21 Boscastle Road, London, NW5 1EE

Desk Study & Basement Impact Assessment

February 2015

FAIRHURST

CONTROL SHEET

CLIENT: Ms Barbara Storch & Mr Mayamiko Kachingwe

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This document has been prepared in accordance with procedure OP/P02 of the *Fairhurst Quality and Environmental Management System*

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1.0 NON TECHNICAL SUMMARY

Project Objectives	At the request of Elliott Wood Partnership LLP, working on behalf of Ms Barbara Storch & Mr Mayamiko Kachingwe, a Basement Impact Assessment has been carried out at 21 Boscastle Road, London, NW5 1EE in support of a planning application for a proposed new development which includes a full width single storey basement extension beneath the footprint of the existing building and extending 1.50m into the rear garden. A lightwell is also proposed at the front of the building.
Desk Study Findings	From historical map evidence it would appear that the site was occupied by gardens until the existing property was built in circa 1896. No further change to the site is evident. The surrounding area has been primarily residential over the years.
Ground Conditions	The boreholes and trial pits revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.25m in thickness overlying the London Clay Formation at depth. Groundwater was encountered at a maximum depth of 3.21m bgl (50.06mOD) in the monitoring piezometer in Borehole 1 during two monitoring visits over a period approximately four weeks.
Recommendations	A ground movement sensitivity monitoring plan should be set out at design stage and should include a movement monitoring strategy, instrumentation and action plans. More specifically trigger levels on movements will need to be defined. This should be done by way of precise levelling or reflective survey targets being installed at the garden walls and neighbouring buildings. It would also be prudent to continue to monitor the groundwater standpipes for groundwater levels as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

2.0 INTRODUCTION

The purpose of this assessment is to consider the effects of a proposed basement extension on the local hydrology, geology and hydrogeology at 21 Boscastle Road, London, NW5 1EE. For this assessment a representative of Fairhurst visited the property on 7th December 2015.

The site comprises a four storey terraced residential property (21 Boscastle Road) including an existing lower ground floor/cellar and front and rear garden areas. From the development plans provided it is understood that the proposals for the site include a full width single storey basement extension beneath the footprint of the existing building and extending 1.50m into the rear garden. A lightwell is also proposed at the front of the building.

The information contained within this BIA has been produced specifically to meet the requirements set out by Camden Planning Guidance – Basements and Lightwells (CPG4) (July 2015) in order to assist London Borough of Camden with their decision making process.

2.1 Data Sources

This section provides the baseline data used to complete the BIA in relation to the proposed development. Reference information used for this purpose is outlined below:

- Barton N (1992) The Lost Rivers of London. Historical Publications Ltd, London;
- British Geological Survey – 1:50,000 Geological Sheet 256, North London (Solid & Drift);
- British Geological Survey (BGS) borehole archive records;
- CIRIA C580 Embedded retaining walls – guidance for economic design (2003)
- Elliott Wood Partnership Loading Calculation Sheets
- London Borough of Camden (LBC) Planning Guidance (CPG4) – Basements and Lightwells (July 2015).
- Environment Agency Groundwater Vulnerability Mapping (1:100,000 series) Sheet 40, Thames;
- Environment Agency Internet database (www.environment-agency.gov.uk);
- River Basin Management Plan (RBMP). Thames River Basin District (2009);
- Site reconnaissance survey completed by Fairhurst (December 2015);
- Finkernagel Ross Architect drawings
    - Existing Drawings No’s 21BOS – 000, 001, 002, 003, 020, 021, 030
    - Proposed Drawings No’s 21BOS – 101, 102, 103, 200, 203, 300,

2.2 Guidance and Frameworks

The proposed basement is located in the London Borough of Camden (LBC) and as such will be required to be developed in accordance with the guidance and policies outlined in the following documents:

- LBC (Nov 2010). Camden geological, hydrogeological and hydrological study. Guidance for subterranean development (produced by Arup Consulting).
- LBC. Camden Planning Guidance. Basements and Lightwells (CPG 4) (July 2015).

- Development Policy (DP) 27 Basements and Lightwells.

2.3 BIA Approach

The BIA approach follows current planning procedure for basements and lightwells adopted by LBC and comprises the following elements:

- Screening;
- Scoping;
- Site Investigation and study (divided into desk study, field investigation, monitoring, reporting & interpretation);
- Impact Assessment; and
- Review & Decision Making (completed by Camden Council).

2.4 Qualifications

The qualifications required by LBC are fulfilled as documented in Table 1 below. All assessors meet the qualification requirements of the Council guidance.

Table 1 – Qualification Summary

Subject	Qualifications Required by CPG4	Relevant person(s) in Fairhurst
Surface flow and flooding	A hydrologist or a Civil Engineer specialising in flood risk management and surface water drainage, with either: The 'CEng' (Chartered Engineer) qualification from the Engineering Council; or a Member of the Institution of Civil Engineers ('MICE') The CWEM (Chartered Water and Environmental Manager) qualification from the Chartered Institution of Water and Environmental Management	Mr Alan Connell BSc (Hons) CEng MICE Mr Andrew Smith BSc(Hons) FGS MCIWEM
Subterranean (groundwater flow)	A hydrogeologist with the 'CGeol' (Chartered Geologist) qualification from the Geological Society of London	Mr Phil Brown BSc (Hons) FGS CGeol
Land Stability	A Civil Engineer with the 'CEng (Chartered Engineer) qualification from the Engineering Council	Mr Alan Connell BSc (Hons) CEng MICE

3.0 BASELINE CONDITIONS

3.1 Site Description and Walkover Survey

The site is located to the west of Boscastle Road in Hampstead, North London at approximately postcode NW5 1EE. The site covers an approximate area of 0.03 Hectares and is under the general authority of Camden Council.

The site comprises a four storey terraced residential property including an existing lower ground floor/cellar and front and rear garden areas.

The front garden is small and comprises a large shrub and hedge and concrete steps up to the front door of the property. The rear garden is largely hard landscaped with concrete paving although there are numerous overgrown shrubs and bushes present adjacent to the site boundaries and a Palm tree located approximately 10m from the property. There is a small man-made pond/water feature in the rear garden bounded by concrete.

The property is bound by Boscastle Road to the north east, No. 23 Boscastle Road to the north west, No 19 Boscastle Road to the south east (which is split into flats) and Grove Terrace Mews to the west.

The site slopes gently to the east with levels of 53.72mOD measured in the garden area and 52.32mOD measured in the front garden area. The existing lower ground floor has a level of around 51.21mOD.

In the surrounding area there is a slight slope in topographic gradient to the south from approximately 53mOD at the junction with Woodsome Road to 51mOD at Chetwynd Road. This equates to around a 2-3˚ slope angle. The wider general area slopes also to the south towards the River Thames.

With reference to the Groundsure Report (Appendix C) there are no railway or tube tunnels below the site.

3.2 Site History

The site history has been researched by reference to publically available online maps and purchased historical Ordnance Survey (OS) maps sourced from the Groundsure database. The findings of this review are summarised in Table 2 below

Table 2. Historical Map Overview

Date	Source Map Scale	Onsite	Offsite
1871	1:1,056	The site is shown as being undeveloped and forming gardens.	The surrounding area is well developed with Boscastle Road present to the east (labelled as Grove Road) and numerous residential properties present either side of the road. Grove Terrace Mews is present to the west of the site.

Date	Source Map Scale	Onsite	Offsite
1896	1:1,056	A terraced building is now shown on the site	Further development of the surrounding area is evident with Woodsome Road and Croftdown Road now present to the north of the site and further residential properties evident along Grove Road. The existing railway is now present 125m south of the site. The River Fleet is evident 200m north east of the site. A large convent is detailed 150m north of the site.
1915	1:2,500	No discernible differences.	A school is detailed 200m west of the site and further housing is present to the north along Croftdown Road. A miniature rifle range is present 280m south east of the site.
1936	1:2,500	No discernible differences.	Further residential housing is detailed 100m to the south of the site and the rifle range is now labelled as allotment gardens
1952	1:1,250	No discernible changes.	Residential properties are now detailed in the area previous used as allotment gardens.
1966	1:1,250	No discernible changes.	An additional building is detailed 20m west of the site
1975	1:1,250	No discernible changes.	An additional building is detailed 5m south west of the site
1991	1:1,250	No discernible changes.	No discernible changes.
2015	1:10,000	No discernible changes.	No discernible changes.

From historical map evidence it would appear that the site was occupied by gardens until the existing property was built in circa 1896. No further change to the site is evident.

The surrounding area has been primarily residential over the years.

3.3 Site Environmental Setting

A search of public registers and databases has been made via the Groundsure database and relevant extracts from the search are detailed in Appendix C.

The search has revealed that there are no landfills, waste management, transfer, treatment or disposal sites within 500 m of the site. The search has indicated that the site is located in an area where less than 1% of homes are affected by radon emissions; which is the lowest classification given by the Health Protection Agency (HPA) and therefore no radon protective measures will be necessary.

There is one pollution incident within 250m of the study site located 140m south west of the site which occurred in 2001. The pollutant is not provided although the incident is stated as having no impact on land and water (category 4) and a minor impact on air.

3.4 Geology

The British Geology Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by the London Clay Formation. The boundary to the overlying Claygate Beds is indicated to be approximately 800m west of the site.

The BGS's online records indicate there are no historical boreholes located within 100m of the site.

With reference to LCB online planning portal there have been no recent ground investigations or Basement Impact Assessments located along Boscastle Road or within 50m of the site.

3.5 Hydrology and Drainage

3.5.1 Rainfall and Runoff

According to Mayes (1997) rainfall in the local area averages around 610mm and significantly less than the national average of around 900mm.

Evapotranspiration is typically 450 mm/yr resulting in about 160 mm per year as 'hydrologically effective' rainfall which is available to infiltrate into the ground or runoff as surface water flow.

With reference to Stanforth's 1864 map of London and Talling (2011) and Barton (1992) the site is approximately 200m south west from a tributary of the River Fleet (See Figures 2 and 2a). The Fleet rises on Hampstead Heath as two springs - one on the western side near Hampstead and one on the eastern side in the grounds of Kenwood House. Then they go underground, pass under Kentish Town, join in Camden Town and flow onwards to King's Cross. The river then flows below Farringdon Road and Farringdon Street, and joins the River Thames beneath Blackfriars Bridge.

The River Fleet has been largely lost through a culverting system as the urban extent of London has grown over time.

The area located immediately around the site is highly developed with more than 80% of the surface covered with hardstanding. Most of the rainfall in the area will run-off hard surface areas and be collected by the local sewer network.

3.5.2 Flood Risk

River or Tidal flooding

According to Environment Agency Flood maps the site lies within Flood Zone 1, which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs.

Surface Water Flooding

According to CPG4 (2015) Boscastle Road did not flood during either the 1975 or the 2002 flood events. The closest roads to the property which flooded in either of these events are Woodsome Road located to the north and York Rise located to the east which both flooded in 1975.

Modelling of surface water flooding has been undertaken by the Environment Agency and a copy for the site area is reproduced as Figure 3 to this report. The site is shown as having a 'Very Low' risk of flooding; the lowest category for the national background level of risk.

Despite this, as detailed in Table 3 below, the scheme will result in an increase in impermeable areas by 25.70m2.

Table 3. Existing and Proposed Permeable/Impermeable Areas

Element	Existing (m2)	Proposed (m2)
Impermeable (hardstanding - building footprint, concrete areas)	91m2 (house) 6.5 (shed)	123.2sqm Shed removed
Permeable (softscaping - grassed areas, (including green roof), permeable and porous paving)	82.1m2	56.4m2
Total (should be the site area and remain the same)	179.6m2	179.6m2

There is a small man-made pond in the rear garden of the site surrounded by concrete. The pond measures 0.50m (length) x 0.25m (width) x 0.25m (depth). There are no other surface water features within 100m of the site.

Sewer Flooding

The London Regional Flood Risk Appraisal (2009) advises that foul sewer flooding is most likely to occur where properties are connected to the sewer system at a level below the hydraulic level of the sewage flow, which in general are often basement flats or premises in low lying areas. There is no record of sewer flooding having occurred at Gough House and therefore the risk of sewer flooding is considered low.

3.6 Hydrogeology

The Environment Agency Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems.

The Bedrock geology underlying the site (London Clay Formation) has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Other hydrogeological data obtained from the Groundsure Report for the site includes:

- The underlying soil classification of the site is of high leaching potential;
- There are no source protection zones within 500m of the site
- The nearest groundwater abstraction license is located 1384m south of the site and relates to a borehole on Prince of Wales Street, Kentish Town for drinking, cooking, sanitary (household) uses. This abstraction is also the nearest potable license to the site;
- There are no surface water abstraction licenses within 2km of the site
- There are no water wells within 250m of the site

3.7 Proposed Development

From the development plans provided it is understood that the proposals for the site include a full width single storey basement extension beneath the footprint of the existing building and extending 1.50m into the rear garden. A lightwell is also proposed at the front of the building.

The basement and lightwell are to extend to a maximum depth of approximately 3.00m below ground level with a finished floor level of 50.10mOD proposed. This level will be approximately 1.11m deeper than the existing basement.

There have been five recent planning applications with reference the above proposals as detailed in Table 4 below.

Table 4. Recent Planning Applications with reference to the site

Application Number	Development Description	Date Registered	Status
2014/7317/NEW	Erection of a single storey rear extension as replacement to existing, installation of rooflights to rear roofslope, alterations to rear elevation fenestration and balustrade and replacement of rear garden shed.	--	Withdrawn Decision
2014/7318/P	Erection of a single storey rear extension as replacement to existing, replacement of rooflights to rear roofslope, alterations to rear elevation fenestration and balustrade, replacement of rear garden shed and rear landscaping.	04-12-2014	Granted
2014/7246/P	Extension to existing basement	12-01-2015	Withdrawn Decision
2015/0644/P	Installation of 1 x rooflight on rear roof slope.	11-02-2015	Granted
2015/1434/P	Erection of a single storey full-width rear extension.	13-03-2015	Granted

3.8 Existing and Proposed Basement Structures

Reference to LBC planning portal (1987 to present) shows that there has been no recent basement developments along Boscastle Road.

3.9 Results of Basement Impact Assessment Screening

A screening process has been undertaken in accordance with the most recent guidance from Camden Council (CPG 4, 2015) and the findings are described below.

Subterranean (Groundwater) flow

Question	Response	Details
1a. Is the site located directly above an aquifer.	No	The Bedrock geology underlying the site (London Clay Formation) has been classified as Unproductive Strata.
1b. Will the proposed basement extend beneath the water table surface.	Unknown	To be confirmed by ground investigation and groundwater monitoring
2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	No	Although there is a small pond within the rear garden on the site it is man-made, very shallow (0.25m) and surrounded by concrete and therefore not considered a potential spring line. There are no other surface water features within 100m of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is not within 100m of a former river or watercourse.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	The site is over 600m south east from these features
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	Yes	Yes, there will be a change in the area of hard surfacing. The surface permeability will be affected by an increase in the footprint of the new building specifically at the proposed lightwell and an increase in the amount of impermeable surfacing across the site
5. As part of 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	Soakaways are not considered appropriate to the site due to the sub-soil conditions and therefore no surface water will be discharged to ground as part of the site drainage.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line.	No	Although there is a small pond within the rear garden on the site it is man-made, very shallow (0.25m) and surrounded by concrete and therefore not considered a potential spring line and will not affect the development. There are no other surface water features within 100m of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is not within 100m of a former river or watercourse.

