:

Hole dry on completion.

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Environmental & Geotechnical
Tel: 01342 333100

| Project No. | Machine Type | Trialpit No |
|---|---|---|
| **J11987** | **Hand Dug** | **TP1** Sheet 1 of 1 |

Project Name: 18 Grove Terrace ( London NW5 )

NGR: -
Level: -

Date: 23/09/2014

Location: London NW5

Dimensions: 0.50m
Depth 1.40m
0.70m

Client: Archetype Associates Limited

Logged By AW

| Samples & In Situ Testing | | | Level (m AOD) | Thickness | Legend | Depth (m) | Stratum Description |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type | Results | | | | | |
| | | | | 0.06 | | | Crazy Paving. |
| | | | | | | 0.06 | MADE GROUND composed of brown to black, silty, sandy, CLAY, with frequent fine to medium, angular brick fragments, occasional fine to medium glass, ceramic fragments, fine to medium ash and rootlets throughout (TOPSOIL). |
| | | | | 0.15 | | | |
| | | | | | | 0.21 | MADE GROUND composed of grey brown, slightly silty, CLAY, with frequent fine angular brick fragments and occasional cobbles of sub-angular bricks. |
| 0.50 | D | | | | | | |
| | | | | 1.19 | | | |
| 1.00 | D | | | | | | |
| | | | | | | 1.40 | Trial Pit Complete at 1.40 m |

Remarks: Stable and dry on completion.

Pit Stability:

Groundwater:

PPT = Perth Penetration Test 'N' Value , UCS = Unconfined Compressive Strength (kN/m2) by Hand Penetrometer, HV= Hand Vane Result (kPa)

Southern Testing | ST Consult Tel: 01342 333100

| Project No. | Machine Type | Trialpit No |
|---|---|---|
| **J11987** | **Hand Dug** | **TP2** Sheet 1 of 1 |

Project Name: 18 Grove Terrace ( London NW5 )

NGR: -

Level: -

Date: 23/09/2014

Location: London NW5

Dimensions: 0.60m

Depth 1.47m

0.32m

Client: Archetype Associates Limited

Logged By AW

| Samples & In Situ Testing | | | Level (m AOD) | Thickness | Legend | Depth (m) | Stratum Description |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type | Results | | | | | |
| | | | | 0.06 | | 0.06 | Crazing Paving. |
| 0.30 | ES | | | | | | MADE GROUND composed of dark grey to brown, silty, sandy, CLAY, with occasional fine to medium, angular brick fragments, ceramic fragments, ash and rootlets throughout (TOPSOIL). |
| 0.50 | D | | | 0.76 | | | |
| | | | | | | 0.82 | MADE GROUND composed of grey brown, slightly silty, CLAY, with frequent fine angular brick fragments and occasional cobbles of sub-angular bricks. |
| 1.00 | D | | | 0.42 | | | |
| | | | | | | 1.24 | Soft to firm, low to medium strength, orange brown, slightly silty, CLAY. |
| 1.40 | ES | | | 0.23 | | | |
| 1.47 | D | | | | | 1.47 | Trial Pit Complete at 1.47 m |

Remarks: Stable and dry on completion.

Pit Stability:

Groundwater:

PPT = Perth Penetration Test 'N' Value , UCS = Unconfined Compressive Strength (kN/m2) by Hand Penetrometer, HV= Hand Vane Result (kPa)

| Southern Testing \| ST Consult | Tel: 01342 333100 | Project No. J11987 | Machine Type Hand Dug | Trialpit No TP3 Sheet 1 of 1 |
|---|---|---|---|---|
| Project Name: 18 Grove Terrace ( London NW5 ) | | NGR: - Level: - | | Date: 23/09/2014 |
| Location: London NW5 | | Dimensions: Depth 1.10m | 0.50m / 0.28m | |
| Client: Archetype Associates Limited | | | | Logged By AW |

| Samples & In Situ Testing | | | Level (m AOD) | Thickness | Legend | Depth (m) | Stratum Description |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type | Results | | | | | |
| | | | | 0.06 | | 0.06 | Crazy Paving. |
| 0.20 | D | | | 0.30 | | | MADE GROUND composed of dark brown to black, silty, sandy, CLAY, with frequent fragments of fine to medium, sub-angular brick, ash and occasional ceramic and rootlets throughout. |
| 0.30 | ES | | | | | 0.36 | MADE GROUND composed of brown/black, silty CLAY, with occasional fragments of medium to coarse, sub-angular to sub-rounded, brick, concrete, ceramic, and fine to coarse, sub-rounded, flint gravel. |
| 0.50 | D | | | | | | |
| 0.60 | ES | | | 0.64 | | | |
| | | | | | | 1.00 | MADE GROUND composed of soft to firm, low to medium strength, grey brown, slightly silty, CLAY, with occasional fine sub-angular brick fragments. |
| 1.05 | | UCS = 120 | | 0.10 | | | |
| 1.05 | D | | | | | 1.10 | Trial Pit Complete at 1.10 m |

Remarks: Stable and dry on completion.

Pit Stability:

Groundwater:

PPT = Perth Penetration Test 'N' Value , UCS = Unconfined Compressive Strength (kN/m2) by Hand Penetrometer, HV= Hand Vane Result (kPa)

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Tel: 01342 333100

| Project No. | Machine Type | Trialpit No |
|---|---|---|
| **J11987** | **Hand Dug** | **TP4** Sheet 1 of 1 |

Project Name: 18 Grove Terrace ( London NW5 )

NGR: -

Level: -

Date: 23/09/2014

Location: London NW5

Dimensions: 0.72m

Depth 1.30m

0.38m

Client: Archetype Associates Limited

Logged By AW

| Samples & In Situ Testing | | | Level (m AOD) | Thickness | Legend | Depth (m) | Stratum Description |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type | Results | | | | | |
| | | | | 0.65 | | | MADE GROUND composed of black to brown, silty, sandy, CLAY, with frequent fragments of fine to medium, angular brick, occasional fine to medium, glass, ceramic and ash, rootlets throughout. |
| 0.50 | D | | | | | | |
| | | | | | | 0.65 | |
| 0.70 | ES | | | | | | MADE GROUND composed of grey brown, slightly silty, CLAY, with frequent fine, angular brick fragments and occasional sub-angular brick cobbles. |
| | | | | 0.65 | | | |
| 1.00 | D | | | | | | |
| 1.30 | D | | | | | 1.30 | Trial Pit Complete at 1.30 m |

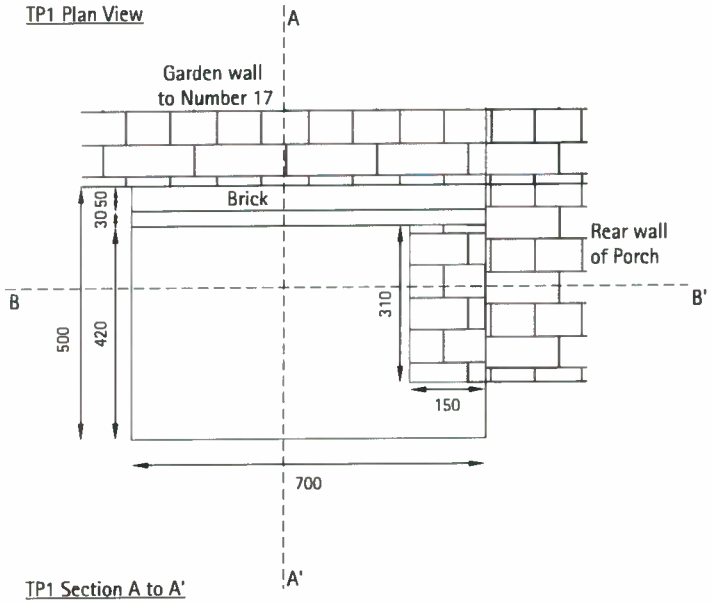
Remarks: Stable and dry on completion.

Pit Stability:

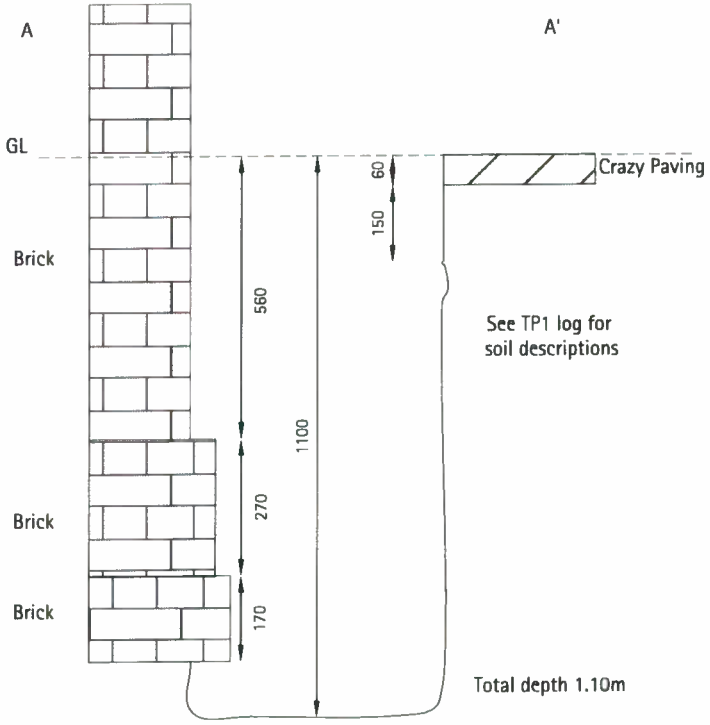
Groundwater:

PPT = Perth Penetration Test 'N' Value , UCS = Unconfined Compressive Strength (kN/m2) by Hand Penetrometer, HV= Hand Vane Result (kPa)

