11th March 2014

Rob van der Valk
Flat 1, 85 Greencroft Gardens
LONDON
NW6 3LJ

Our Ref: 401-04869-00001

Dear Rob

RE: 85 GREENCROFT GARDENS – HYDROLOGY REPORT FOR BASEMENT IMPACT ASSESSMENT

SLR Consulting has been appointed to carry out the groundwater and surface water components of a Basement Impact Assessment (BIA) for the basement development at Flat 1, 85 Greencroft Gardens, as required by Camden Planning Guidance CPG4 'Basements and Lightwells'.

The SLR staff involved in the preparation of this letter includes two hydrogeologists with the Chartered Geologist qualification and one hydrologist who is a Chartered Civil Engineer and holds a Masters Degree in Hydrology, as required by section 2.10 of CPG4.

1.0 PROJECT INFORMATION FOR SCREENING PROCESS

CPG4 states that the BIA should start with a Screening Process, and that where the answers to any of the questions in the flowcharts are 'YES' OR 'UNKNOWN', these matters will need further investigation. Paragraph 233 of 'Guidance for Subterranean Development', LBC, 2010, indicates that the following summary information should be included in the BIA Screening Process.

1.1 Brief Description of the Development

The basement development involves the construction of a basement beneath the whole of the property as shown in Drawing 13-499-SK-402, and includes deepening the current shallow cellar which is beneath the western side of the property only, and which is shown in Drawing 13-499-P-010. The proposed basement would have a floor level approximately 3m below ground floor level, and would include lightwells at the front and western side of the property outside the current building footprint. The proposed basement would also extend to the rear beneath current areas of decking and soft garden. There is a slight slope down from north to south i.e. from front to rear of the property, with the front end of the rear garden approximately 0.6m lower than the front drive, and the rear garden falling by a further approximately 0.5m to the rear.

1.2 Construction Programme

The key phases of construction are understood from Michael Chester and Partners structural engineers to be:

- excavation of soil for the basement extension;
- construction of concrete underpinning beneath the existing house footings where necessary;
- reinforced concrete retaining walls to the new basement perimeter;
- construction of new concrete floor slab; and
- application of a waterproof membrane over the concrete structure tanking the new basement.

2.0 GROUNDWATER FLOW

2.1 Subterranean (Groundwater) Flow Screening Flowchart Questions

Q1a: Is the site located directly above an aquifer?

SLR Response: **NO.** The available published information[1] indicates that the application site is located on London Clay, which is not an aquifer. The nearest geological boundary is approximately 1km north-east of the site, as shown in Drawing 001.

The site geology was confirmed by February 2104 site investigation involving excavation of four trialpits and drilling of two 5m deep boreholes at the site (locations and logs appended to this letter). The site geology is summarised in Table 1 below.

Table 1 – Site Geology based on Site Investigation

metres below ground floor FFL	**TP1**	**BHA**	**BHB**	**TP2-4**
Topsoil	0.5 – 0.7 m	Paving	1.1 – 1.3 m	Started deeper
Silty Clay Made Ground	0.7 – 1.25 m	0.7 – 1.9 m	1.3 – 1.7 m	2.2 – 2.6m[a]
Firm weathered London Clay	1.25 – 1.5 m	Not present	1.7 – 2.4m	Not present
Stiff weathered London Clay	Not reached	1.9 – 3.0 m	2.4 – 4.3m	2.6 – 2.85m
Very Stiff In Situ London Clay	Not reached	3.0 – 5.5 m	4.3 – 6.1m	Not reached
Comments on Water	Not recorded	Dry	Dry	Not recorded

Note: the elevations shown in this table assume that ground floor FFL is 0.5m above front/side ground level, 1.1m above rear garden level at borehole BHB, and 2.2m above existing cellar floor level
[a] – these trialpits through the current cellar floor indicate that the underlying local thin Made Ground is sandy silt

Q1b: Will the basement extend beneath the water table surface?