Slope stability

Question	Response	Details
1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8).	No	The site is essentially flat
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8).	No	Re-profiling of landscaping at the site is not proposed
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8).	No	In the surrounding area there is a slight slope in topographic gradient from approximately 53.4mOD at the junction with Woodsome Road to 51mOD at Chetwynd Road. This equates to around a 2-3˚ slope angle.
4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8).	No	There is a general slope to the south towards the River Thames but this is less than 7 degrees.
5. Is the London Clay the shallowest strata at the site.	Yes	The British Geology Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by the London Clay Formation.
6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained.	No	No trees will be felled as part of the development
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence	Yes	The London Clay Formation is prone to shrinking and swelling.

of such effects at the site.		
8. Is the site within 100m of a watercourse or a potential spring line.	No	Although there is a small pond within the rear garden on the site it is man-made, very shallow (0.25m) and surrounded by concrete and therefore not considered a potential spring line. There are no other surface water features within 100m of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is not within 100m of a former river or watercourse.
9. Is the site within an area of previously worked ground.	No	According to information from the BGS the site is not in the vicinity of any recorded areas of worked ground
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 Bedrock geology underlying the site (London Clay Formation) has been classified as Unproductive Strata.
11. Is the site within 50m of the Hampstead Heath Ponds	No	The site is over 250m from these features
12. Is the site within 5m of a highway or pedestrian right of way.	Yes	The site is within 5m of Boscastle Road
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes	The development will increase the depths of foundation at the site, although the foundation depths of adjacent properties are not known.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	No	Reference to the Groundsure Report (Appendix C) shows that there are no Tfl or Network Rail owned tunnels below the site.

Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the ponds chains on Hampstead Heath	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain
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	On completion of the development the surface water flows will be routed similarly to the existing condition, with rainwater run-off collected in a surface water drainage system and discharged to a combined sewer. Any groundwater flows will not be impeded by the basement.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	Yes	Yes, there will be a change in the area of hard surfacing. The surface permeability will be affected by an increase in the footprint of the new building specifically at the proposed lightwell and an increase in the amount of impermeable surfacing across the site
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	All surface water for the site will be contained within the site boundaries and collected as described above; hence there will be no change from the development on the quantity or quality of surface water being received by adjoining sites.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	All surface water for the site will be contained within the site boundaries and collected as described above; hence there will be no change from the development on the quantity or quality of surface water being received by adjoining sites.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.	No	According to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.21. There are no surface water features within 100m of the site which could create a flood risk for the proposed basement. According to CPG4 (2015) Boscastle Road did not flood during either the 1975 or the 2002 flood events.

3.10 Non-Technical Summary of Screening Process

The site is located to the west of Boscastle Road in Hampstead, North London at approximately postcode NW5 1EE. The site comprises a four storey terraced residential property including an existing lower ground floor/cellar and front and rear garden areas. The site slopes gently to the east with levels of 53.72mOD measured in the garden area and 52.32mOD measured in the front garden area. The existing lower ground floor has a level of around 51.21mOD.

From the development plans provided it is understood the proposals for the site include a full width single storey basement extension beneath the footprint of the existing building and extending 1.50m into the rear garden. A lightwell is also proposed at the front of the building.

From historical map evidence it would appear that the site was occupied by gardens until the existing property was built in circa 1896. No further change to the site is evident.

The British Geology Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by the London Clay Formation which has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

According to Environment Agency Flood maps the site lies within Flood Zone 1, which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year.

The scheme will result in an increase in impermeable areas by 25.70m2.

The following have been identified as being the potential issues which will be carried forward to the Scoping Phase in this report:

Subterranean Groundwater Flow

- Will the proposed basement extend beneath the water table surface
- Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.

Slope Stability

- Is the London Clay the shallowest strata at the site.
- Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.
- Is the site within 5m of a highway or pedestrian right of way.
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.
- Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.

4.0 SCOPING PHASE

This purpose of the scoping phase is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified impact factors and recommendations are stated.

Subterranean (Groundwater Flow)

Screening Question		**Potential impacts and actions**
1b	Will the proposed basement extend beneath the water table surface?	**Potential impact:** Local restriction of groundwater flows (perched groundwater or below groundwater table). **Action:** Ground investigation required, then review.
4	Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	**Potential impact:** May increase flow rates to sewer, and thus increase the risk of flooding **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SuDS for use as site-specific mitigation.

Slope Stability

Screening Question		**Potential impacts and actions**
5	Is the London Clay the shallowest strata at the site.	**Potential Impact:** The London Clay is prone to seasonal shrink-swell (subsidence and heave). **Action:** Ground investigation required, then review.
7	Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	**Potential Impact:** If a new basement is not dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties. **Action:** Ground investigation required, then review.
12	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Excavation of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice working methods.
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the new foundations to neighbouring properties if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice methods.

Surface Water and Flooding

Screening Question		**Potential impacts and actions**
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	**Potential impact:** May increase flow rates to sewer, and thus increase the risk of flooding **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SuDS for use as site-specific mitigation.

These potential impacts have been further assessed through the ground investigation, as detailed in Section 4 below.

4.1 Non-Technical Summary of Chapter 4.0

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Review of site’s hydrogeology and groundwater control requirements.
- Review flood risk and include appropriate flood resistance and mitigation measures in the scheme’s design.

All these actions are covered in the ground investigation and basement impact assessment described in the following chapters.

5.0 GROUND INVESTIGATION AND MONITORING

5.1 Records of Site Investigations

A ground investigation has been undertaken by LMB Geosolutions in December 2015, which included the following:

- One cable percussive borehole using a cut down (demountable) rig to a depth of 15.00m bgl (Borehole 1)
- One dynamic sampler borehole to a depth of 6.0m bgl (Borehole 2) with in-situ SPT's with follow-on Dynamic probe testing completed to 10.0m bgl
- Five hand excavated foundation inspection trial pits to maximum depths of 0.25m below lower ground floor level (Trial Pits 1, 2, 2a, 3 and 4) and 1.25m below ground level.
- Installation of groundwater monitoring wells, one to depth of 10.00m bgl in Borehole 1 and another to a depth of 6.00m bgl in Borehole 2.
- Monitoring of groundwater levels on three occasions.

The factual report describing the results of the investigation dated January 2016 is contained in Appendix A.

5.2 Ground Conditions

The boreholes and trial pits revealed ground conditions that were consistent with the geological records and known history of the area. They comprised Made Ground up to 1.25m in thickness resting on deposits of the London Clay Formation at depth.

The Made Ground extended down to respective depths of 0.11m below lower ground floor level (blgl) in Trial Pit 1 (51.56mOD), 0.80m below ground level (bgl) in Trial Pit 4 (52.55mOD), 0.90m bgl in Borehole 1 (52.37mOD), 0.50m bgl in Borehole 2 (51.81mOD) and to the full depths of investigation of up to 1.25m bgl in Trial Pits 2, 2a and 3 (52.09mOD). The soils were generally found to comprise sandy slightly gravelly clay with flint, brick and concrete.

Weathered London Clay was encountered below the Made Ground comprising of soft to firm becoming stiff mottled clay. These weathered soils extended down to depths of 3.50m bgl in Boreholes 1 and 2 (48,81 to 49.77mOD) and to the full depths of investigation of up to 0.25m bgl in Trial Pit 1 (51.42mOD) and 0.95m bgl in Trial Pit 4 (52.40mOD). In Borehole 1 the upper horizon of Weathered London Clay between 0.90m to 2.10m bgl (51.17 to 52.37mOD) was found to include occasional pyrite and flint gravel which could be indicative of some re-working by geological processes.

These soils were underlain by more competent unweathered London Clay comprising stiff and then very stiff fissured clay with occasional selenite crystals which extended down to the maximum depths of drilling of 15.00m bgl in Borehole 1 (38.27mOD) and 10.0m bgl in Borehole 2 (42.31mOD).

5.3 Groundwater

Groundwater was not encountered in the trial pits and boreholes and the soils remained essentially dry throughout.

Following drilling operations Boreholes 1 and 2 were installed with water-monitoring piezometers. The response zones were from 1-10m bgl in Borehole 1 and 2.0-5.0m bgl in Borehole 2.

A summary of the groundwater monitoring results is provided below as Table 5.

Table 5. Monitoring Summary

Date	**Location**	**Ground Level (mOD)**	**Groundwater Level**	
			m	**mOD**
15/01/2016	BH1	53.27	5.41	47.80
	BH2	52.31	DRY	
29/01/2016	BH1	53.27	3.21	50.06
	BH2	52.31	DRY	

The groundwater monitoring data was collected in January 2015 and although this does not provide an indication of any seasonal fluctuations it is considered to be reflective of high winter groundwater levels. It would be prudent to continue to monitor the existing installed borehole standpipe for as long as possible in order to determine equilibrium level and the extent of any seasonal variations.

5.4 Foundations

Trial Pits 1, 2, 3 and 4 were excavated adjacent to the existing walls in order to expose the existing foundation structures and founding soils. Copies of the logs and sketches of the foundation details are contained in LMB Geosolutions report contained in Appendix A.

5.5 In-Situ and Laboratory Testing

The results of the laboratory and in-situ tests are presented in the factual report contained in Appendix A whilst certain tests are summarised on Figures 4, 5 and 6 in this report.

5.5.1 Classification Tests

Atterberg Limit tests have been conducted on four selected samples taken from Boreholes 1 and 2, and showed the samples tested to fall into Class CV according to the British Soil Classification System. These are representative of fine grained silty clay soils of high plasticity and as such generally have a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values of between 45% and 48% and are summarised on a Casagrande Plasticity Chart included as part of this report as Figure 4.

5.5.2 Standard Penetration Testing

The results of the Standard Penetration Tests carried out in the London Clay soils are shown on the appropriate exploratory hole records in Appendix A and are summarised on Figure 5. SPT 'N' values range between 6 and 31 with a general increase in depth apparent.

Values of undrained shear strength have been ascertained from the results of SPT tests undertaken on cohesive London Clay soils using the following relationship;

Cu = f1 x N (Stroud and Butler, 1975).

Based on results from Atterberg limit testing (see section 5.5.1) an f1 value of 4.5 has been used as a conservative approach. Based on this, the undrained shear strength values within the cohesive London Clay soils can be estimated to be around 27-162kPa, which is representative of a low becoming very high strength soil. These results are detailed on Figure 6.

5.5.3 Undrained Triaxial Compression Tests

Undrained triaxial compression tests were carried out on three selected undisturbed 100mm diameter samples taken from Borehole 1 at 3.20m, 5.20m and 8.20m bgl within the London Clay Formation. The results show the samples to be of a high strength in accordance with BS 5930 (2015) and show a good correlation with the results estimated for SPT N Values as detailed in Figure 6.

5.5.4 Sulphate and pH Analyses

The results show the soil samples to have water soluble sulphate contents of up to 2.95g/litre associated with near neutral pH values. The sample of Made Ground selected for contamination analysis indicate the soil to have a soluble sulphate content of 1.9g/litre associated with a slightly alkaline pH value.

5.6 Non-Technical Summary of Chapter 5.0

The boreholes and trial pits revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.25m in thickness overlying the London Clay Formation at depth. Groundwater was encountered at a maximum depth of 3.21m bgl (50.06mOD) in the monitoring piezometer in Borehole 1 during a monitoring period of approximately four weeks.

6.0 FOUNDATION DESIGN

6.1 General

It is understood that the proposed development includes the construction of a basement extension and lightwell to a maximum depth of approximately 3.00m below ground level with a finished floor level of 50.10mOD proposed. This level will be approximately 1.11m deeper than the existing basement.

The existing vertical dead loads imposed at founding level by the existing lower ground floor level range between 15kN/m2 and 90kN/m2 whilst the dead loads at the existing ground floor level range between 30kN/m2 and 70kN/m2. The pressures applied by the new structure are expected to be of the order 20kN/m2 plus the self-weight of the basement slab which is expected to be 300mm thick.

6.2 Foundation Appraisal

Due to the inherent variability and nature of Made Ground it would not be recommended to found on the Made Ground deposits without some form of treatment/ground improvement. Foundations should therefore, be taken through any Made Ground and into suitable underlying natural strata of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in the boreholes and trial pits, it should be possible to support the proposed new development on conventional spread or pad foundations taken down below the Made Ground and any weak superficial soils and placed in the high strength clay deposits which were encountered at a level of 50.10mOD across the site (3.20m bgl).

6.2.1 Conventional Spread or Pad Foundations

Pad foundations placed within these natural cohesive soils may be designed to allowable net bearing pressures of approximately 180kN/m2 at 3.20m bgl (50.10mOD) and should be sufficiently low to ensure that overstressing of the underlying soils does not occur. The calculation limits to the above stresses to no more than 25mm of settlement.

Laboratory testing of the London Clay Formation at the site has revealed plasticity index values of between 45% and 48%. A minimum foundation depth of 1.00m is therefore recommended and the provisions of Appendices 4.2-C and 4.2-H of NHBC Standards Chapter 4.2, “Building near trees”, should be followed for the design of shallow foundations for buildings on shrinkable clay near trees.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with suitably compacted granular fill. All excavations to formation levels should be monitored and inspected by a suitably qualified geotechnical engineer.

6.2.2 Piled Foundations

For the ground conditions at this site a driven or bored pile could be adopted although a driven pile would have the advantage of minimising the spoil that is generated. Consideration would need to be given to the effects of noise and vibrations on neighbouring sites. Some form of bored pile may therefore be the most appropriate type.

A conventional rotary augered pile may be suitable but casing will be required to maintain stability and prevent any groundwater inflows within the clay, bored piles installed using continuous flight auger (cfa) techniques are therefore likely to be the most appropriate technique.

All piling works should be overseen and inspected by a suitably qualified engineer.

Specialist piling contractors should be consulted with regard to the design of an appropriate piling scheme and the need for additional deeper investigation. Their attention should be drawn to the possible presence of groundwater and silt and sand layers within the London Clay.

6.3 Retaining Walls

It is considered unlikely that extensive slopes are to be formed during development of the site. However, slope stability analysis should be undertaken where these are proposed. It is considered unlikely that slopes within the existing Made Ground London Clay Formation will be suitable at slopes of greater than 1 in 3 without reinforcement or shoring within temporary conditions. Furthermore assessment should be carried out for appropriate slope angles within the London Clay Formation both in the temporary and permanent conditions if required. However this should be further assessed at detailed design stage if slopes are anticipated.

Based on the available information, it is believed the more appropriate retaining wall type to be a gravity based or small scale cantilever walls. Some preliminary retaining wall characteristic geotechnical design parameters are provided in Table 6 below:

Table 6: Preliminary Retaining Wall Characteristic Parameter Values

Material Type	**Unit Weight (kN/m3)**	**Undrained Shear Strength (kN/m²)**	**Φ' crit**	**c' (kN/m²)**
Made Ground	18	-	28**	-
Sandy, Silty CLAY (London Clay Formation)	18	27 to 162 (increasing with depth)*	-	-

*Undrained Shear Strength obtained from SPT N Values and Undrained Triaxial Testing (See Figure 6) **Based on guidance from BS8002 (2015)

6.4 Excavations

On the basis of the borehole findings it is considered that shallow excavations for foundations and services that extend through the Made Ground and into the underlying clay should remain generally stable in the short term. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

Inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the Made Ground, particularly within the vicinity of existing foundations, although such inflows should be suitably controlled by sump pumping.

6.5 Buried Concrete

Utilising the minimum pH and maximum water soluble sulphate concentration as characteristic values, the concrete classification to protect buried concrete structures from aggressive ground conditions (in accordance with BRE Special Digest 1 (2005) for Brownfield) is Design Sulphate Class DS-3 and ACEC class AC-2s.

In addition, segregations of selenite were noted within the London Clay and scattered small selenite crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may also be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-3 conditions.

6.6 Preliminary Waste Acceptance Classification

A single Waste Acceptance Criteria (WAC) test was carried on 1 No. selected sample within the Made Ground (BH1 0.5m). The results of the test indicate very low determinand concentrations and therefore it is considered likely that this material would be accepted in landfill as inert wastes.