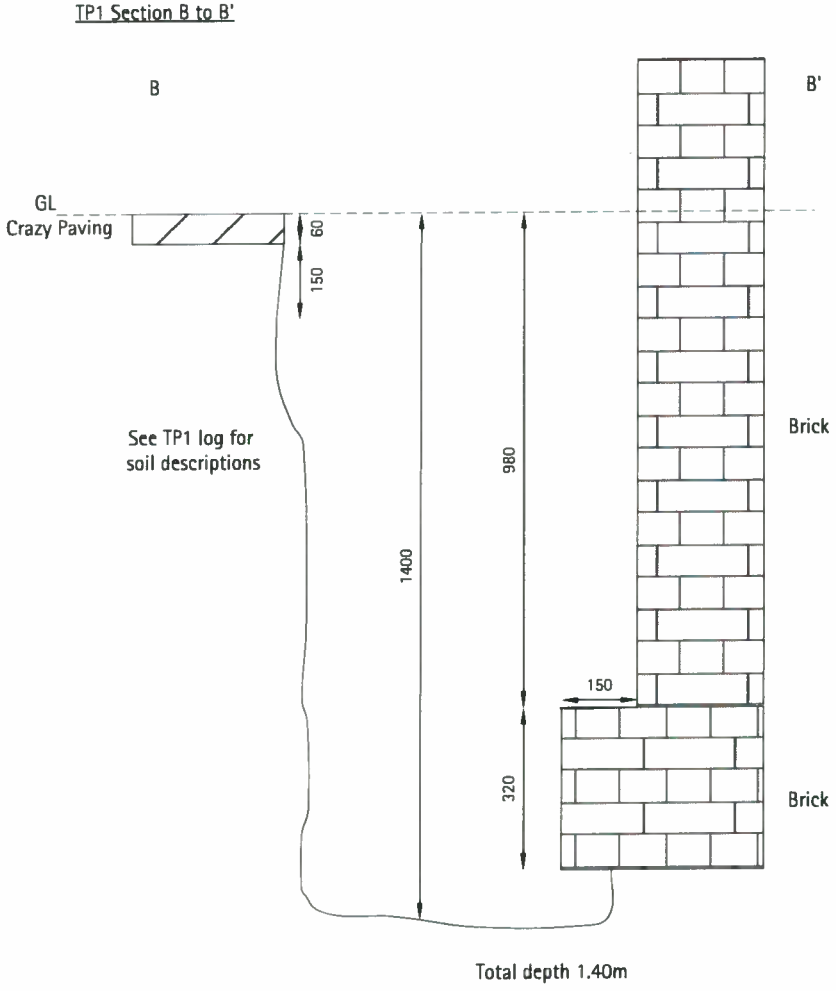
## TP1 Plan View




## TP1 Section A to A'




## TP1 Section B to B'




## Notes

1. All dimensions in mm unless stated otherwise.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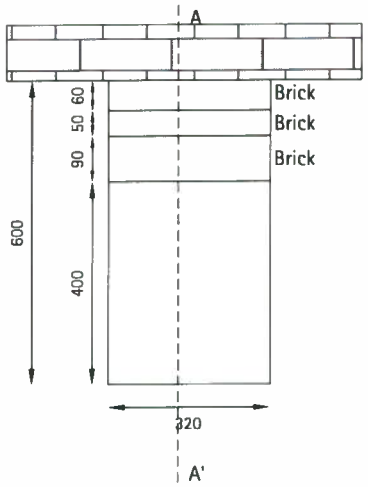
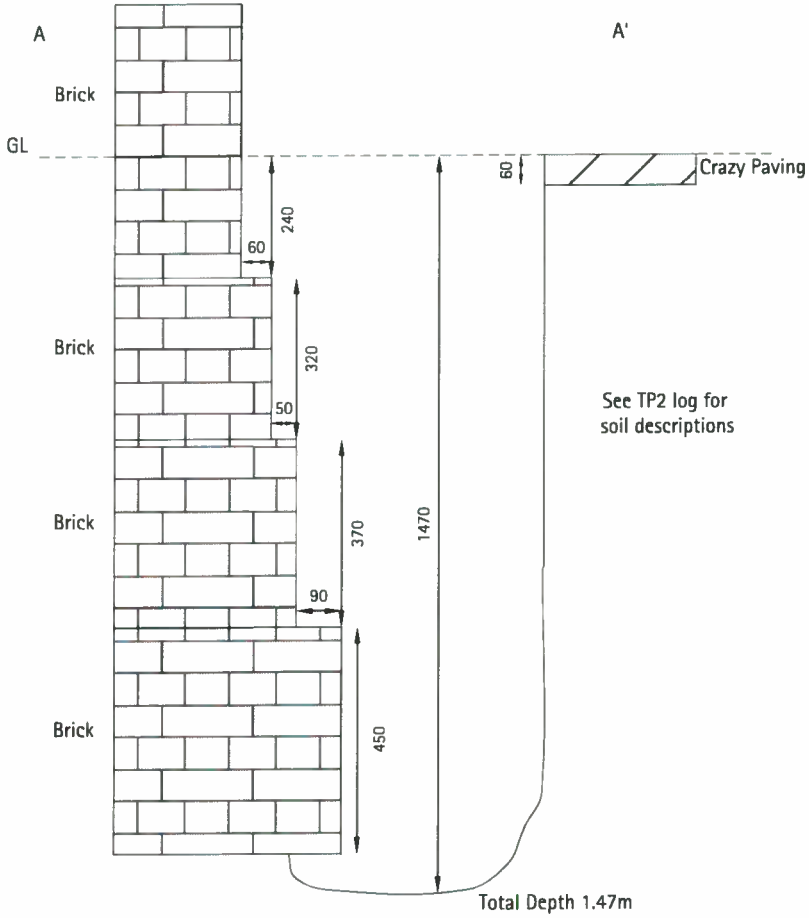
| | |
|---|---|
| Client: Archetype Associates Limited | |
| Job Title: 18 Grove Terrace (London NW5) | |
| Description: Trial Pit Sections | |
| Drawing No: TPA | |
| Scale: 1:100 | Paper Size: A3 |
| Drawn by: SM | Checked by: DV |
| Date: 23/09/2014 | |

TP2 Plan View




TP2 Section A to A'




Notes

1. All dimensions in mm unless stated otherwise.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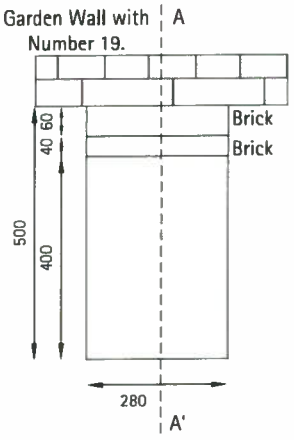
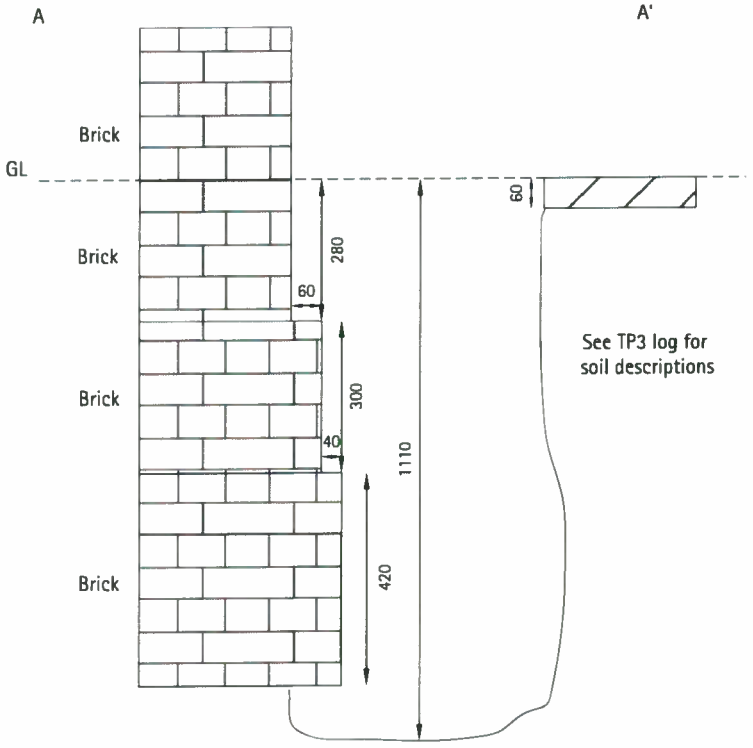
| | |
|---|---|
| Client: Archetype Associates Limited | |
| Job Title: 18 Grove Terrace (London NW5) | |
| Description: Trial Pit Sections | |
| Drawing No: TP2 | |
| Scale: 1:100 | Paper Size: A3 |
| Drawn by: SM | Checked by: DV |
| Date: 23/09/2014 | |

TP3 Plan View




TP3 Section A to A'