SLR Response: **NO**. As stated in the response to Q1, the geological map indicates that the site is located on London Clay, which does not contain an effective water table due to its low permeability. This was confirmed by the lack of groundwater encountered during drilling at boreholes BHA and BHB in February 2014, which it is noted was a time of generally very high groundwater levels due to historic winter rainfall.

[1] Based on Figure 8 of 'Guidance for Subterranean Development' showing the areas of aquifer and the 1994 British Geological Survey geological map (Sheet 256 North London, reproduced as Figure 4 of 'Guidance for Subterranean Development', LB Camden, 2010).

Q2: Is the site within 100m of a watercourse, well (used/disused) or potential springline?

***SLR Response:* UNKNOWN.** The nearest potential springline is approximately 1km north-east of the site at the boundary of the more permeable Claygate Beds, as discussed in Q1a above. Figure 2 of 'Guidance for Subterranean Development' indicates that no wells were present within 100m in 1920, and the British Geological Survey Geoindex http://maps.bgs.ac.uk/GeoIndex/default.aspx confirms that this remains the case.

The available information regarding watercourses within 100m, which would only be culverted underground watercourses as no surface watercourses are indicated on current maps, is contradictory as summarised in Drawing 001, and comprises:

- watercourses 'visible' or 'concealed' (i.e. culverted) in 1920 as shown on Figure 2 of 'Guidance for Subterranean Development';
- watercourses shown (rather indistinctly) on 1871 historical map with similar locations to those shown in the 1920 map in Figure 2;
- location of Thames Water storm relief sewers near the site, which are likely to be the culverts carrying the abovementioned watercourses; and
- the approximate watercourse locations indicated by Figure 11 of 'Guidance for Subterranean Development', which is considered[2] less accurate than the other sources of information above.

Q3: Is the site within the catchment of the pond chains on Hampstead Heath?

***SLR Response:* NO,** as indicated in Figure 14 of 'Guidance for Subterranean Development' (LBC, 2010).

Q4: Does the basement development result in a change in the proportion of hard surfaced/paved areas?

***SLR Response:* YES.** The basement footprint is proposed to extend outside the current building footprint in the following areas:

- side lightwell – as this area is currently an unpaved gravel path, the side lightwell would lead to an increase in hard surfaced areas;
- rear of current footprint – significant unpaved areas including lawn and bedding would be replaced by hard surfaced areas.

Q5: As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)

***SLR Response:* NO.** Due to the extended footprint of the property at the side and rear, there would be less rainfall infiltration into the ground at the rear than at present.

Q6: Is the lowest point of the excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or springline.

[2] In telephone conversation between Nick Humfrey (Sustainability Officer, LB Camden) and Phil Slater (SLR) on April 4th 2013 it was agreed that the watercourse locations shown in Figure 11 may not be very accurate

SLR Response: **NO.** As discussed in Q2, based on the local geology any nearby potential springline would be approximately 1km north-east of the site. Based on the Ordnance Survey 1:25000 map[3] and satellite mapping[4], there are no ponds in close proximity to the site.

2.2 Subterranean (Groundwater) Flow Scoping and Impact Assessment

2.2.1 Introduction

As the response to Q2 in the Subterranean (Groundwater) Flow Screening regarding nearby watercourses was UNKNOWN, and the response to Q4 was YES, it is necessary to proceed to further stages of the BIA. As detailed in CPG4 and chapter 6 of 'Guidance for Subterranean Development', these further stages involve presentation of a conceptual ground model, additional site investigation (if necessary) and identification of potential impacts. Site investigation carried out by Michael Chester structural engineers in February 2014 (as summarised in section 2.1 above) facilitated the development of the conceptual ground model and impact assessment.

2.2.2 Conceptual Ground Model and Potential Impacts

Geology

The available published information indicates that the application site is located on London Clay, as detailed in Q1a above. Site investigations confirmed that this is the case as detailed in section 2.1 above. Available published information also indicates that the geological boundary with the silty clays and sandy silt of the Claygate Member is approximately 1km north-east of the site.