6.7 Non-Technical Summary of Chapter 6.0

It is understood that the proposed development includes the construction of a basement extension and lightwell to a maximum depth of approximately 3.00m below ground level with a finished floor level of 50.10mOD proposed. This level will be approximately 1.11m deeper than the existing basement on the site.

Based on the ground and groundwater conditions encountered in the boreholes and trial pits, it should be possible to support the proposed new development on conventional spread or pad foundations taken down below the Made Ground and any weak superficial soils, and placed in the firm clay deposits which were encountered at a level of 50.10mOD across the site.

Specialist piling contractors should be consulted with regard to the design of an appropriate piling scheme if required and the need for additional deeper investigation. Their attention should be drawn to the possible presence of groundwater and silt and sand layers within the London Clay. All piling works should be overseen and inspected by a suitably qualified engineer.

It is considered unlikely that extensive slopes are to be formed during development of the site. However, slope stability analysis should be undertaken where these are proposed.

Utilising the minimum pH and maximum water soluble sulphate concentration as characteristic values, the concrete classification to protect buried concrete structures from aggressive ground conditions (in accordance with BRE Special Digest 1 (2005) for Brownfield) is Design Sulphate Class DS-3 and ACEC class AC-2s.

7.0 BASEMENT IMPACT ASSESSMENT

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

Impact	Site Investigation Conclusions	Impact sufficiently addressed without further justification?
The proposed basement extends beneath the water table surface.	It is proposed to excavate to a maximum depth of approximately 3.00m depth (50.10mOD) through Made Ground into clay strata belonging to the London Clay Formation. Observations made in standpipe piezometers installed in Boreholes 1 and 2 indicate maximum groundwater levels of 3.21m bgl (50.06mOD) being just below the maximum dig level. Given the site is underlain by a non-aquifer (London Clay Formation) which cannot support baseflow to watercourses, the groundwater encountered in BH1 is likely to be related to slow surface water infiltration into the standpipe installation and not reflective of large scale groundwater flow. Significant groundwater ingress is therefore not expected during the excavation and any minor inflows should be suitably controlled by sump pumping. Based on the above it is also concluded that the proposed basement would not present an effective barrier to flow or impact upon groundwater sensitive features.	Yes
There a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	The London Clay Formation was proven below the site and was recorded as having a high susceptibility to shrinkage and swelling. However, the base of proposed basement will extend well below the potential depth of root action in accordance with guidance from NHBC Standards, Chapter 4.2.	Yes
The site is within 5m of a highway or pedestrian right of way.	The proposed basement is not to be extended below Boscastle Road and therefore it is suggested that the impact on these access roads is likely to be minimal. Temporary works to address potential instability are to be incorporated into the design and construction sequence. There is nothing unusual in the proposed development that would give rise to any concerns with regard to the stability of public highways.	Yes
The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.	The development will result in the extension of the foundation depth of the basement relative to neighbouring property's at No 21 and 25 Boscastle Road	No – see Section 7.1 for further details.
Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	There is a small increase in impermeable area on site following development, which equates to an increase in the rate of runoff from the site.	No – See section 7.2 for further details

7.1 Prediction of Ground Movements and Damage Assessment

7.1.1 Introduction

In connection with the proposed basement construction a ground movement and damage assessment has been undertaken at the site. The purpose of this assessment is to determine the effects of the proposed basement construction upon the neighbouring structures.

The soil behaviour over the footprint of the excavated area is different from the behaviour outside and the associated ground movements require assessment using different approaches.

In the area of the new basement the soil will tend to move as a result of change of vertical load on the ground due to excavation and demolition. Movements in the long term would also be expected as a result of changes in the pore pressure in the clay layer under the basement.

Around the site the construction activities that may result in ground movements during and after the works are mainly related to the excavation, which would induce a reduction of vertical and lateral stresses in the ground along the excavation boundaries.

The magnitude and distribution of ground movements inside and outside the excavated area are a function of changes of load in the ground and also, critically, are a function of workmanship.

Ground movements within the area of the proposed excavation have been estimated using Geotechnical Software (PDISP by OASYS) whilst the expected movements in the area around the site have been estimated using an empirical approach that is based on field measurements of movements from a number of basement constructions across London (CIRIA report C580 ‘Embedded retaining walls guidance for economic design’).

The calculations provided are specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

7.1.2 The adjacent properties

The properties more likely to be affected by the ground movements associated with the proposed basement construction are No. 23 Boscastle Road to the north west and No. 19 Boscastle Road to the south east.

No’s 19 and 23 are constructed in a similar manor to No 21 being four storey terraced residential properties with existing lower ground floor/cellars and front and rear garden areas. From historical map evidence it would appear that the properties have a similar history to No. 21 being constructed in circa 1896.

The properties are believed to be mirrored along this terrace and therefore the same existing coal cellar should be found on the other side of the party wall with No. 19. On this basis it is assumed that there will not be a cellar on the other side of the party wall with No. 23 as this cellar should be located along the party wall with No. 25.

7.1.3 Ground Model

For the purposes of the ground movement analyses, the ground stratigraphy can be summarised as follows:

- Made Ground to approximately 1.25m below ground floor level (52.17mOD)
- London Clay Formation to 15.0m below ground floor level (38.42mOD)

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. This relates values of Eu and E', the drained and undrained stiffness respectively, to values of undrained cohesion, as described by Padfield and Sharrock (1983) and Butler (1974) and more recently by O'Brien and Sharp (2001). Relationships of Eu = 500 Cu and E' = 300 Cu for the cohesive soils have been used to obtain values of Young's modulus. More recent published data (2001) indicates stiffness values of 750 x Cu for the London Clay and a ratio of E' to Eu of 0.75, and it is considered that the use of the more conservative values provides a sensible approach for this stage in the design.

7.1.4 Ground Movements inside the area of the new basement.

The vertical ground movements in the area of the site associated with the proposed extension have been calculated using PDISP by OASYS. This approach assumes linear elastic behaviour of the soil and the changes in vertical stresses and settlement/heave have been assessed using the Boussinesq approach. Elastic vertical strains are calculated on the basis of the calculated stress changes and then integrated to obtain vertical movements.

This analysis does not take account of the stiffness of the neighbouring buildings; the result is conservative in this respect.

Three stages of the redevelopment have been modelled as follows:

1. A first stage simulating excavation across the site with unloading due to the removal of soil. Assuming that no delays occur during the construction process, this stage has been simulated using short term soil parameters only (i.e. undrained conditions for the London Clay).

   A model for the excavation of the basement to 3.00m bgl is provided as Figure 7.

   The proposed excavation will result in a net unloading of around 55kN/m^2 below the majority of the property and 22kN/m^2 below the existing lower ground floor/cellar level.

2. A second stage simulating the conditions at the end of the construction phase when the site is to be re-loaded with the pressures from the new structures applied at the new foundation level. It is understood that a 20kN/m2 net loading will be applied at basement level plus the weight of the 300mm thick slab. The model outputs are presented as Figure 8.
3. The third stage simulated a long term condition after construction when the ground has been allowed to consolidate under the new pressures. The model outputs are presented as Figure 9.

The elastic parameters for the soil have been chosen as appropriate for the short and long term conditions. Short term analyses have used undrained parameters for the London Clay, for long term assessments fully drained parameters were used.

Stages 1 and 2. Ground movements due to excavation and loading

The results of the PDISP analysis show at the end of the excavation the ground heaves upwards around 8mm within the footprint of the property, 4mm adjacent to No. 19 and 5mm adjacent to No. 23. The less movement at the party wall with No. 19 is due to the existing basement being present at this location and therefore reduction in soil removed and subsequent heave.

The construction of the new structure, with application of new loads, causes settlements that reduce the initial heave to around 4mm within the property, 2mm at the party wall with No. 23 and 1mm at the party wall with No. 19.

Stage 3. Long term (drained) movements

The heave is expected to increase over long term conditions to 7mm within the footprint of the property, 2mm adjacent to No. 19 and 5mm adjacent to No. 23.

7.1.5 Ground Movements outside the area of the new basement.

Movements due to installation of underpins.

It is understood that underpins will be installed along the party walls with No’s 19 and 23 to allow the construction of the new basement.

No data are presented by CIRIA (C580) for underpinned walls, and no other data are available from other sources for underpin walls. Underpin walls are therefore, as a worst case, assumed to be similar in behaviour to bored pile walls which can cause movement as a consequence of a loss of horizontal support during drilling. The data in CIRIA shown, as Figure 10, can be used to estimate the expected movement.

Records of horizontal movement are limited and very scattered and in practice horizontal movement should be ignored. Adjacent to the underpin wall, vertical ground settlement results from wall installation can be taken to equal 0.04% of wall depth, reducing linearly to zero at a distance of 2 x wall depth (As shown in Figure 10). The above trends rely on good workmanship and adequately-propped, stiff walls. Temporary support of excavations should be designed to BS5975 and BS8002.

For the basement walls of 3.00m depth the expected settlements at the walls are predicted to be approximately 1mm.

Movements due to excavation

During excavation the reduction of lateral support to the excavated walls would induce the ground behind the walls to settle and move towards the excavation as the wall bends.

Figure 11 shows empirical data based on the movements of ground behind retaining walls as a result of excavations into the London Clay (Source CIRIA C580). The movements depend on the propping sequence and on the final depth of the excavation and although there is considerable scattered, the data lies within an envelope which can be used to predict the likely upper limit of movement at any particular distance from the excavation.

Using Figure 11 it is estimated that adjacent to the underpin wall vertical ground settlement resulting from wall deflection can be taken to equal 0.04% of excavation depth, increasing to 0.08% of excavation depth at a distance of 0.6 x excavation from the wall, then reducing approximately linearly to zero at a distance of 3 x excavation depth from the wall.

Horizontal ground movements resulting from wall deflection can be taken as being equal to 0.15% of excavation depth, reducing linearly to zero at a distance of 4 x dig depth from the wall.

Assuming that the excavated walls will be fully propped during excavation and overall good workmanship, the data in Figure 11 suggest that the maximum vertical settlements resulting from the 3.00m excavation will be approximately 2mm whilst the maximum horizontal settlements will be 5mm.

7.1.6 Discussion of Results

Movements between short and long term

The results of the PDISP analysis show at the end of the excavation the ground heaves upwards around 8mm below the property, 4mm adjacent to No. 19 and 5mm adjacent to No. 23. The construction of the new structure, with application of new loads, causes settlements that reduce the initial heave to around 4mm within the property, 2mm at the party wall with No. 23 and 1mm at the party wall with No. 19. The heave is expected to increase over long term conditions to 7mm within the footprint of the property, 2mm adjacent to No. 19 and 5mm adjacent to No. 23.

The neighbouring buildings at No. 19 and No. 23 Boscastle Road are shown to be impacted by the ground movements however all movements (both short and long term) are predicted to be less than 5mm specifically at the location of the boundary walls so the buildings are not predicted to experience any significant change. In addition, based on the nature of the calculations, PDISP will tend to overestimate these values so in real terms they are unlikely to approach the numbers stated. Monitoring should however be in place during works (see section 7.1.7).

Effects of ground movements on No. 21 and neighbouring structures

The potential damage of the predicted ground movements on No. 21 and the neighbouring properties around the site can be estimated as suggested in CIRIA C580 by correlating the horizontal strains with the deflection ratio, which is the ratio between the maximum distortion of a structure and its length.

Ignoring the effects of underpin installation and using guidance from CIRIA C580, the deflection at No’s 19, 21 and 23 Boscastle Road is in the order of 0.05%, which, in combination of horizontal strains of about 0.05% is likely to cause a damage to the structures that can be classified as Category 0 to Category 1 in the Category of Damage Chart (CIRIA C580) shown in this document as Figure 12 (Negligible to very slight).

Tilting and deflections of No’s 19, 21 and 23 Boscastle Road would be restricted by the fact that they are part of a terrace. They are unlikely to experience significant horizontal strains and would be expected to experience only shearing of the walls as a result of mostly vertical movements caused by the excavation of the basement.

7.1.7 Ground Movement Assessment Conclusions

The movements associated with the proposed basement extension at No 21 Boscastle Road have been estimated using linear analyses and empirical methods.

The excavated area will be subjected to upward movements caused by heaves of the ground due to the net load changes following the basement excavation. The design of the basement foundation should be carried out considering these load changes and the associated movements.

Providing that good workmanship and construction sequences are used and that full support and propping is provided during excavations, the basement construction at No. 21 Boscastle Road is likely to cause settlements and horizontal strains that would induce limited damage on the existing building and surrounding structures. The properties at No’s 19, 21 and 23 Boscastle Road would be affected by ground movements that could create damage classified as Category 0 to Category 1 in the Category of Damage Chart (CIRIA C580) (negligible to very slight).

In addition to the above, based on direct experience with respect to the construction of underpinned retaining walls, ground movements should remain typically within the range 2mm to 5mm following completion of the works provided that they are installed by a reputable and experience contractor in accordance with the guidelines published by the Association of Specialist Underpinning Contractors (2013).

7.2 Hardstanding

As identified in the initial screening and scoping stages the scheme will result in an increase in impermeable areas by approximately 25.70m2.

The sealing of the ground surface to rainfall, by increasing the building area, would result in decreased recharge to the underlying ground, although the low permeability of the underlying London Clay would result in a low recharge in any case and consequently there would be little to negligible effect on groundwater.

Given the above, no additional SUDS are considered necessary; however, the scheme could incorporate a French drain / swale area adjacent to the proposed rear basement extension to increase surface water storage on site.

Given limited scope of the scheme and minimal increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of National Planning Policy Framework (NPPF) and Camden policy.

7.3 Advice on Further Work and Monitoring

Despite the ground movement analysis indicating a negligible to very slight category of damage to the neighbouring buildings during construction, movement monitoring of the boundary walls to the neighbouring buildings is recommended during the construction stage and trigger levels should be set in order to protect the adjoining property's as a precautionary measure. A specification for movement monitoring should be incorporated into the final construction scheme for the proposed development to monitor the adjacent property and establish the extent of any future potential movement to the building. The temporary and permanent works will be designed to limit eventual movement.

It would be prudent to continue to monitor the existing installed borehole standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations.

The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure which are considered to be able to be managed through a conventional sump pump system.

Trial excavations to the proposed basement depth could be carried out by the main contractor to confirm the depth of Made Ground and stability of the soil specifically at the locations of the excavations and to further investigate the presence of any groundwater inflows.

7.4 Non-Technical Summary of Chapter 7.0

Given good workmanship, the basement to No 21 Boscastle Road can be constructed without imposing more than very slight damage on the existing building and adjoining properties. The development is not likely to significantly affect the existing local groundwater regime.

It is not considered that the proposed basement would result in a significant change to the groundwater flow regime in the vicinity of the proposal. Also, given limited scope of the scheme and minimal increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of NPPF and Camden policy.

It would be prudent to continue to monitor the groundwater standpipes for as long as possible in order to determine the average groundwater level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure. Trial excavations to the proposed basement depth could be carried out by the main contractor to confirm the composition and stability of the soil and to further investigate the presence of any groundwater inflows.