Total Depth 1.10m

Notes

1. All dimensions in mm unless stated otherwise.

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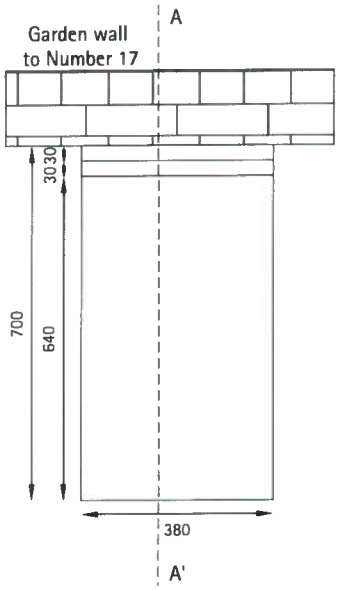
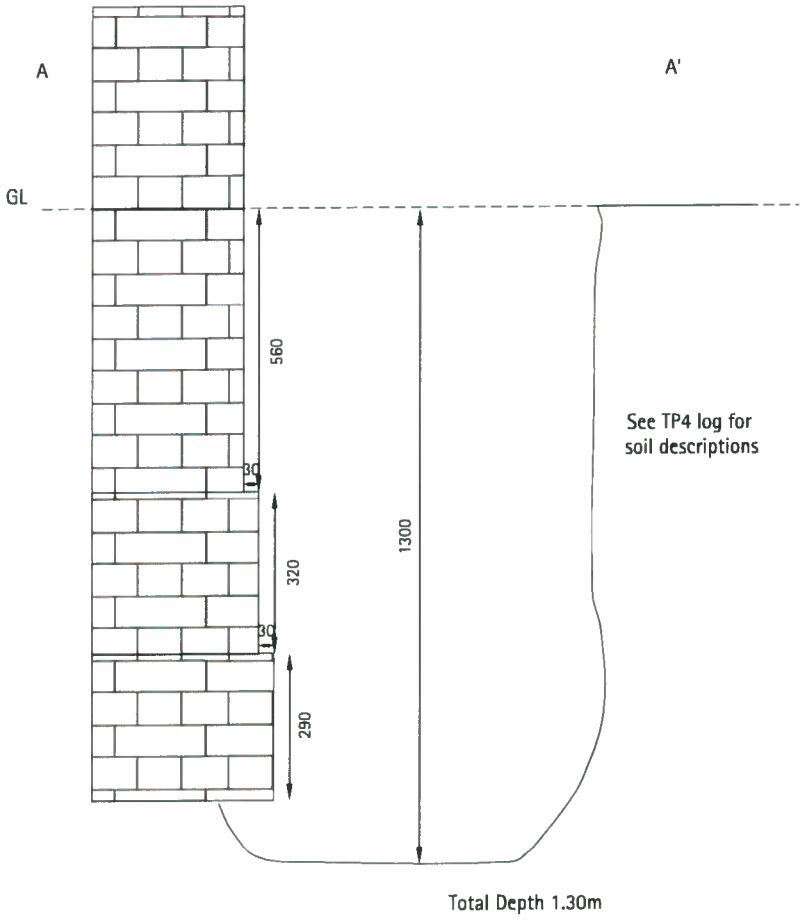
| | |
|---|---|
| Client: Archetype Associates Limited | |
| Job Title: 18 Grove Terrace (London NW5) | |
| Description: Trial Pit Sections | |
| Drawing No: TP3 | |
| Scale: 1:100 | Paper Size: A3 |
| Drawn by: SM | Checked by: DV |
| Date: 23/09/2014 | |

TP4 Plan View




TP4 Section A to A'




Total Depth 1.30m

## Notes

1. All dimensions in mm unless stated otherwise.

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| | |
|---|---|
| Client: Archetype Associates Limited | |
| Job Title: 18 Grove Terrace (London NW5) | |
| Description: Trial Pit Sections | |
| Drawing No: TP4 | |
| Scale: 1:100 | Paper Size: A3 |
| Drawn by: SM | Checked by: DV |
| Date: 23/09/2014 | |

TP1

TP2

TP3

TP4

# APPENDIX B

Field Sampling and in-situ Test Methods & Results

## Field Sampling and in-situ Test Methods

### Disturbed Samples

Disturbed samples were taken from the trial holes intervals and stored in sealed glass jars and polythene bags, as appropriate.

### Hand Penetrometer Test

The hand penetrometer consists of a spring loaded and calibrated plunger which is forced into the soil. A reading of unconfined compression strength (equal to twice cohesion) is given on a calibrated scale. In common with other hand methods of strength assessment (eg. the shear vane) it does not give an accurate indication of bearing capacity in stiff or fissured soils, because of the small test area. The figures are used for strength classification according to the table below

.

| Hand Penetrometer Value (kPa) | Undrained Shear Strength cu (kPa) | Undrained Shear Strength of Clays |
|---|---|---|
| Less than 20 | Less than 10 | Extremely Low |
| 20 to 40 | 10 to 20 | Very Low |
| 40 to 80 | 20 to 40 | Low |
| 80 to 150 | 40 to 75 | Medium |
| 150 to 300 | 75 to 150 | High |
| 300 to 600 | 150 to 300 | Very High |
| More than 600 | More than 300 | Extremely High |

# APPENDIX C

## Geotechnical Laboratory Test Methods & Results

Southern Testing | ST Consult

# Atterberg and Moisture Content Summary

To BS1377-2:1990(2003) cl.3.2, 3.3, 4.2, 4.3

AGS

| Project Name | 18 Grove Terrace ( London NW5 ) | | | | | | Project Number | | J11987 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Client | Archetype Associates Limited | | | | PE | DV | Date Issued | | 07-Oct-14 | |
| Location | Depth m | Sample Type | Visual Description | Comments | Natural MC % | Liquid Limit % | Plastic Limit % | Plasticity Index | Classi-fication | Passing 425 micron % |
| WS1 | 2.00 | D | Soft low strength light brown sandy CLAY with frequent fine sandstone gravel. | Sieve Prep | 33 | 54 | 22 | 32 | CH | 88 |
| WS1 | 2.50 | D | | | 27 | | | | | |
| WS1 | 3.00 | D | Stiff high strength light brown CLAY. | | 26 | 56 | 25 | 31 | CH | 100 |
| WS1 | 3.50 | D | | | 23 | | | | | |
| WS1 | 4.00 | D | Stiff high strength light brown CLAY. | | 22 | 60 | 28 | 32 | CH | 100 |
| WS1 | 4.50 | D | | | 29 | | | | | |
| WS1 | 5.00 | D | Stiff high strength light brown CLAY. | | 27 | 59 | 20 | 39 | CH | 100 |
| WS1 | 5.50 | D | | | 29 | | | | | |
| WS1 | 6.00 | D | | | 30 | | | | | |
| WS2 | 1.50 | D | Stiff high strength grey oxidised brown organic CLAY. | | 35 | 73 | 23 | 50 | CVO | 100 |

Southern Testing | ST Consult

# Atterberg and Moisture Content Summary

To BS1377-2:1990(2003) cl.3.2, 3.3, 4.2, 4.3

AGS

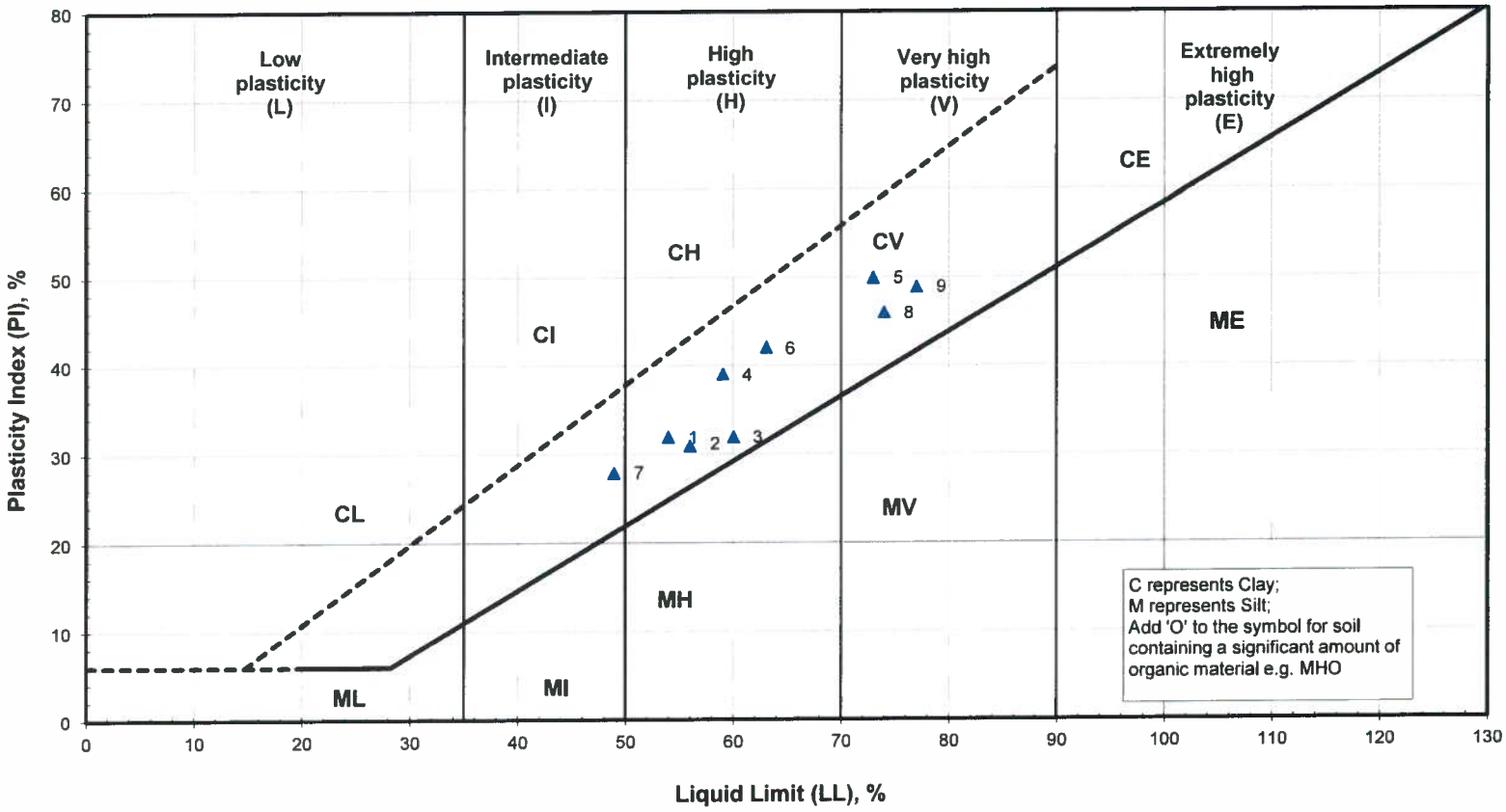
| Project Name | 18 Grove Terrace ( London NW5 ) | | | | | | Project Number | | J11987 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Client | Archetype Associates Limited | | | | PE | DV | Date Issued | | 07-Oct-14 | |
| Location | Depth m | Sample Type | Visual Description | Comments | Natural MC % | Liquid Limit % | Plastic Limit % | Plasticity Index | Classi-fication | Passing 425 micron % |
| WS2 | 2.00 | D | *Stiff high strength brown grey sandy CLAY with occasional sandstone gravel.* | | *26* | *63* | *21* | *42* | *CH* | *98* |
| WS2 | 2.50 | D | | | *25* | | | | | |
| WS2 | 3.00 | D | *Stiff high strength light brown CLAY.* | | *20* | *49* | *21* | *28* | *CI* | *100* |
| WS2 | 3.50 | D | | | *26* | | | | | |
| WS2 | 4.00 | D | *Stiff high strength light brown CLAY.* | | *30* | *74* | *28* | *46* | *CV* | *100* |
| WS2 | 4.50 | D | | | *38* | | | | | |
| WS2 | 5.00 | D | *Stiff very high strength light brown CLAY.* | | *31* | *77* | *28* | *49* | *CV* | *100* |
| WS2 | 5.50 | D | | | *32* | | | | | |
| WS2 | 6.00 | D | | | *30* | | | | | |