Figure 1 – Site Location Plan

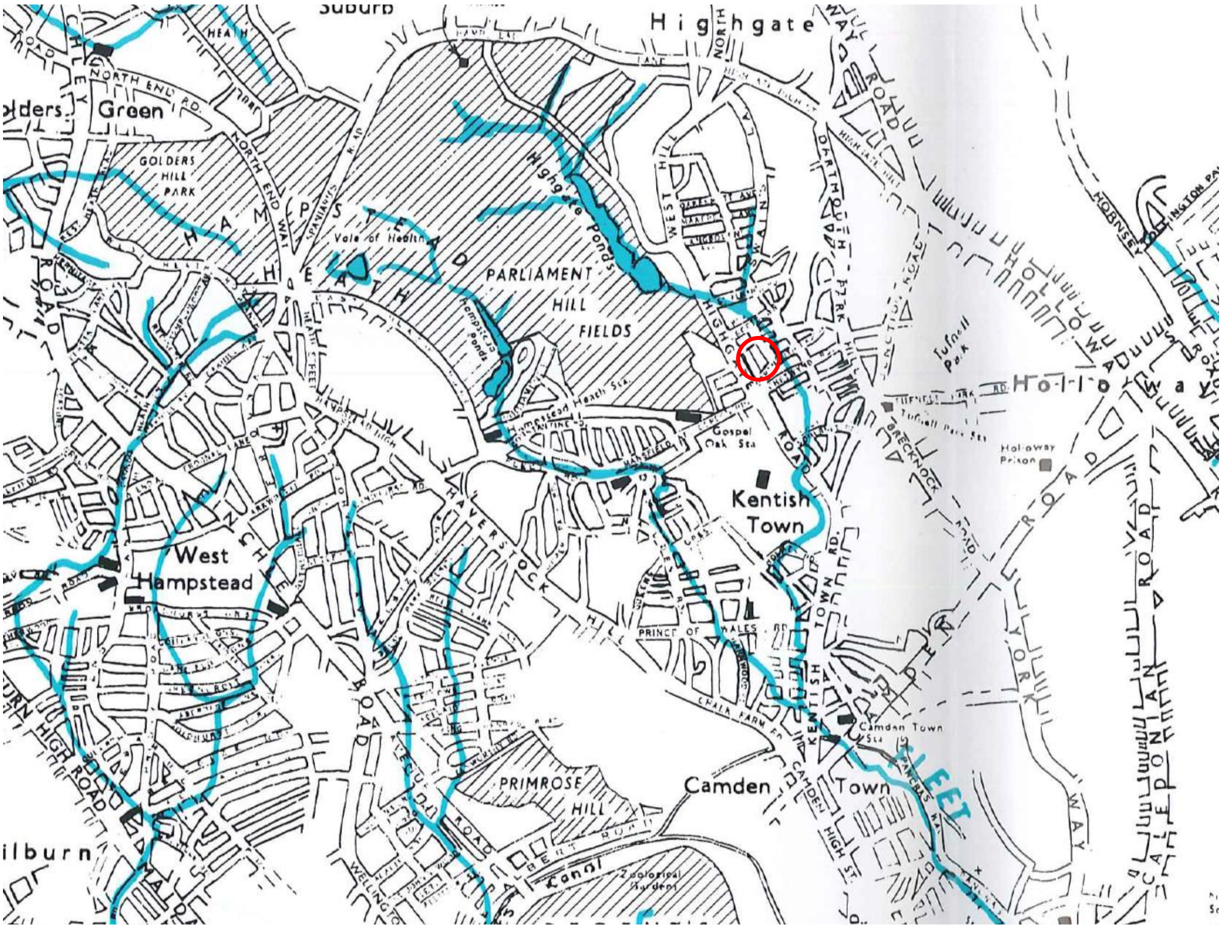


Figure 2 – Location of site relative to the ‘Lost Rivers’ of London (Source: Barton, 1992)

Figure 2a – Route of the River Fleet (arrowed) relative to the site (Stanford, 1864)

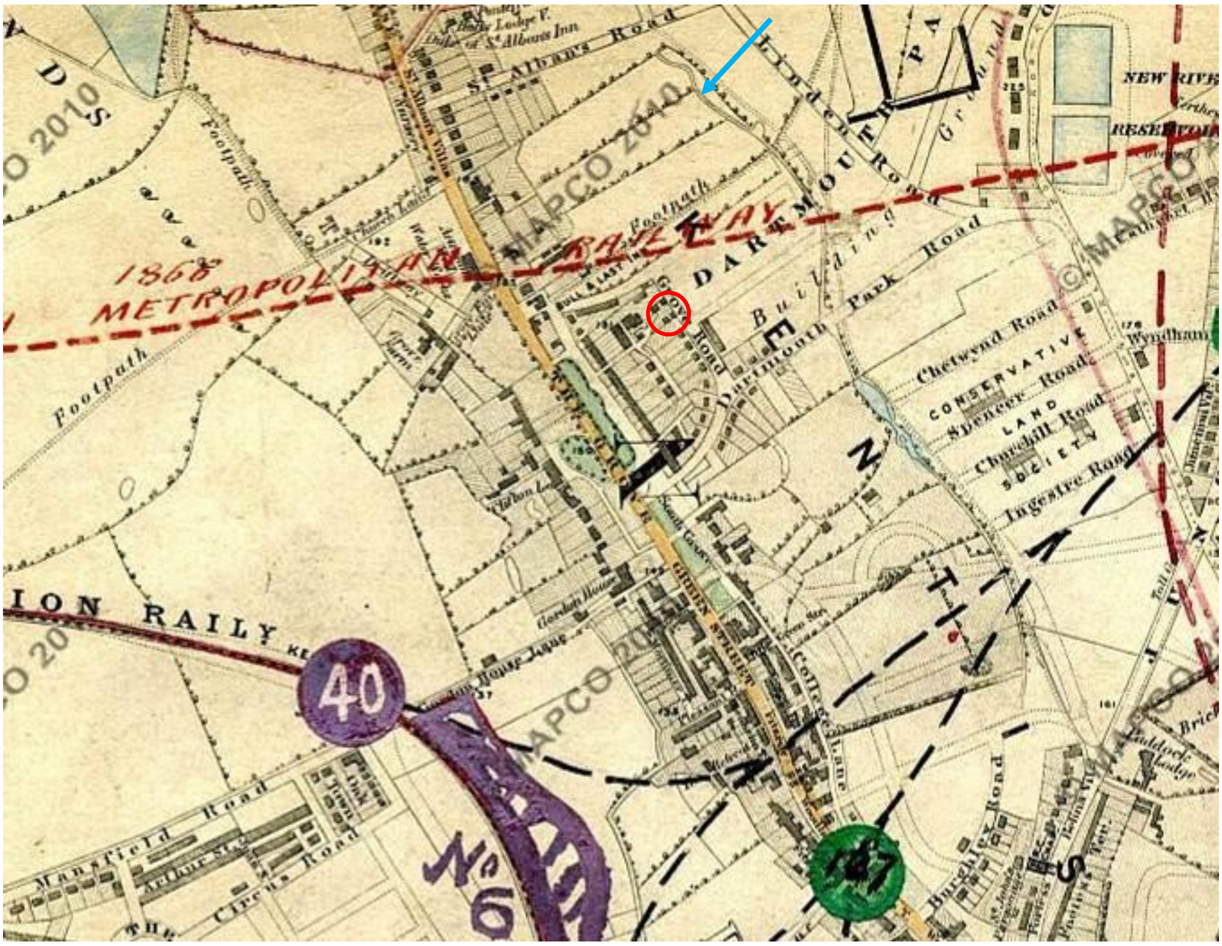
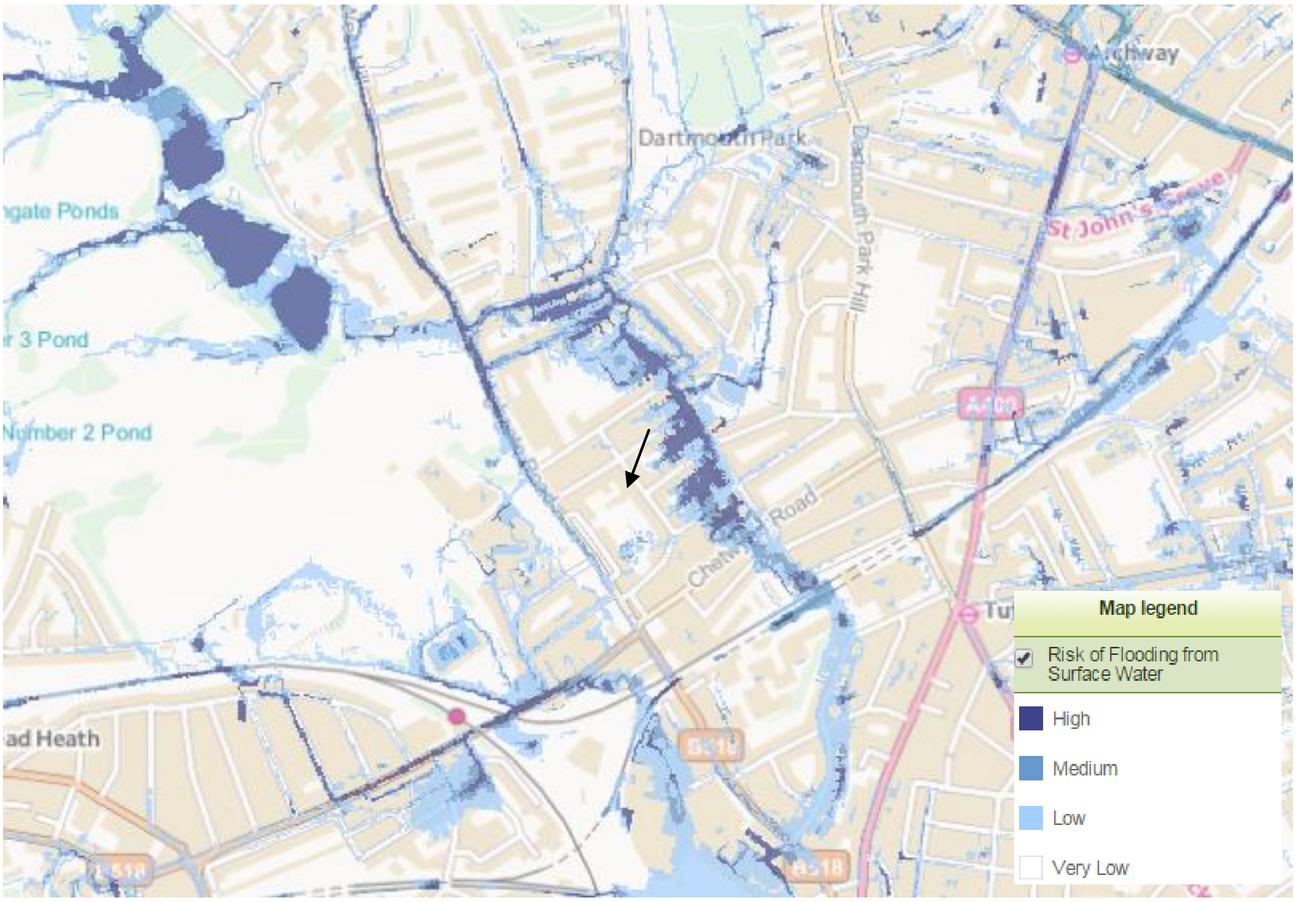
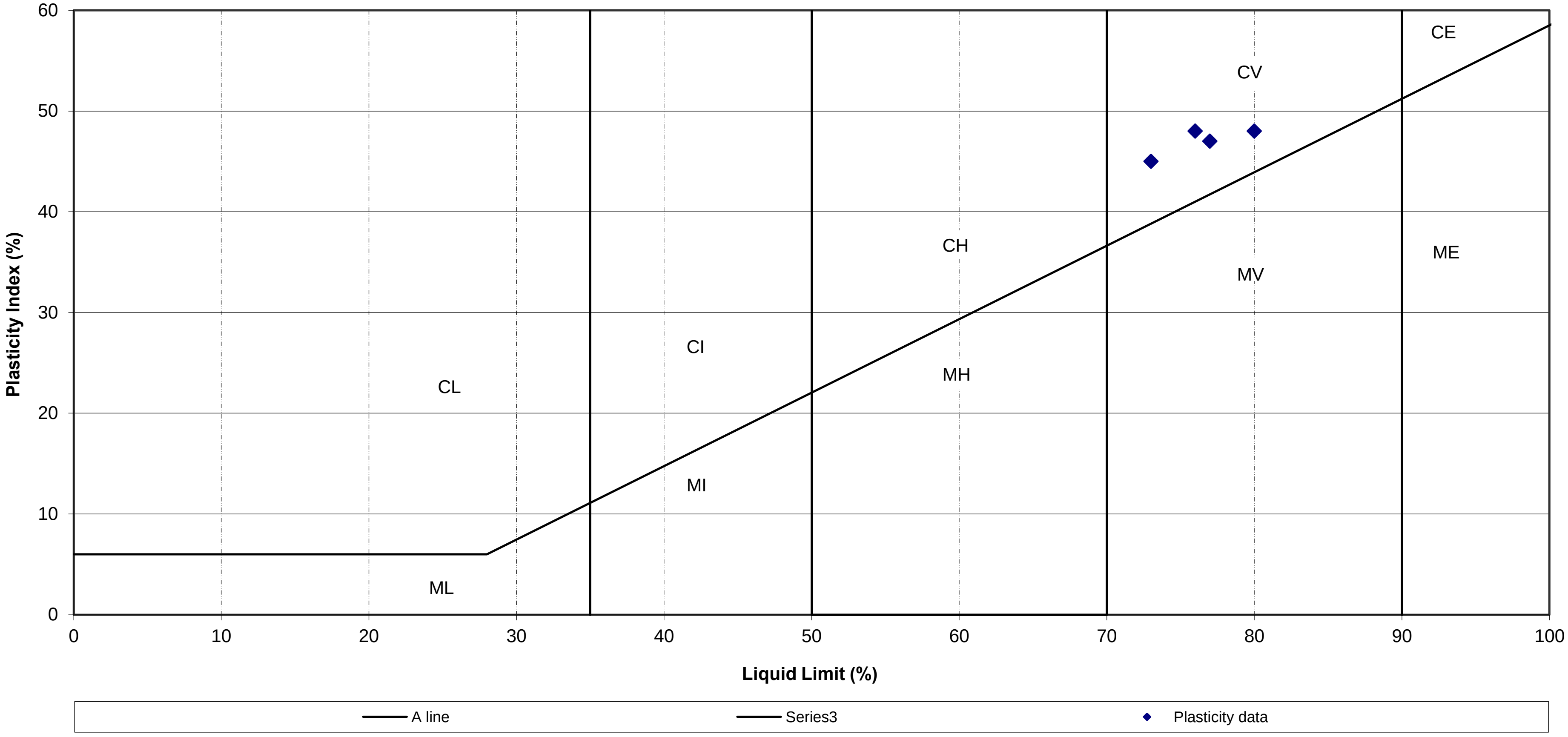


Figure 3 – Risk of Flooding from Surface Water (Source: Environment Agency 2015)