# Plasticity Chart for Atterberg Limit Tests

| | | | | | |
|---|---|---|---|---|---|
| **Project Name** | *18 Grove Terrace ( London NW5 )* | | | **Project Number** | *J11987* |
| **Client Name** | *Archetype Associates Limited* | **PE** | *DV* | **Date Issued** | *07-Oct-14* |

Key

| No. | TH No. | Depth |
|---|---|---|
| 1 | WS1 | 2.00 |
| 2 | WS1 | 3.00 |
| 3 | WS1 | 4.00 |
| 4 | WS1 | 5.00 |
| 5 | WS2 | 1.50 |
| 6 | WS2 | 2.00 |
| 7 | WS2 | 3.00 |
| 8 | WS2 | 4.00 |
| 9 | WS2 | 5.00 |



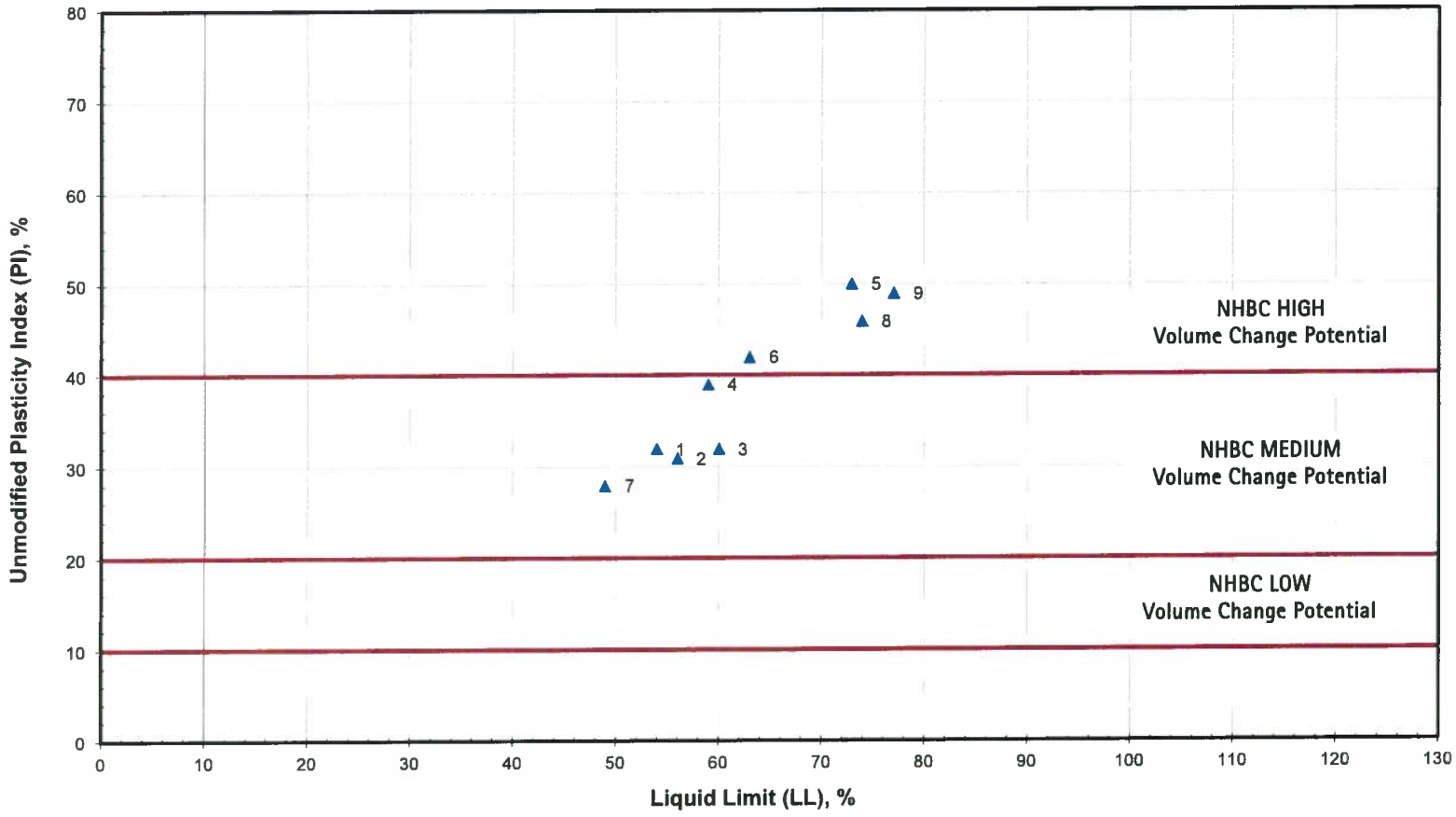

| **Liquid Limit** | | **Plastic Limit** | | **Plasticity Index** | |
|---|---|---|---|---|---|
| Maximum Value | 77 | Maximum Value | 28 | Maximum Value | 50 |
| Minimum Value | 49 | Minimum Value | 20 | Minimum Value | 28 |
| Average Value | 63 | Average Value | 24 | Average Value | 39 |

# NHBC Classification for Volume Change Potential

| | | | | | |
|---|---|---|---|---|---|
| **Project Name** | *18 Grove Terrace ( London NW5 )* | | | **Project Number** | *J11987* |
| **Client Name** | *Archetype Associates Limited* | **PE** | *DV* | **Date Issued** | *07-Oct-14* |

Key

| No. | TH No. | Depth |
|---|---|---|
| 1 | WS1 | 2.00 |
| 2 | WS1 | 3.00 |
| 3 | WS1 | 4.00 |
| 4 | WS1 | 5.00 |
| 5 | WS2 | 1.50 |
| 6 | WS2 | 2.00 |
| 7 | WS2 | 3.00 |
| 8 | WS2 | 4.00 |
| 9 | WS2 | 5.00 |




| **Liquid Limit** | | **Plastic Limit** | | **Unmodified Plasticity Index** | |
|---|---|---|---|---|---|
| Maximum Value | 77 | Maximum Value | 28 | Maximum Value | 50 |
| Minimum Value | 49 | Minimum Value | 20 | Minimum Value | 28 |
| Average Value | 63 | Average Value | 24 | Average Value | 39 |

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# CHEMICAL & ELECTROCHEMICAL TESTING SUMMARY

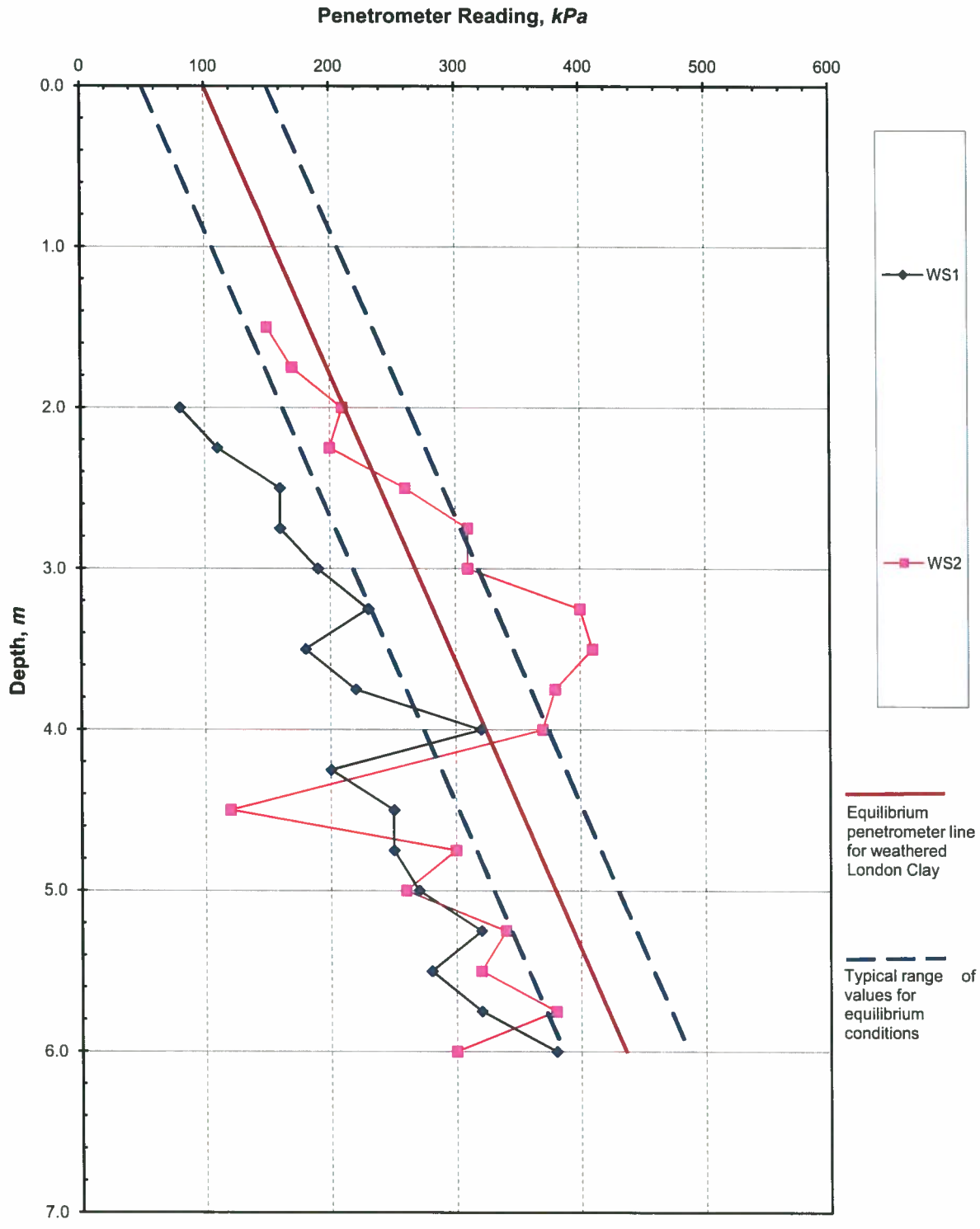
To BS1377-3:1990(2003) cl 5.6 & 9.5

AGS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project Name** | | **18 Grove Terrace ( London NW5 )** | | | | | **Project Number** | | J11987 | |
| **Client** | | **Archetype Associates Limited** | | | **PE** | *DV* | **Date Issued** | | *07-Oct-14* | |
| TH No. | Depth m | Sample Type | Visual Description | Comments | Passing 2mm % | pH Value | Soil Sulphate 2:1 Water Extract | | Groundwater Sulphate | |
| | | | | | | | g/l $SO_3$ | BRE mg/l $SO_4$ | g/l $SO_3$ | BRE mg/l $SO_4$ |
| WS1 | 2.50 | D | Stiff high strength light brown CLAY. | | 100.0 | 7.8 | 0.08 | 96 | | |
| WS1 | 3.50 | D | Stiff high strength light brown CLAY. | | 100.0 | 7.6 | 0.78 | 941 | | |
| WS2 | 1.50 | D | Stiff high strength grey oxidised brown organic CLAY. | | 100.0 | 8.1 | 0.21 | 250 | | |
| WS2 | 4.50 | D | Firm high strength light brown CLAY. | | 100.0 | 7.1 | 0.42 | 499 | | |

# Pocket Penetrometer Reading *vs* Depth

## Test Hole Nos: WS1 and WS2

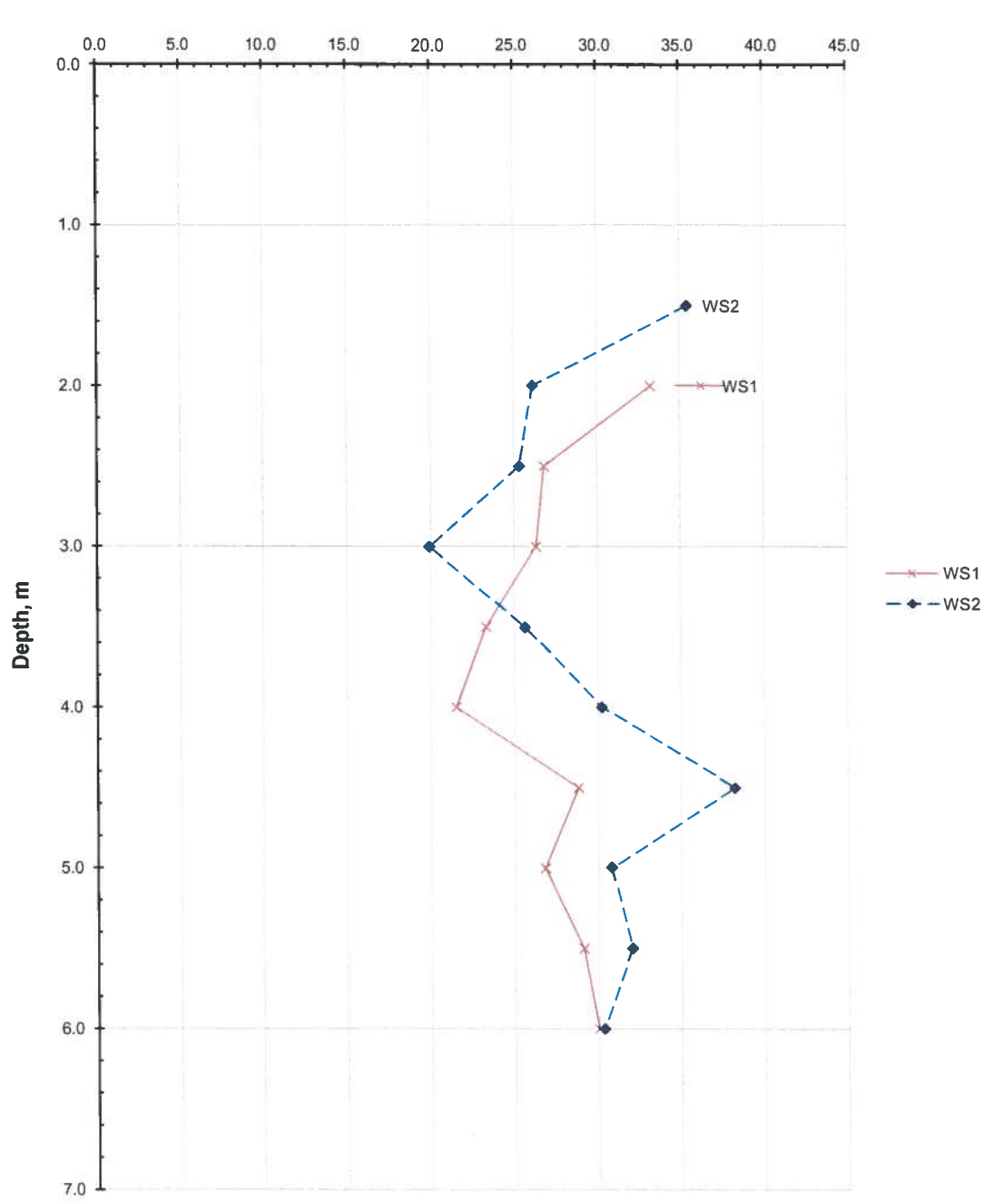



* *Reference made to "A rapid and reliable on-site method of assessing desiccation in clay soils", by R S Pugh, P G Parnell, and R D Parkes, Proc. Instn Civ. Engrs. Geotech. Engng. 1995, 113 pp. 25-30*

| | | | |
|---|---|---|---|
| **Client:** | **Archetype Associates Limited** | **Job No:** J11987 | |
| **Site:** | **18 Grove Terrace, London NW5** | **Date:** 08/10/2014 | **Fig.** **HP1** |