PROJECT TITLE:-

21 Boscastle Road, London, NW5

ORIGINATOR:-

FAIRHURST

SKETCH / FIG TITLE:-

Basement Impact Assessment

Casagrande Plasticity Chart
BH01 & BH02

SKETCH / FIG No.:-

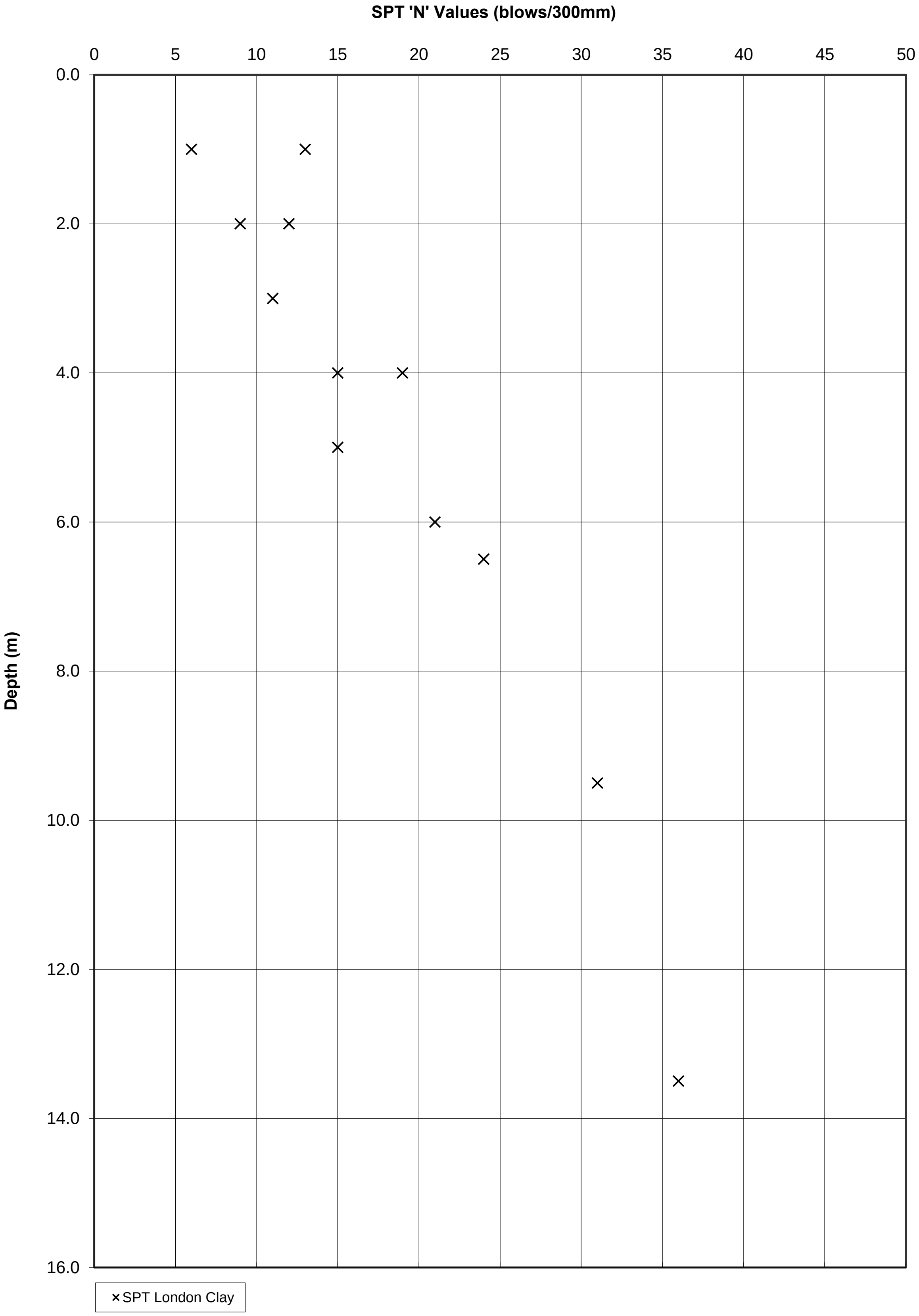
Figure 4

REPORT No.:-

112981

DATE:-

February-2016



PROJECT TITLE:-
21 Boscastle Road, London, NW5

ORIGINATOR:-
FAIRHURST

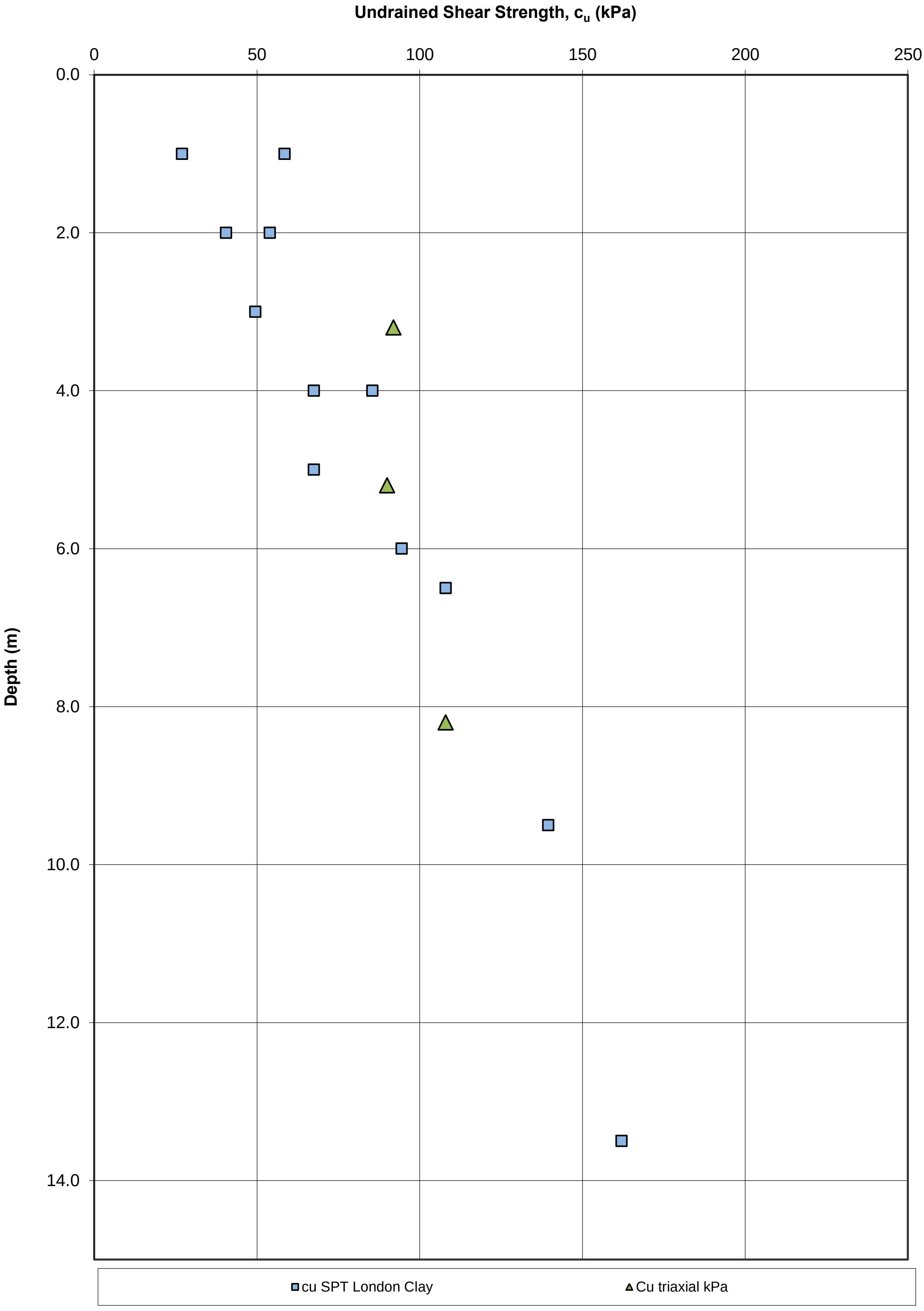
SKETCH / FIG TITLE:-
Basement Impact Assessment
SPT N Values versus Depth

BH01 & BH02

SKETCH / FIG No.:-
Figure 5

REPORT No.:-
112981

DATE:-
February-2016



PROJECT TITLE:-
21 Boscastle Road, London, NW5

ORIGINATOR:- FAIRHURST

SKETCH / FIG TITLE:-
Basement Impact Assessment
Undrained Shear Strength versus Depth

BH01 & BH02

SKETCH / FIG No.:-
Figure 6

REPORT No.:-
112981

DATE:-
February-2016

Oasys

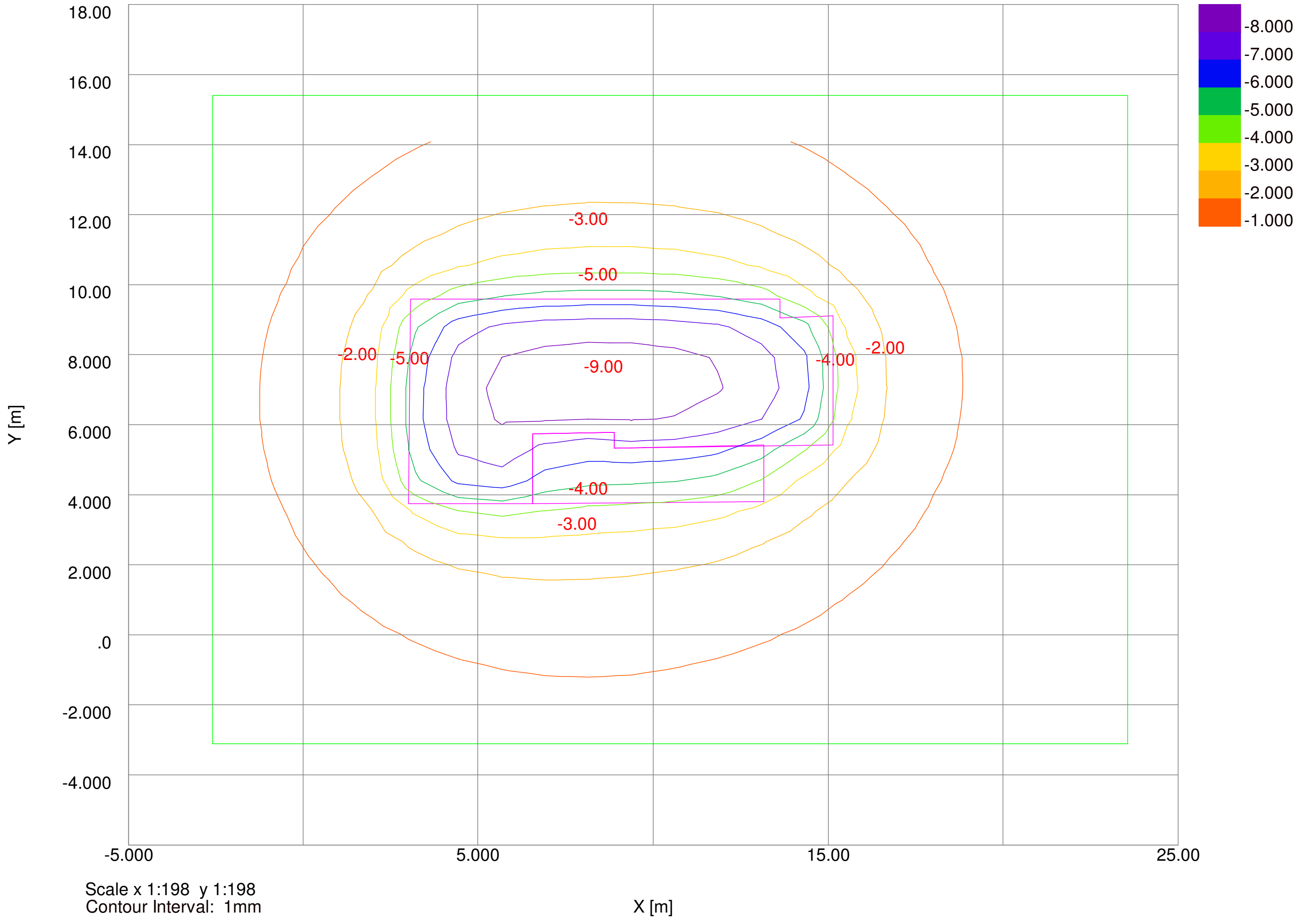
21 Boscastle Road

Ground Movement Assessment

Immediate Displacements Following Excavation

Job No.	***Sheet No.***	***Rev.***
112981		
Drg. Ref. Figure 7		
Made by	***Date***	***Checked***

Settlement Contours : Grid 1 at -3.0000m



Scale x 1:198 y 1:198

Contour Interval: 1mm

Oasys

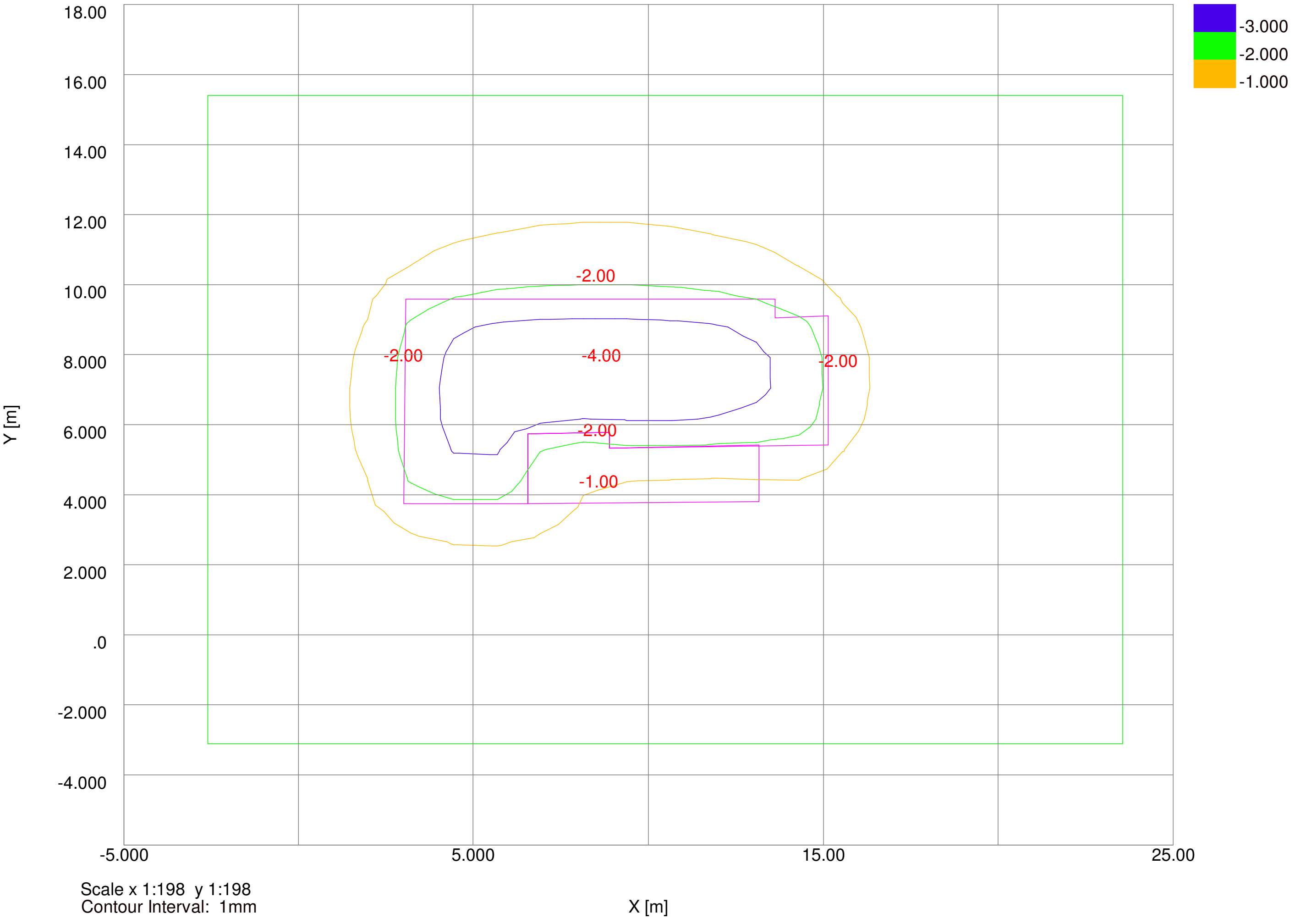
21 Boscastle Road
Ground Movement Assessment
Immediate Displacements Following Loading