# Moisture Content *vs* Depth

*In Accordance with BS 1377 : Part 2 : 1990 : Clause 3*

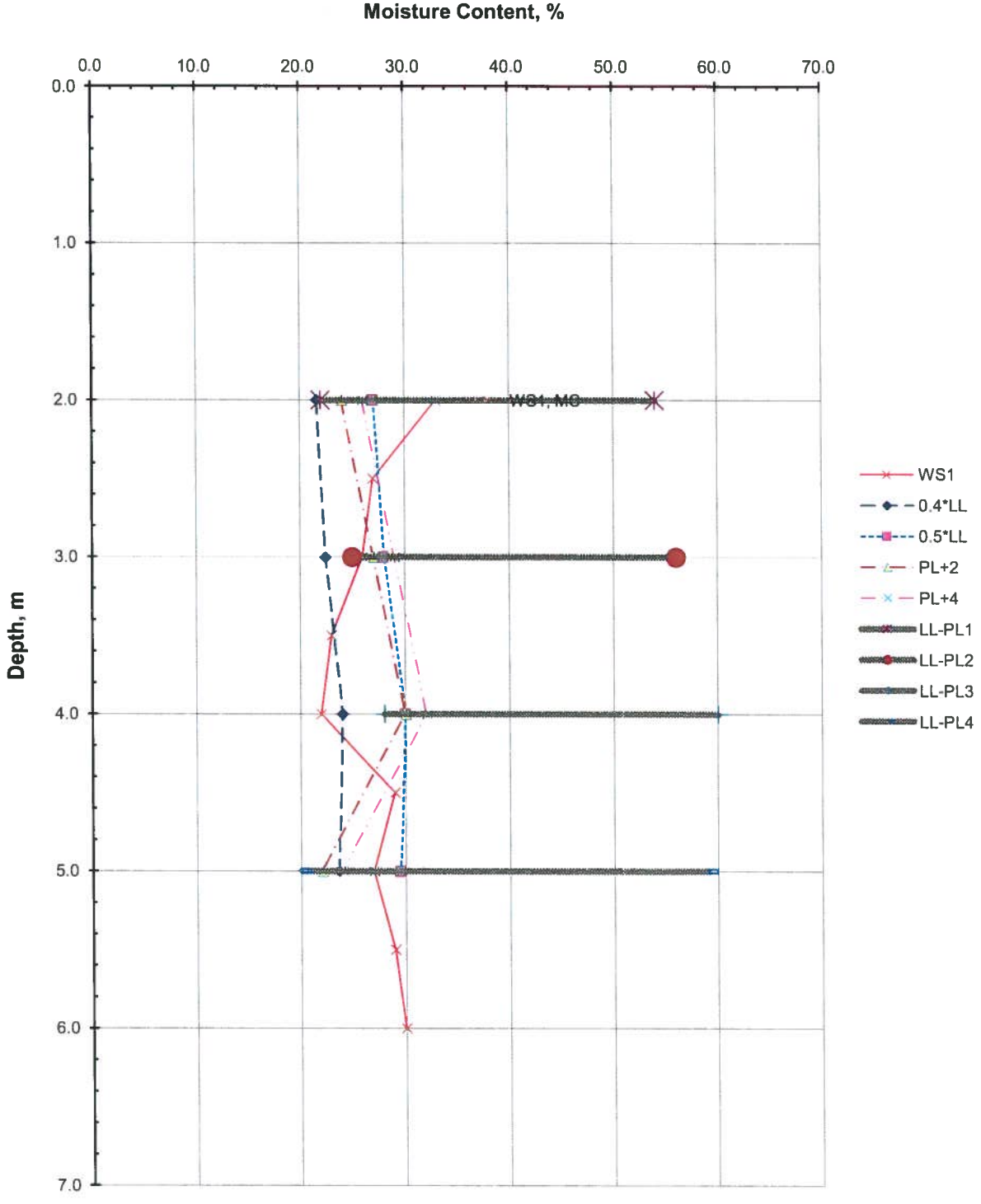



Note:

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | **Archetype Associates Limited** | **Site:** | **18 Grove Terrace, London NW5** | | |
| **Job No:** | J11987 | **Date:** | 07/10/2014 | **Figure:** | MC1 |

# Moisture Content and Atterberg Limit Tests *vs* Depth

*In Accordance with BS 1377 : Part 2 : 1990 : Clause 3*

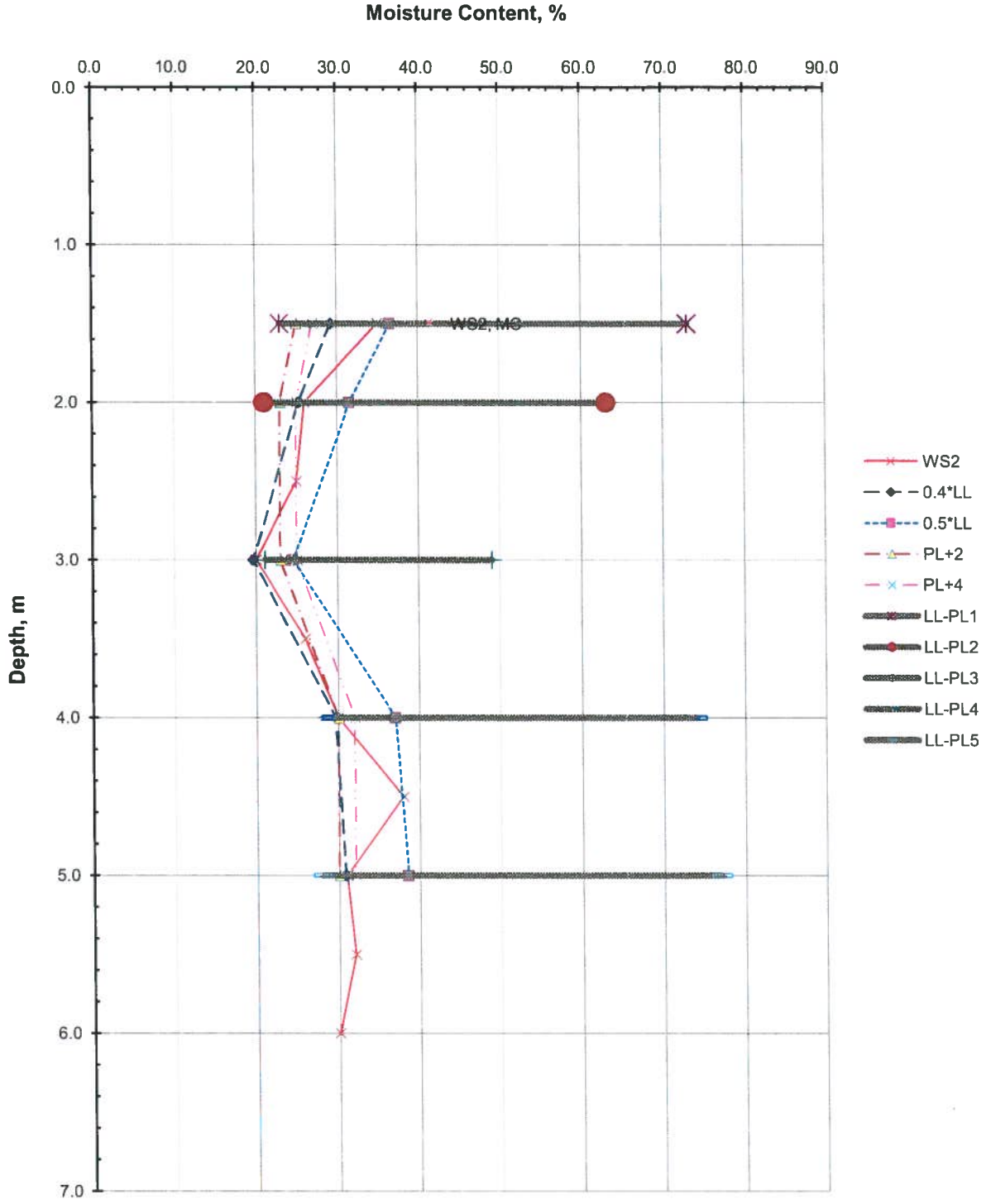



Note:

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | **Archetype Associates Limited** | **Site:** | **18 Grove Terrace, London NW5** | | |
| **Job No:** | J11987 | **Date:** | 08/10/2014 | **Figure:** | MC2 |

# Moisture Content and Atterberg Limit Tests *vs* Depth

*In Accordance with BS 1377 : Part 2 : 1990 : Clause 3*




Note:

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | **Archetype Associates Limited** | **Site:** | **18 Grove Terrace, London NW5** | | |
| **Job No:** | J11987 | **Date:** | 08/10/2014 | **Figure:** | MC3 |

# APPENDIX D

Bomb Map

**Colour Key References**
*(for guidance only)*

**Black**
Total destruction

**Purple**
Damaged beyond repair

**Dark Red**
Seriously damaged; doubtful if repairable

**Light Red**
Seriously damaged, but repairable at cost

**Orange**
General blast damage – not structural

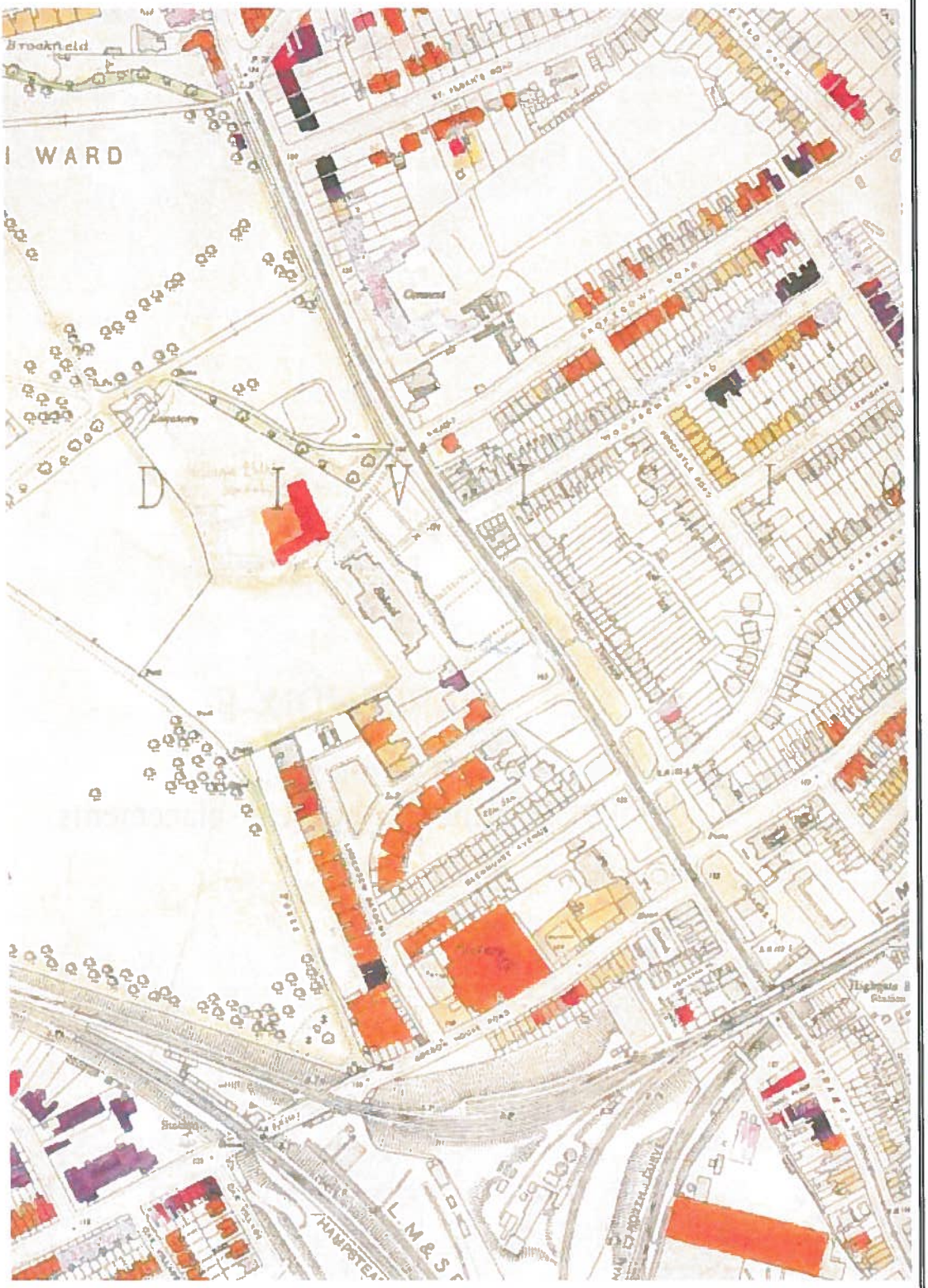
**Yellow**
Blast damage, minor in nature