Job No.	**Sheet No.**	**Rev.**
112981		

Drg. Ref. Figure 8

Made by	***Date***	***Checked***

Settlement Contours : Grid 1 at -3.0000m



Scale x 1:198 y 1:198
Contour Interval: 1mm

Oasys

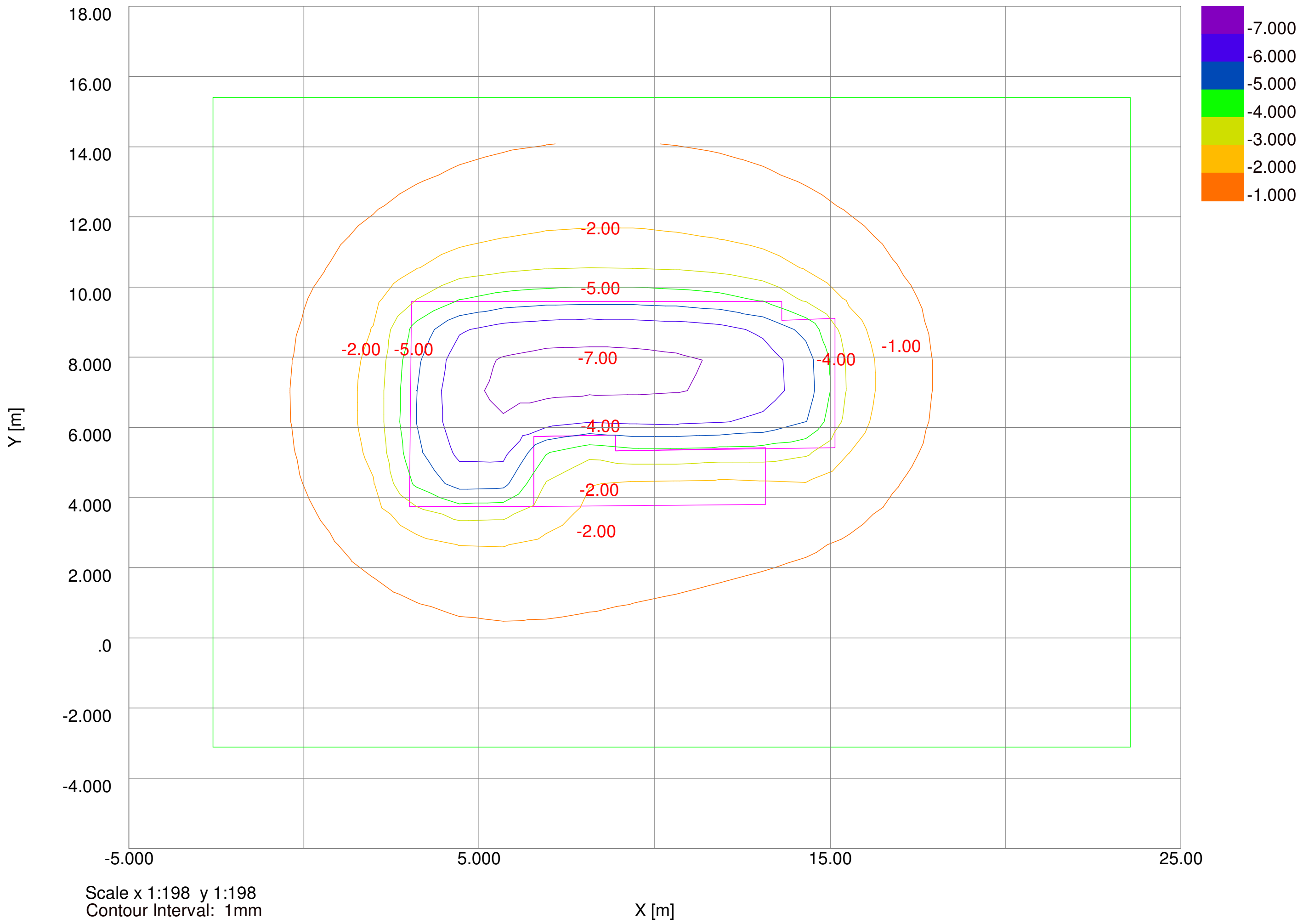
21 Boscastle Road
Ground Movement Assessment
Long Term Displacements

Job No.	Sheet No.	Rev.
112981		

Drg. Ref.Figure 9

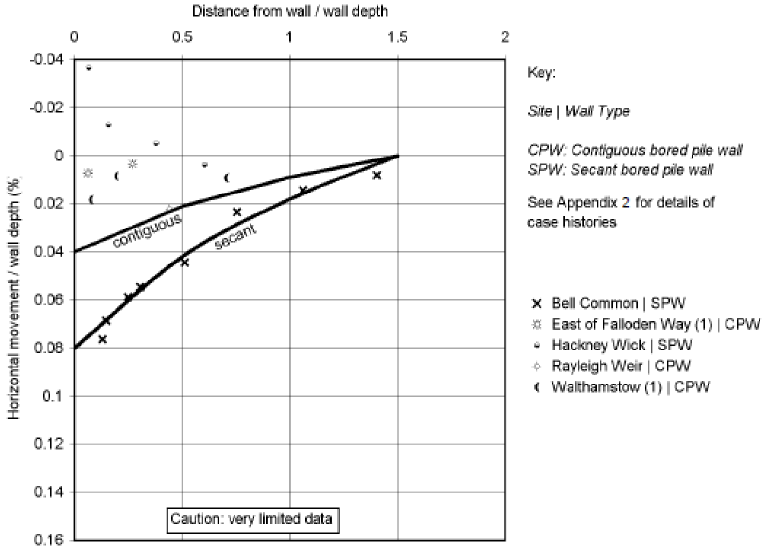
Made by	Date	Checked

Settlement Contours : Grid 1 at -3.0000m

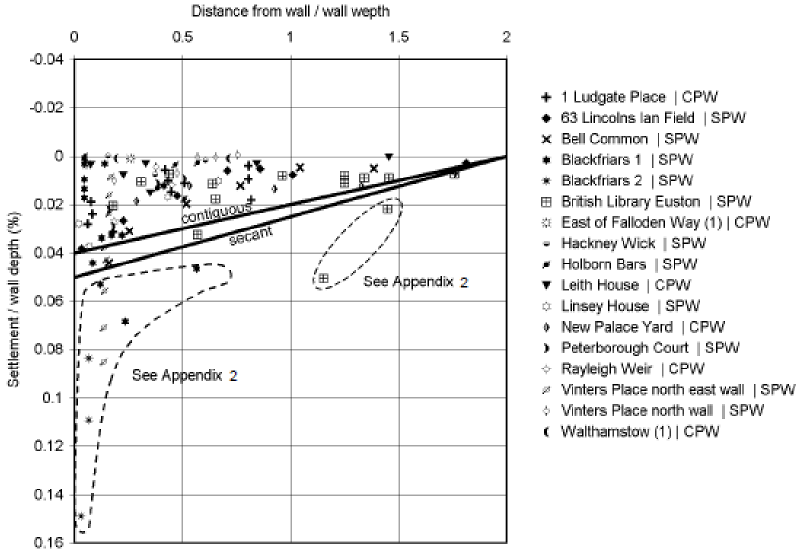


Scale x 1:198 y 1:198
Contour Interval: 1mm

Figure 10 – Measurements of ground movements due to bored pile wall installation in stiff clay (Reproduced from CIRIA C580, Figure 2.8a and b)

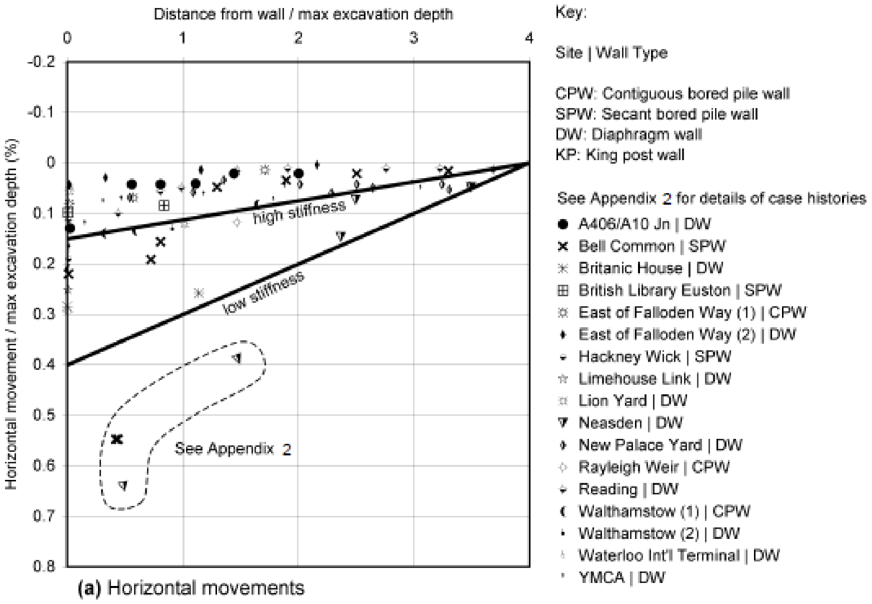


(a) Horizontal movements

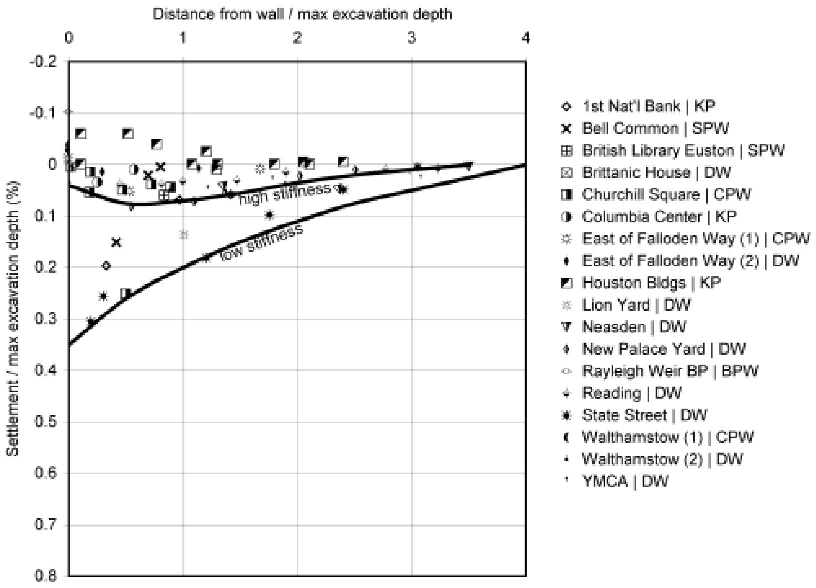


(b) Vertical movements

Figure 11 – Measurements of ground movements due to excavation in front of wall in stiff clay (Reproduced from CIRIA C580, Figure 2.11a and b)

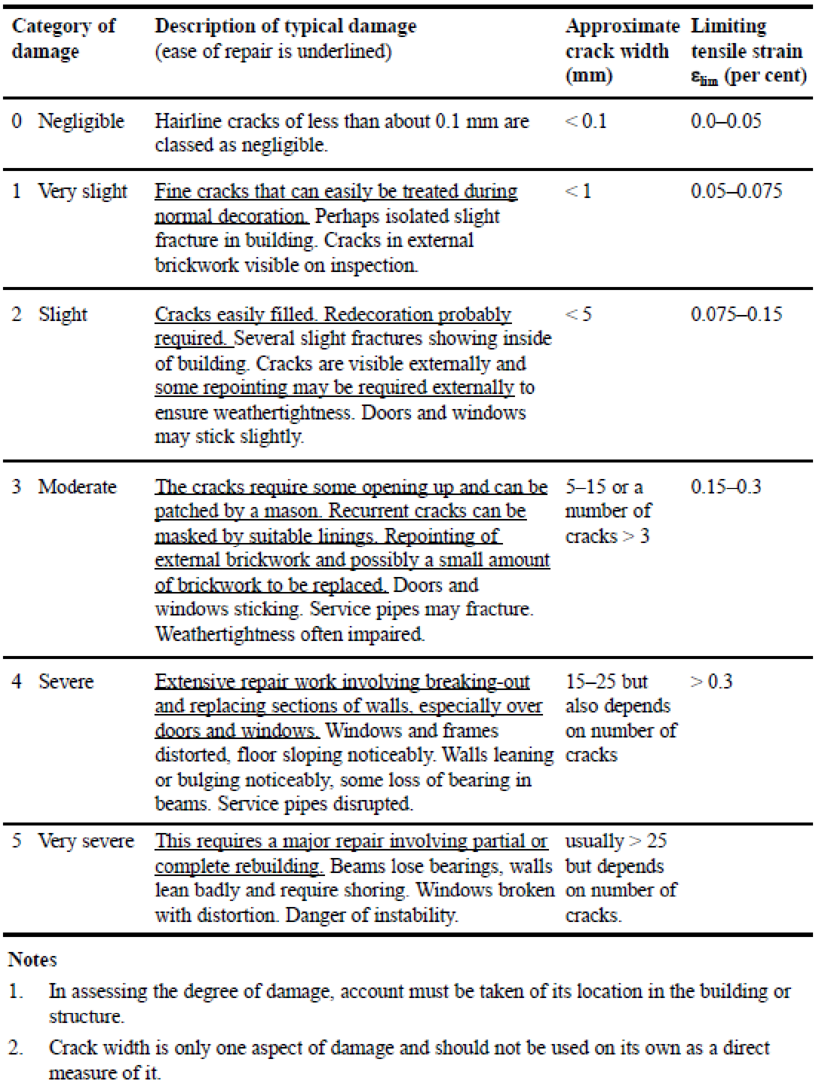


(a) Horizontal movements



(b) Vertical movements

Figure 12 – Damage Classification Chart (Reproduced from CIRIA C580, Table 2.5)



Category of damage	**Description of typical damage** (ease of repair is underlined)	**Approximate crack width (mm)**	**Limiting tensile strain ε_{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.

Appendix A - Factual Report by LMB Geosolutions Limited dated February 2016

LMB GEOSOLUTIONS LTD

FACTUAL REPORT FOR GROUND INVESTIGATION

21 BOSCASTLE ROAD, LONDON NW5

February 2016

DOCUMENT RECORD

Document Title	Factual Report for Ground Investigation
Site	21 Boscatle Road, London NW5 1EE
Document Date	2nd February 2016
Document Version	Issue 2 (updated with elevation data)
Document Authorisation	Philip Lewis BSc (Hons), MSc, CGeol, FGS

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

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Company No. 8303397
LMB Home

TABLE OF CONTENTS

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INTRODUCTION

Introduction

AUTHORISATION

LMB Geosolutions Ltd (LMB) was instructed Fairhurst (Environmental Consultants) on behalf of Ms Barbara Storch & Mr Mayamiko Kachingwe (the Client) in December 2015 to undertake ground investigation works in relation to the proposed development at 21 Boscastle Road, London NW5 1EE (the Site).

PROJECT AND SITE DETAILS

Site Address	21 Boscastle Road, London NW5 1EE. A Site Location Plan is provided as **Figure 1**.
Site Area	<0.5 hectares.
Proposed Development	It is understood that the proposal is to redevelop the existing residential property to include a single storey basement level beneath the footprint of the building.

SCOPE OF WORKS

The scope of works was agreed between LMB and Fairhurst GGA (Environmental Consultants) and included the following:

- Site set up including liaison with Consultant Engineers, Client and appointment of sub-contractors;
- Mobilisation to site and transport of the rig to the proposed location;
- Completion of a service avoidance survey at proposed exploratory hole locations;
- Completion of 1No. cut down cable percussive boreholes to a depth of 15.0m below ground level (bgl) with insitu SPT testing and collection of disturbed and undisturbed samples for laboratory testing.
- Completion of a dynamic sampler borehole to a depth of 6.00m bgl with insitu SPT and DP testing completed to 10.0m bgl with collection of disturbed samples for laboratory testing.
- Completion of 5no. hand excavated trial pits to help observe and record existing foundations and shallow ground conditions;
- Supervision and geological logging of the soil arisings in general accordance with BS5930 by an appropriately experienced geo-environmental engineer;
- Installation of 2no. monitoring well to 5.00m and 10.00m bgl and return monitoring of groundwater levels on 2no.occasions;
- Geotechnical laboratory testing of the soil samples for an appropriate suite of determinands (including pH, sulphate, triaxial testing, atterberg limits, and moisture content);
- Chemical analysis of soil samples for an appropriate suite of determinands, including heavy metals, petroleum hydrocarbons and Waste Acceptance Criteria (WAC);

- Completion of a factual report that will include;
    - A summary of the field works completed.
    - A summary of the ground and groundwater conditions encountered.
    - Schematic sections detailing the existing ground floor slabs and foundations.
    - Geological logs in AGS format.
    - Presentation of chemical analytical results.
    - Presentation of geotechnical laboratory testing results.