**Light Blue**
Clearance areas

**Light Green**
Clearance areas

V1 flying bomb

V2 long range rocket




| | | | |
|---|---|---|---|
| Site: | 18 Grove Terrace, London NW5 | STL: J11987 | Fig No: 2 |
| Date: | 23 October 2014 | Bomb Map | |

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

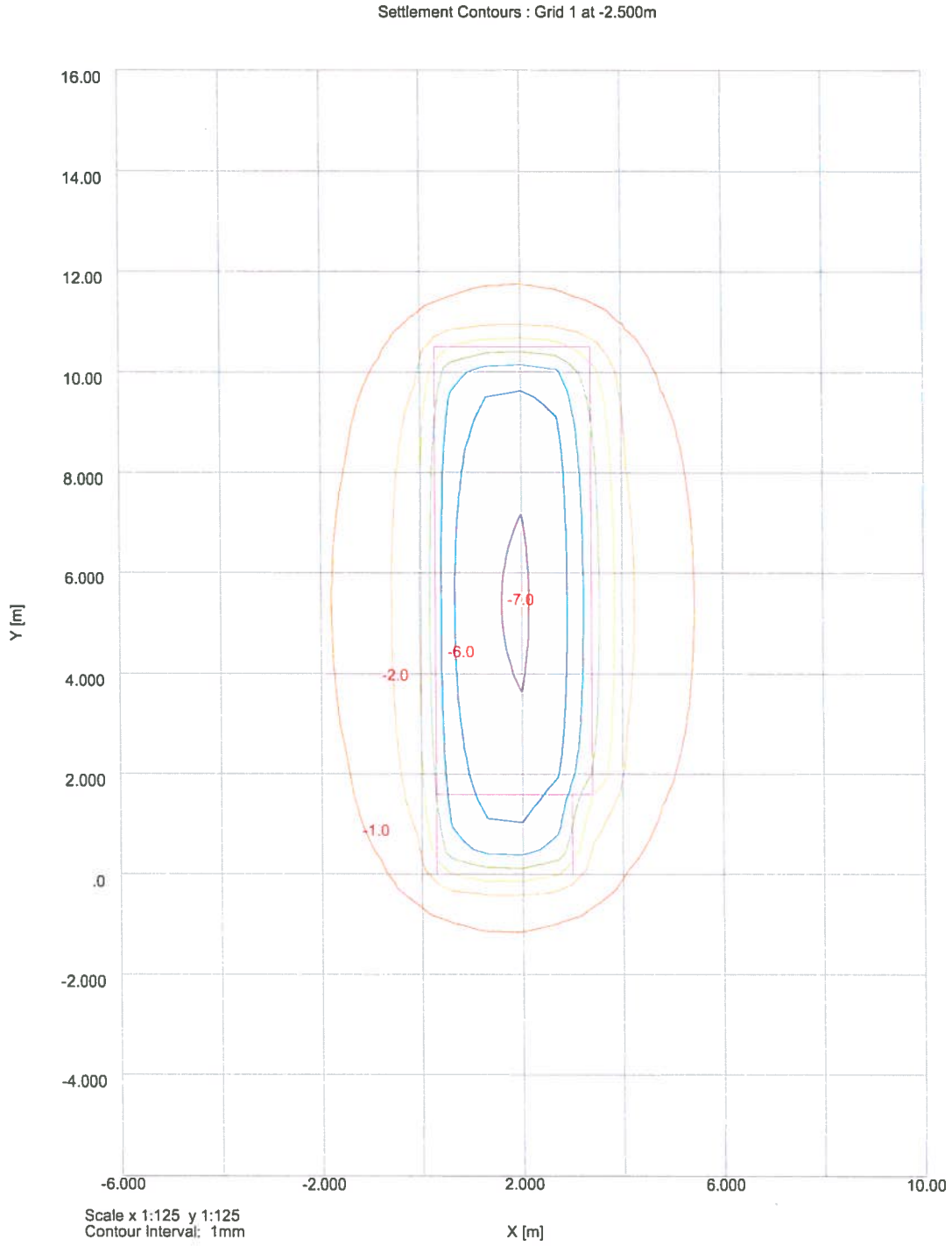
# APPENDIX E

PDISP Output for heave displacements

Oasys

**18 Grove Terrace, NW5**
Undrained Heave Displacements
Figure U1

| Job No. | Sheet No. | Rev. |
|---|---|---|
| J11987 | | |
| Drg. Ref. | | |
| Made by | Date 23-Oct-2014 | Checked |

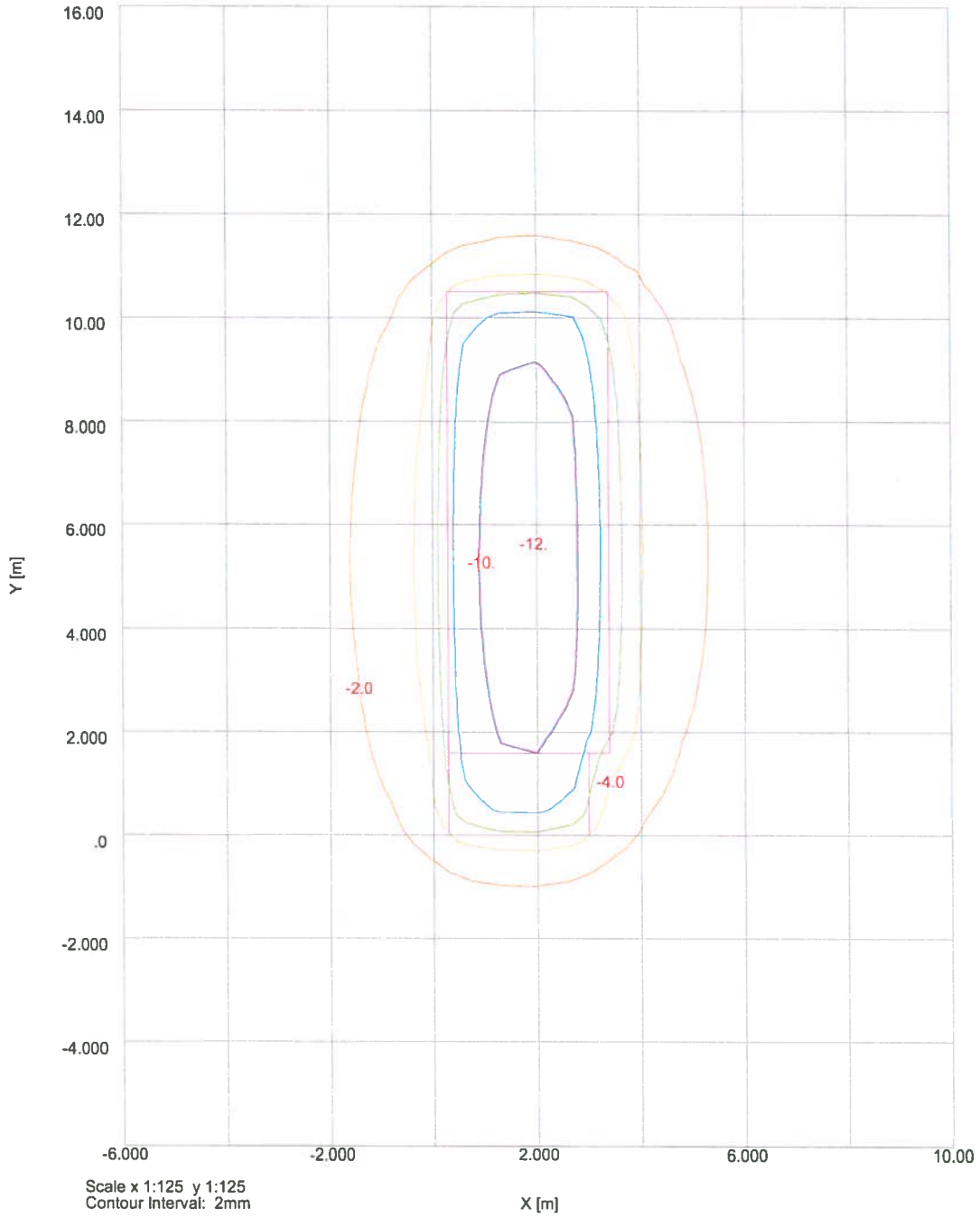


Oasys

**18 Grove Terrace, NW5**
Drained Heave Displacements
Figure V1

| Job No. | Sheet No. | Rev. |
|---|---|---|
| J11987 | | |
| Drg. Ref. | | |
| Made by | Date 23-Oct-2014 | Checked |

Settlement Contours : Grid 1 at -2.500m



# APPENDIX E

## Chemical Test Results

Scientific Analysis Laboratories Ltd
3 Crittall Drive
Springwood Industrial
Estate
Braintree
Essex
CM7 2RT
Tel : 01376 560120
Fax : 01376 552923

# Scientific Analysis Laboratories Ltd

## Certificate of Analysis



**Report Number:** 425408-1

**Date of Report:** 09-Oct-2014

**Customer:** Southern Testing Laboratories
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

**Customer Contact:** Mr David Vooght

**Customer Job Reference:** J11987
**Customer Purchase Order:** J11987_2
**Customer Site Reference:** 18 Grove Terrace (London NW5)
**Date Job Received at SAL:** 26-Sep-2014
**Date Analysis Started:** 30-Sep-2014
**Date Analysis Completed:** 09-Oct-2014

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING
1650

mCERTS

Report checked
and authorised by :
Miss Claire Brown
Customer Service Manager

Issued by :
Miss Claire Brown
Customer Service Manager

**SAL Reference:** 425408
**Project Site:** 18 Grove Terrace (London NW5)
**Customer Reference:** J11987

**Soil** Analysed as Soil
**STL Key Contamintion Suite**

| | | | | | SAL Reference | 425408 001 | 425408 002 | 425408 003 |
|---|---|---|---|---|---|---|---|---|
| | | | | | Customer Sample Reference | TP4 @ 0.70m | WS1 @ 0.50m | WS1 @ 2.00m |
| | | | | | Date Sampled | 23-SEP-2014 | 23-SEP-2014 | 23-SEP-2014 |
| | | | | | Type | Fill | Fill | Clay |
| **Determinand** | **Method** | **Test Sample** | **LOD** | **Units** | | | | |
| Arsenic | T257 | A40 | 2.0 | mg/kg | | 15 | 22 | 15 |
| Cadmium | T257 | A40 | 0.1 | mg/kg | | 0.1 | 0.1 | <0.1 |
| Chromium | T257 | A40 | 0.5 | mg/kg | | 27 | 23 | 49 |
| Copper | T257 | A40 | 2 | mg/kg | | 66 | 250 | 97 |
| Lead | T257 | A40 | 2 | mg/kg | | 450 | 540 | 210 |
| Mercury | T245 | A40 | 1.0 | mg/kg | | 1.1 | 3.7 | <1.0 |
| Nickel | T257 | A40 | 0.5 | mg/kg | | 22 | 22 | 58 |
| Selenium | T257 | A40 | 3 | mg/kg | | <3 | <3 | <3 |
| Zinc | T257 | A40 | 2 | mg/kg | | 110 | 150 | 130 |
| Asbestos ID | T27 | A40 | | | | Asbestos not detected | Asbestos not detected | - |
| Chromium VI | T6 | A40 | 1 | mg/kg | | <1 | <1 | <1 |
| Fraction Organic Carbon - F(oc) | T21 | A40 | 1 | % | | <1 | <1 | <1 |
| pH | T7 | A40 | | | | 8.1 | 8.1 | 8.3 |
| Soil Organic Matter | T287 | A40 | 0.1 | % | | 4.8 | 5.3 | 0.5 |
| (Water Soluble) SO4– expressed as SO4 | T242 | A40 | 0.01 | g/l | | 0.05 | 0.04 | 0.05 |
| Sulphide | T4 | A40 | 10 | mg/kg | | <10 | <10 | <10 |
| Cyanide(Total) | T4 | AR | 1 | mg/kg | | <1 | <1 | <1 |
| Phenols(Mono) | T221 | AR | 1.0 | mg/kg | | <1.0 | <1.0 | <1.0 |
| Moisture @ 105 C | T162 | AR | 0.1 | % | | 15 | 19 | 22 |
| Retained on 2mm | T2 | A40 | 0.1 | % | | 13.0 | <0.1 | <0.1 |

**SAL Reference:** 425408
**Project Site:** 18 Grove Terrace (London NW5)
**Customer Reference:** J11987

**Soil** Analysed as Soil
**Total and Speciated USEPA16 PAH (SE) (MCERTS)**

| | | | | | SAL Reference | 425408 001 | 425408 002 | 425408 003 |
|---|---|---|---|---|---|---|---|---|
| | | | | | Customer Sample Reference | TP4 @ 0.70m | WS1 @ 0.50m | WS1 @ 2.00m |
| | | | | | Date Sampled | 23-SEP-2014 | 23-SEP-2014 | 23-SEP-2014 |
| | | | | | Type | Fill | Fill | Clay |
| **Determinand** | **Method** | **Test Sample** | **LOD** | **Units** | | | | |
| Naphthalene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Acenaphthylene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Acenaphthene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Fluorene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Phenanthrene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Anthracene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Fluoranthene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Pyrene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Benzo(a)Anthracene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Chrysene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Benzo(b/k)Fluoranthene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Benzo(a)Pyrene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Indeno(123-cd)Pyrene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Dibenzo(ah)Anthracene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| Benzo(ghi)Perylene | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |
| PAH(total) | T16 | AR | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 |

## Index to symbols used in 425408-1

| Value | Description |
|---|---|
| AR | As Received |
| A40 | Assisted dried < 40C |
| W | Analysis was performed at another SAL laboratory |
| S | Analysis was subcontracted |
| M | Analysis is MCERTS accredited |
| U | Analysis is UKAS accredited |
| N | Analysis is not UKAS accredited |

## Notes

| |
|---|
| Sub contracted analysis performed by SAL Scotland & REC Asbestos Limited |
| Retained on 2mm is removed before analysis |
| Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis |
| No loose asbestos fibres or asbestos containing materials were found |

## Method Index

| Value | Description |
|---|---|
| T2 | Grav |
| T221 | Colorimetry (CE) |
| T21 | OX/IR |
| T27 | PLM |
| T162 | Grav (1 Dec) (105 C) |
| T245 | ICP/OES(Aqua Regia Extraction) |
| T4 | Colorimetry |
| T7 | Probe |
| T242 | 2:1 Extraction/ICP/OES (TRL 447 T1) |
| T287 | Calc TOC/0.58 |
| T6 | ICP/OES |
| T16 | GC/MS |
| T257 | ICP/OES (SIM) (Aqua Regia Extraction) |

## Accreditation Summary

| Determinand | Method | Test Sample | LOD | Units | Symbol | SAL References |
|---|---|---|---|---|---|---|
| Arsenic | T257 | A40 | 2.0 | mg/kg | U | 001-002 |
| Arsenic | T257 | A40 | 2 | mg/kg | M | 003 |
| Cadmium | T257 | A40 | 0.1 | mg/kg | U | 001-002 |
| Cadmium | T257 | A40 | 0.1 | mg/kg | M | 003 |
| Chromium | T257 | A40 | 0.5 | mg/kg | U | 001-002 |
| Chromium | T257 | A40 | 0.5 | mg/kg | M | 003 |
| Copper | T257 | A40 | 2 | mg/kg | U | 001-002 |
| Copper | T257 | A40 | 2 | mg/kg | M | 003 |
| Lead | T257 | A40 | 2 | mg/kg | U | 001-002 |
| Lead | T257 | A40 | 2 | mg/kg | M | 003 |
| Mercury | T245 | A40 | 1.0 | mg/kg | U | 001-003 |
| Nickel | T257 | A40 | 0.5 | mg/kg | U | 001-002 |
| Nickel | T257 | A40 | 0.5 | mg/kg | M | 003 |
| Selenium | T257 | A40 | 3 | mg/kg | U | 001-003 |
| Zinc | T257 | A40 | 2 | mg/kg | U | 001-002 |
| Zinc | T257 | A40 | 2 | mg/kg | M | 003 |
| Asbestos ID | T27 | A40 | | | SU | 001-002 |
| Chromium VI | T6 | A40 | 1 | mg/kg | N | 001-003 |
| Fraction Organic Carbon - F(oc) | T21 | A40 | 1 | % | WN | 001-003 |
| pH | T7 | A40 | | | U | 001-002 |
| pH | T7 | A40 | | | M | 003 |
| Soil Organic Matter | T287 | A40 | 0.1 | % | WN | 001-003 |
| (Water Soluble) SO4-- expressed as SO4 | T242 | A40 | 0.01 | g/l | U | 001-002 |
| (Water Soluble) SO4-- expressed as SO4 | T242 | A40 | 0.01 | g/l | M | 003 |
| Sulphide | T4 | A40 | 10 | mg/kg | N | 001-003 |
| Cyanide(Total) | T4 | AR | 1 | mg/kg | U | 001-002 |
| Cyanide(Total) | T4 | AR | 1 | mg/kg | M | 003 |
| Phenols(Mono) | T221 | AR | 1.0 | mg/kg | U | 001-002 |
| Phenols(Mono) | T221 | AR | 1.0 | mg/kg | M | 003 |
| Moisture @ 105 C | T162 | AR | 0.1 | % | N | 001-003 |
| Retained on 2mm | T2 | A40 | 0.1 | % | N | 001-003 |
| Naphthalene | T16 | AR | 0.1 | mg/kg | U | 001-003 |

| Determinand | Method | Test Sample | LOD | Units | Symbol | SAL References |
|---|---|---|---|---|---|---|
| Acenaphthylene | T16 | AR | 0.1 | mg/kg | U | 001-003 |
| Acenaphthene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Acenaphthene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Fluorene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Fluorene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Phenanthrene | T16 | AR | 0.1 | mg/kg | U | 001-003 |
| Anthracene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Anthracene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Fluoranthene | T16 | AR | 0.1 | mg/kg | N | 001-003 |
| Pyrene | T16 | AR | 0.1 | mg/kg | N | 001-003 |
| Benzo(a)Anthracene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Benzo(a)Anthracene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Chrysene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Chrysene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Benzo(b/k)Fluoranthene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Benzo(b/k)Fluoranthene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Benzo(a)Pyrene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Benzo(a)Pyrene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Indeno(123-cd)Pyrene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Indeno(123-cd)Pyrene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Dibenzo(ah)Anthracene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Dibenzo(ah)Anthracene | T16 | AR | 0.1 | mg/kg | M | 003 |
| Benzo(ghi)Perylene | T16 | AR | 0.1 | mg/kg | U | 001-002 |
| Benzo(ghi)Perylene | T16 | AR | 0.1 | mg/kg | M | 003 |
| PAH(total) | T16 | AR | 0.1 | mg/kg | U | 001-003 |