PUBLISHED GEOLOGY

Reference to the relevant British Geological Survey map for the area (Sheet 256, Solid and Drift) indicates that the site is located directly on the London Clay Formation (typically silty clay).

LIMITATIONS

LMB has prepared this report solely for the use of the named Client and those parties with whom a warranty agreement and/or assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from LMB and the Client.

LMB accepts no responsibility or liability for:

a) the consequences of this document being used for any purpose or project other than for which it was commissioned, and

b) issue of this document to any third party with whom an agreement has not been executed.

The risk assessment and opinions provided, among other things, take in to consideration currently available guidance and best available techniques relating to acceptable contamination concentrations and interpretation of these values. No liability can be accepted for the retrospective effects of any future changes or amendments to these value.

GROUND INVESTIGATION

Ground Investigation

INTRODUCTION

The ground investigation works were undertaken in two phases. The first phase was completed between 8th December and 10th December 2015 and comprised the progression of 1no. 'cut down' cable percussive borehole and excavation of 4no. hand excavated trial pits, with sampling of soil for laboratory testing

The second phase was completed on 12th January 2016 and comprised progression of a dynamic sampler borehole and excavation of an additional hand excavated trial pit.

An exploratory hole location is provided as **Figure 2**.

Groundwater monitoring was undertaken on completion of the works on 15th January and 29th January 2016.

Details of the ground investigation completed are provided in the following sections. The exploratory hole logs and laboratory results are presented in **Appendix A, B** and **C** respectively.

Guidance Documents

Details of the best practice guidance documents and reference information used in undertaking the ground investigation and assessment are provided at the end of this report (see REFERENCES & GUIDANCE).

INVESTIGATION STRATEGY

The ground investigation was designed based on discussions between LMB and the Environmental Consultants. All works and exploratory holes were supervised and logged by an appropriately experienced chartered geologist in general accordance with BS 5930.

Cable Percussive Boreholes

A single borehole was completed using a modular 'cut down' cable percussive drilling methods to a depth of 15.00m bgl. Disturbed and/or bulk samples were generally collected at regular intervals with Standard Penetration Tests (SPTs) completed at 1.0m intervals in the upper 5m and at 1.5m intervals thereafter. Undisturbed samples were collected at depths of 3.20m, 5.20, 8.20m and 11.20m bgl.

Dynamic (windowless) Sampler Boreholes

A single borehole was completed using dynamic sampling drilling methods to a depth of 10.00m bgl with a continuous percussive hammer. SPTs were completed at 1.0m intervals in the upper 6.0m and continuous Dynamic Probing (DP) was undertaken from 6.0m to 10.0m bgl. Disturbed samples were collected for geotechnical laboratory testing.

GROUND INVESTIGATION

Hand Excavated Trial Pits

Five hand excavated trial pits were completed within the existing property to a maximum depth of 1.30m bgl. One of the locations was undertaken within the existing cellar.

Soil Chemical Analysis & Laboratory Testing

Soil samples were submitted to the UKAS and MCERTS accredited laboratories of i2 Analytical for chemical analysis.

Geotechnical testing of soil samples was undertaken at the UKAS accredited laboratories of K4 soils. Geotechnical testing of soil samples was undertaken at the UKAS accredited laboratories of K4 soils.

All testing was undertaken in accordance with BS 1377:1990 'Methods of test for soils for civil engineering purposes' or other current best practice standards, as appropriate.

SUMMARY OF GROUND & GROUNDWATER CONDITIONS

Ground Conditions

The table below provides a summary of ground conditions encountered with full descriptions provided in the associated exploratory hole logs provided in **Appendix A**:

Strata	Depth Range to Top (m bgl)	Depth Range to (Base (m bgl)	Summary Description
Made Ground	Ground Level	0.50 – 0.90	Within the property the ground surface was generally found to comprise wood flooring over a floor void. In the external locations (BH1 and BH2) the ground surface comprised floor pavers. The Made Ground soils were generally found to comprise sandy slightly gravelly clay with varying proportions of flint, brick and concrete. Beneath the floor boards an upper horizon of gravelly sand was encountered above the clay fill.
London Clay Formation	0.50 – 2.1	10.00 – 15.00(1)	In BH1 the upper horizon of the London Clay (approx. 0.90m to 2.1m) was found to comprise soft to firm clay and to include occasional pyrite and flint gravel, which could be indicative of some re-working via geological processes. The London Clay was found to comprise firm becoming stiff very closely fissured clay.

(1) Base of the London Clay was not determined.

GROUND INVESTIGATION

Groundwater Observations

During drilling of the cable percussive and dynamic sampler boreholes no groundwater strikes/seepages were recorded.

Details are provided on the exploratory hole logs presented in **Appendix A**.

Borehole Elevation

The ground elevation of the borehole location in meters above ordnance datum (m AOD) has been estimated from levels presented on existing Ground Floor and Site drawing (ref. Matrix 14/1887, Sept 2014).

MONITORING AND INSTRUMENTATION

Groundwater monitoring wells were installed in BH1 and BH2 on completion at 10.0m bgl and 5.00m bgl respectively.

Details of the monitoring well installations can be viewed in **Appendix A**, with the groundwater and monitoring results presented in **Appendix D.**

REFERENCES & GUIDANCE

1. Environment Agency/Defra (2002). Model procedures for the Management of Land Contamination (CLR 11)
2. Environment Agency/Defra.. Contaminated Land Statutory Guidance (April 2012)
3. BS 10175 (2011) Investigation of Potentially Contaminated Sites. Code of Practice.
4. BS5930 (2007) Code of Practice for Site Investigations.
5. BS 5667-11:2009. Water quality sampling. Part 11: Guidance on sampling of groundwaters.
6. BS 8002 (1994) Code of Practice for Earth Retaining Structures
7. Tomlinson, M.J. (1986) Foundation Design and Construction.
8. Department of the Environment Industry Profiles.
9. Environment Agency/Defra (2002). Sampling strategies for contaminated land (CLR4)[1]
10. Environment Agency/Defra (2002). Priority Contaminants for the Assessment of Land (CLR8)[2]
11. CIRIA (2007). Assessing risks posed by hazardous ground gases to buildings
12. BS 8485:2007. Code of Practice for the Characterisation and Remediation from Ground Gas in affected Development.
13. NHBC (2007). Guidance on the Evaluation of Development proposals on sites where Methane and Carbon dioxide are present.
14. CL:AIRE (December 2013). Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination.
15. CL:AIRE / CIEH (2008), Guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008;
16. CL:AIRE / EIC (2009), The Soil Generic Assessment Criteria for Human Health, December 2009.
17. Environment Agency (2003), Review of fate & transport of selected contaminants in the Environment, Report P5-079-TR1;
18. Environment Agency (2004), Model Procedures for the Management of Land Contamination, September 2004, ISBN: 1844322955;
19. Environment Agency (2008a), Compilation of Data for Priority Organic Pollutants, Report SC050021/SR7, November 2008;
20. Environment Agency (2009a), Human Health Toxicological Assessment of Contaminants in Soil, Report SC050021/SR2, January 2009;
21. Environment Agency (2009b), CLEA Software (Version 1.04) Handbook (and Software), Report SC050021/SR4, January 2009;
22. Environment Agency (2009c), Updated Technical Background to the CLEA Model, Report SC050021/SR3, January 2009;

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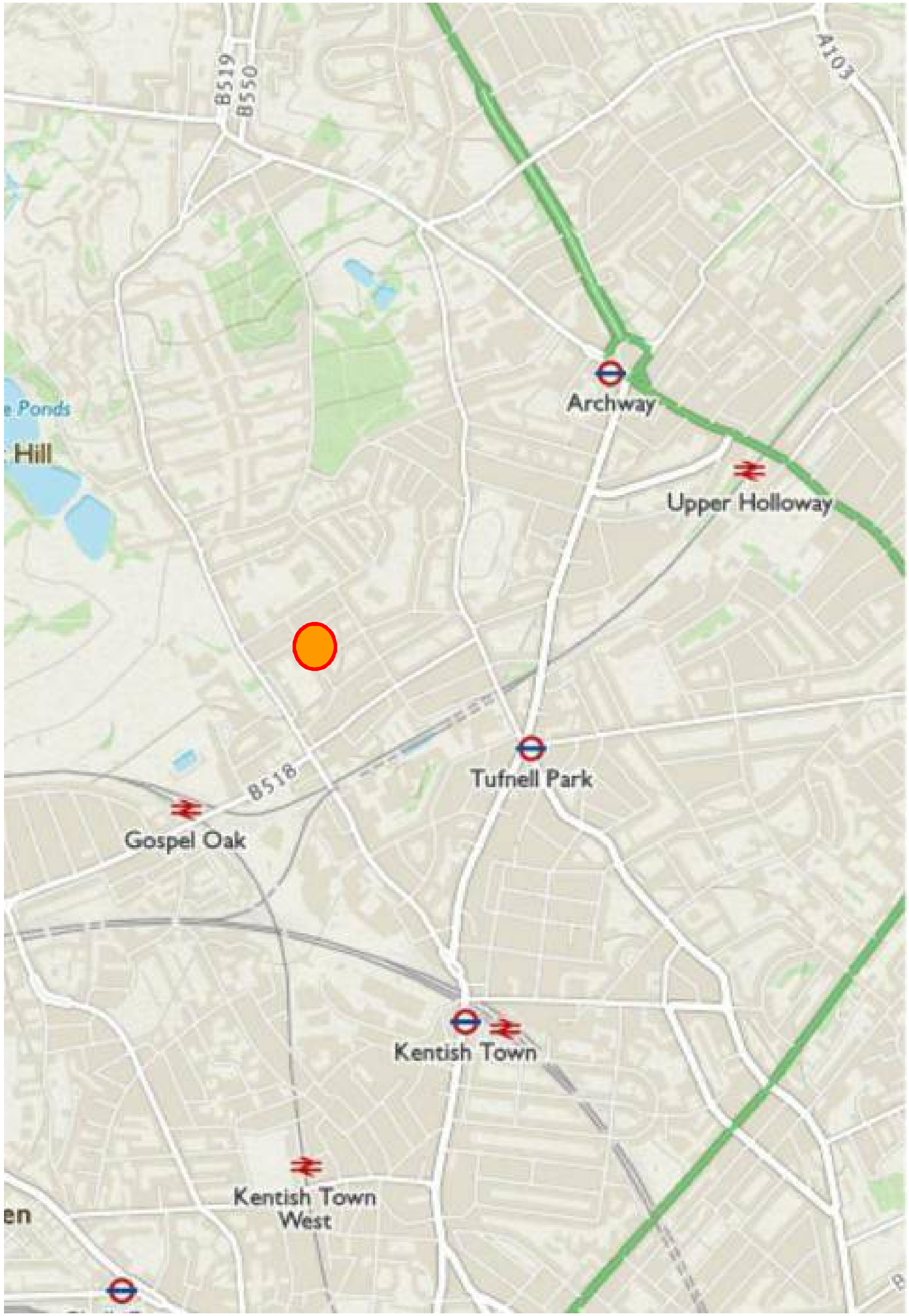
[1] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

[2] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

REFERENCES & GUIDANCE

23. Environment Agency (2009d), A Review of Body Weight and Height Data Used in the CLEA Model, Report SC050021/Final Technical Review 1, January 2009;
24. Nathanial et. al., (2009), The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition), Land Quality Press, Nottingham, ISBN 0-9547474-7-X
25. USEPA (2004), User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings
26. Environment Agency (2013). Groundwater Protection: Principles and Practice (GP3)
27. Water Framework Directive (2000/60/EC)
28. Groundwater Regulations (2009).
29. Drinking Water Quality Standards England & Wales 2000 (Amended 2004, DWS).
30. World Health Organisation (WHO) Petroleum Products in Drinking Water.
31. Environmental Quality Standards (EQS). The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
32. Environment Agency (2006). Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.
33. Environment Agency (2013). Technical Guidance WM2 (v3). Interpretation of the definition and classification of hazardous waste.

FIGURES



N

Key:

● Approximate site location.

IMPORTANT – Please Read

This drawing is for illustrative purposes only and is for use only in conjunction with associated reports relating to the project details below. LMB accepts no liability for the mis-interpretation or use of this illustration by any other parties.

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

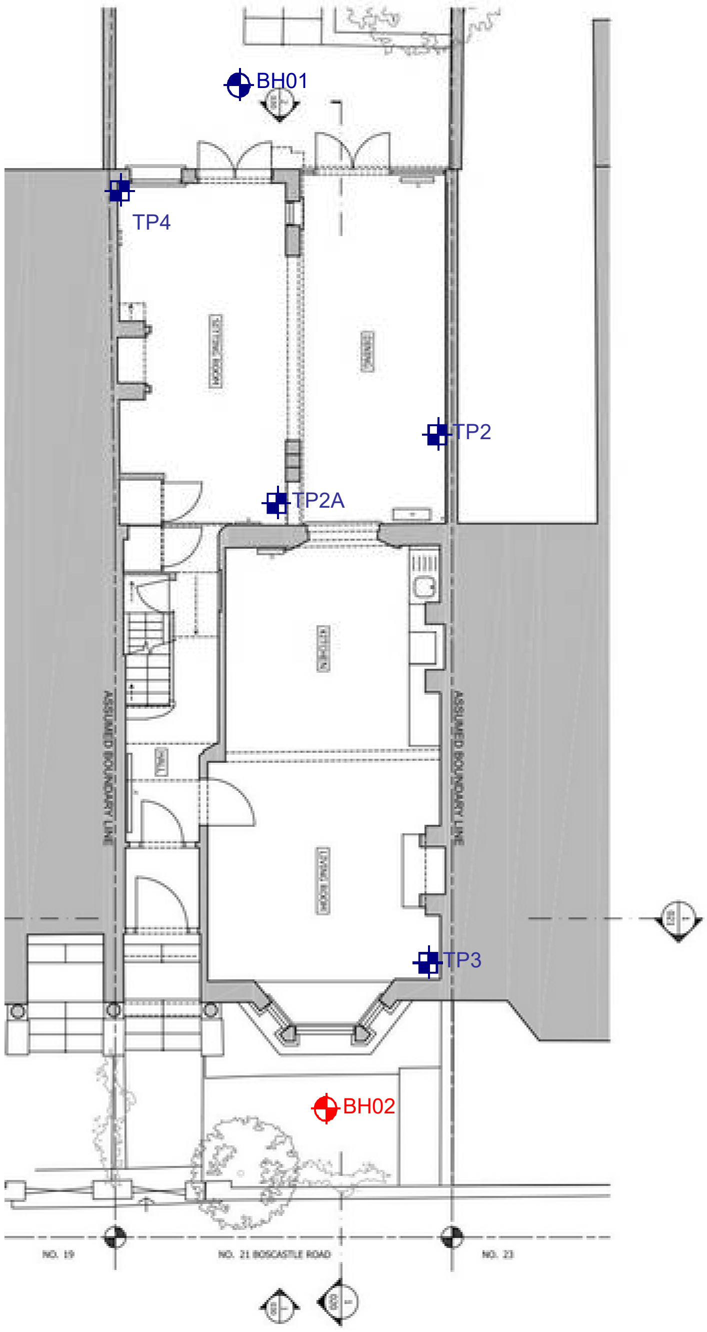
Site: 21 Boscastle Road, London NW5

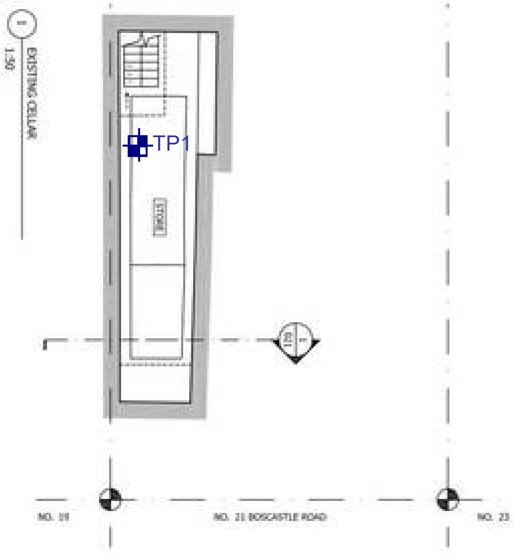
Figure Number: Figure 1

Title: Site Location Plan

Project No:	**Created By:**	**Date:**
	PIL	Jan 2016

Client: Fairhurst GGA





Key:

BH	Cable percussive borehole.
BH	Dynamic (windowless) sampler borehole.
TP	Hand excavated trial pits.

IMPORTANT – Please Read

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Hydrogeology
Engineering Geology

Site: 21 Boscastle Road, London NW5

Figure Number: Figure 2

Title: Exploratory Hole Location Plan

Project No:

Created By: PIL

Date: Jan 2016

Client: Fairhurst GGA

APPENDICES

Appendices

LMB
Ground Investigation
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Borehole Log

Borehole No.	**BH1**
Sheet 1 of 2	
Project Name:	21 Boscastle Road
Project No.	LMB_Boscatle
Co-ords:	-
Hole Type	CP
Location:	London NW5
Level:	53.27
Scale	1:50
Client:	Ms Barbara Storch & Mr Mayamiko Kachingwe
Dates:	09/12/2015 - 10/12/2015
Logged By	

Samples and In Situ Testing

Depth (m)	Type	Results
0.50	ES	
0.70	D	
1.00		N=13 (1,0/1,4,4,4)
1.00	D	
1.70	D	
2.00		N=12 (3,2/3,3,3,3)
2.00	D	
2.70	D	
3.20	U	
3.70	D	
4.00		N=19 (4,4/5,4,5,5)
4.00	D	
4.70	D	
5.20	U	
5.70	D	
6.50		N=24 (4,5/5,6,6,7)
6.50	D	
8.20	U	
9.50		N=31 (5,6/6,7,8,10)
9.50	D	

Depth (m)	Level (m)	Stratum Description
0.04	53.23	Pavers.
0.06	53.21	MADE GROUND: brown fine to medium sand.
0.60	52.67	MADE GROUND: brown to dark brown sandy gravelly clay with numerous brick cobbles. Gravel sub-angular to sub-rounded fine to coarse brick and rare concrete.
0.90	52.37	MADE GROUND: brown with grey mottling clay with rare sub-rounded to rounded fine to medium brick and flint gravel.
1.70	51.57	Soft brown with grey mottling CLAY. (POSSIBLY REWORKED LONDON CLAY).
2.10	51.17	Firm brown with orange/brown mottling slightly gravelly CLAY. Gravel sub-angular to sub-rounded medium to coarse flint and occasional pyrite. (POSSIBLY REWORKED LONDON CLAY).
3.50	49.77	Firm becoming stiff brown with occasional blue/grey veining CLAY. (LONDON CLAY).
		Stiff brown with occasional blue/grey veining CLAY. Some close fissuring observed. *becoming very closely fissured with occasional orange/brown mottling and blue/grey veining.*

Continued on next sheet

Remarks

Borehole Log

Borehole No. **BH1** Sheet 2 of 2		
Project Name: 21 Boscastle Road	Project No. LMB_Boscatle	Co-ords: -
Hole Type CP		
Location: London NW5	Level: 53.27	Scale 1:50
Client: Ms Barbara Storch & Mr Mayamiko Kachingwe	Dates: 09/12/2015 - 10/12/2015	Logged By

Well	Water Strikes	**Samples and In Situ Testing**			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		11.20	U					
		12.50	D					
					13.00	40.27		Stiff dark grey CLAY with occasional fine shell gravel. Very closely fissured. (LONDON CLAY).
		13.50		N=36 (6,6/8,8,9,11)				
					15.00	38.27		End of borehole at 15.00 m

Remarks

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Borehole Log

Borehole No.	**BH2**
Sheet 1 of 2	
Project Name:	21 Boscastle Road
Project No.	LMB_Boscatle
Co-ords:	-
Hole Type	WLS
Location:	London NW5
Level:	52.31
Scale	1:50
Client:	Ms Barbara Storch & Mr Mayamiko Kachingwe
Dates:	12/01/2016 - 12/01/2016
Logged By	

Well	Water Strikes	Samples and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	
					0.05	52.26		Paving stone.	
					0.10	52.21		MADE GROUND: yellow/brown medium sand (sub-base).	
					0.30	52.01		MADE GROUND: brown to dark/brown sandy slightly gravelly clay. Gravel sub-angular to sub-rounded fine to medium flint, rare chalk and brick.	
		0.40	ES						
					0.50	51.81		MADE GROUND: brown with orange/brown and grey mottling slightly gravelly clay with rare brick fragments. Gravel sub-rounded fine to coarse flint.	
		1.00		N=6 (1,1/2,1,1,2)					1
		1.00	SPTLS						
					1.60	50.71		Soft becoming firm brown with orange/brown and grey mottling CLAY with occasional rootlets. (LONDON CLAY).	
		2.00		N=9 (1,2/2,2,2,3)					2
		2.00	SPTLS					Firm brown with blue/grey veining CLAY. (LONDON CLAY).	
								grey moderately strong calcareous mudstone nodule.	
								some close fissuring observed.	
		3.00		N=11 (2,2/2,3,3,3)				*orange/brown silty fine sand parting.*	3
		3.00	SPTLS						
					3.50	48.81		Stiff brown with blue/grey veining CLAY. Very closely fissured with rare selenite crystals. (LONDON CLAY).	
		4.00		N=15 (3,3/3,3,4,5)				*pocket of orange/brown medium to coarse sand - slightly damp.*	4
		4.00	SPTLS						
		4.60	U					*rare very fine shell gravel.*	
		5.00		N=15 (3,3/3,4,4,4)				*no blue/grey veining visible but rare selenite crystals*	5
		5.00	SPTLS						
		6.00		N=21 (3,3/4,5,5,7)					6
		6.00	SPTLS						
									7
									8
									9
					10.00	42.31			10

Continued on next sheet

Remarks

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Borehole Log

Borehole No.
BH2
Sheet 2 of 2

Project Name: 21 Boscastle Road
Project No. LMB_Boscatle
Co-ords: -
Hole Type WLS

Location: London NW5
Level: 52.31
Scale 1:50

Client: Ms Barbara Storch & Mr Mayamiko Kachingwe
Dates: 12/01/2016 - 12/01/2016
Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Refusal on hard substrate. End of borehole at 10.00 m	
									11
									12
									13
									14
									15
									16
									17
									18
									19
									20

Remarks

AGS

Ground Investigation
Land Contamination
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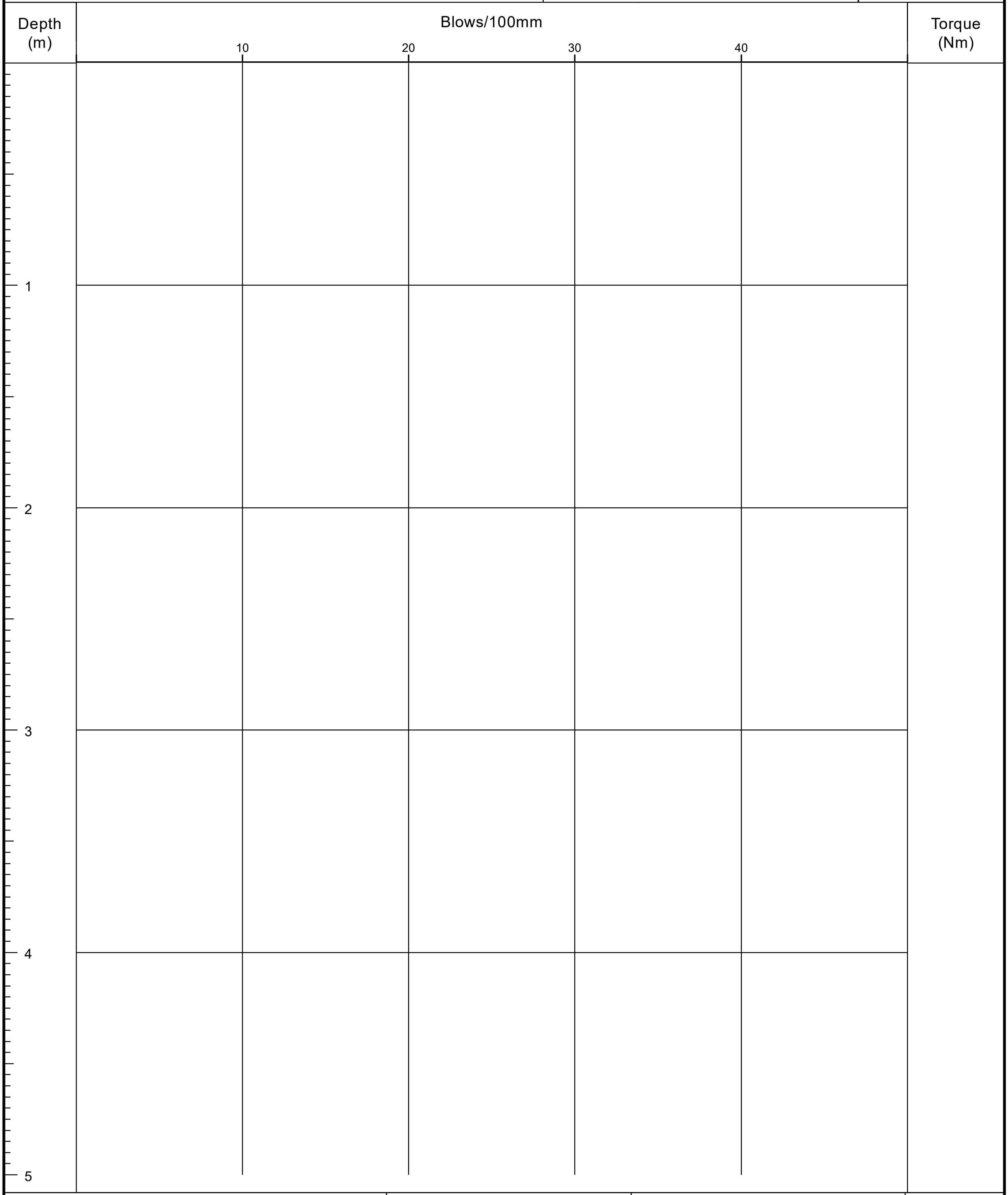
Probe Log

Borehole No.
BH2_DP
Sheet 1 of 2

Project Name: 21 Boscastle Road	Project No. LMB_Boscatle	Co-ords: -	Hole Type DCP
Location: London NW5		Level: 52.31	Scale 1:25
Client: Ms Barbara Storch & Mr Mayamiko Kachingwe		Dates: 12/01/2015 -	Logged By



Remarks	Fall Height	Cone Base Diameter
	Hammer Wt	Final Depth 10.00
	Probe Type DPSH- A	Log Scale 1:25

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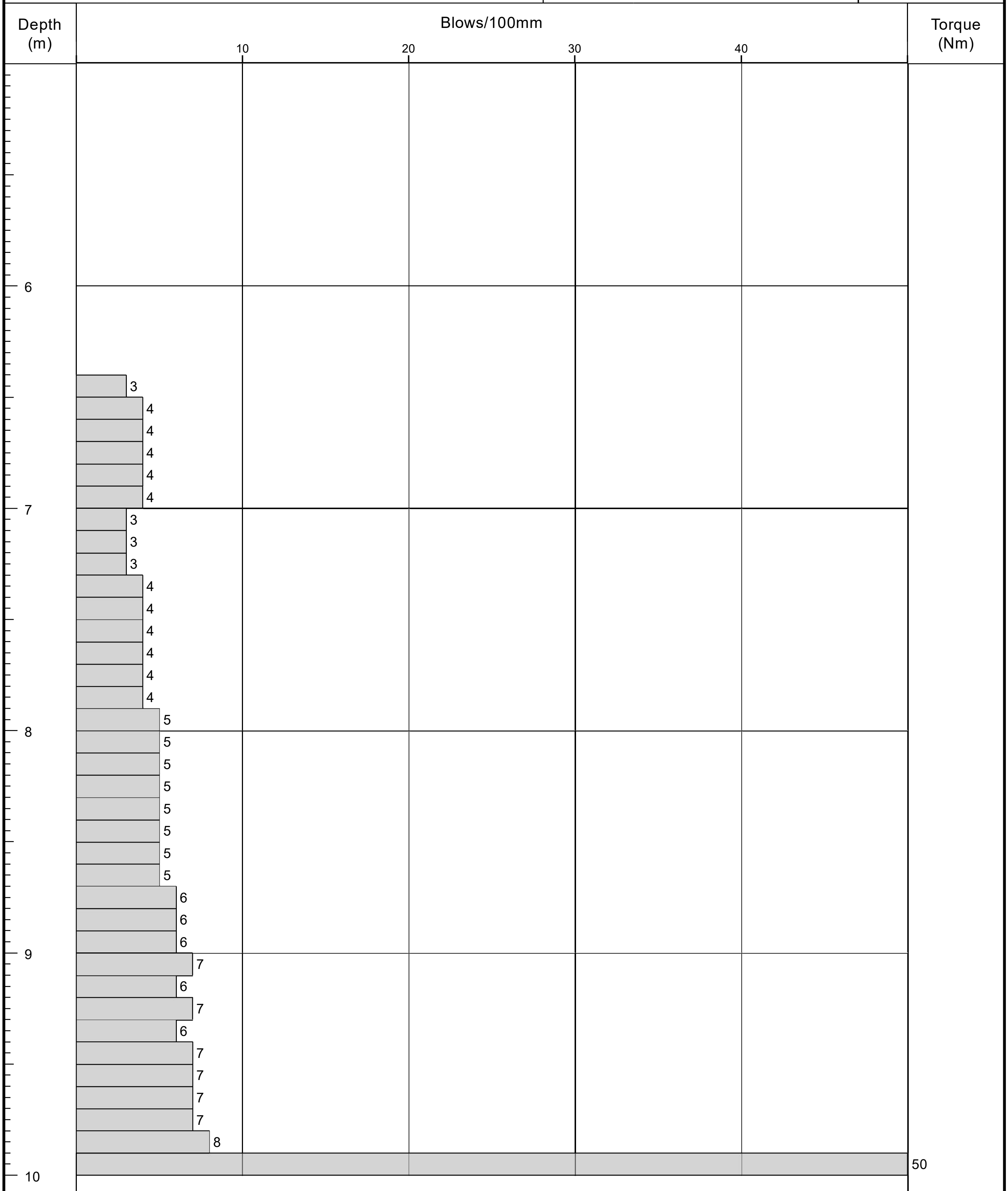
Probe Log

Project Name: 21 Boscastle Road	Project No. LMB_Boscatle	Co-ords: -	Borehole No. **BH2_DP** Sheet 2 of 2
			Hole Type DCP
Location: London NW5		Level: 52.31	Scale 1:25
Client: Ms Barbara Storch & Mr Mayamiko Kachingwe		Dates: 12/01/2015 -	Logged By



Remarks	Fall Height	Cone Base Diameter
	Hammer Wt	Final Depth 10.00
	Probe Type DPSH- A	Log Scale 1:25