Site investigations indicated that the natural geology at the application site is covered by silty clay Made Ground up to approximately 1.5m thick. This is underlain by up to 2.6m thickness of firm to stiff weathered London Clay overlying the very stiff unweathered London Clay.

Hydrogeology

The hardstanding to the front of the property drains to the road, hence the main rainfall infiltration to ground is in the rear garden. Any rainfall infiltration in the rear garden is most likely to seep laterally in the topsoil and underlying Made Ground towards the lower-elevated garden to the south, rather than vertically down into the low permeability underlying weathered London Clay. Any water infiltrating deeper into the weathered London Clay is likely to gather as perched water on top of the very low permeability unweathered London Clay.

As discussed in section 2.1 above, there is contradictory information available regarding the proximity of a nearby watercourse. It is considered likely that the nearest culverted watercourse flows in the Thames Water storm relief sewer which crosses beneath the road at 65 Greencroft Gardens i.e. approximately 100m north-east of no.85. However, based on the approximate watercourse locations indicated by Figure 11 of 'Guidance for Subterranean Development' (which is considered[5] less accurate than the other sources of information

[3] OS Explorer 173 'London North'

[4] Google Maps accessed February 10th 2014

[5] In telephone conversation between Nick Humfrey (Sustainability Officer, LB Camden) and Phil Slater (SLR) on April 4th 2013 it was agreed that the watercourse locations shown in Figure 11 may not be very accurate

above) it is possible that there is a culverted underground watercourse flowing to the south only 15m east of the site, as shown in Drawing 001.

Site investigation indicated weathered London Clay beneath all parts of the site – there is no indication of any change of lithology which would be expected in the immediate proximity of a watercourse. The level of the base of the Made Ground around the no.85 site (excluding the current cellar footprint) is approximately 1.5-1.9m below ground floor finished floor level, (i.e. approximately 1.1-1.6m below the road surface). Any nearby culverted underground watercourse is likely to be at a greater depth than both the road drains (which are typically at least 1m below the road surface) and probably than the combined sewer (which is likely to be at least 2.5m below the sidepath elevation hence over 2m below the road surface). Hence the pathway for any potential seepage between the nearest culverted underground watercourse and the basement at no.85 would be likely to be well below the base of the Made Ground through London Clay i.e. a low permeability pathway. The potential risks are discussed in section 3.3.6 of the Flood Risk Assessment below.

Assuming in fact that the nearest culverted underground watercourse is the Thames Water storm relief sewer crossing Greencroft Gardens some 100m to the north-east of the site, as shown on Drawing 001, then the relative elevations are such that the top soffit of that culvert is likely[6] to be lower than the elevation of the basement at 85 Greencroft Gardens.

The above conceptual model indicates that there not likely to be any significant seepages of underground water between the nearest culverted underground watercourse and the basement at 85 Greencroft Gardens.

Potential Impacts of Basement on Subterranean (Groundwater) Flow

The potential impacts of the basement on groundwater flow are as follows (the first two listed is mentioned in Appendix F2 of LB Camden's 2010 'Guidance for Subterranean Development' for sites where there is a watercourse within 100m and an increase in hard surfaced areas):

- '*the flow in a watercourse may increase or decrease if the groundwater flow regime which supports that water feature is affected by a proposed basement'* – as any underground water seepages between the basement at 85 Greencroft Gardens and the nearest watercourse would be through low permeability London Clay, such seepages are likely to be negligible, and changes in seepages due to the presence of the basement would also be negligible;
- '*the sealing of the ground surface by pavements and buildings to rainfall will result in decreased recharge to the underlying ground. In areas of non-aquifer (i.e. on the London Clay) this may mean changes in the degree of wetness which in turn may affect stability'* – the proposed loss of infiltration from an additional over 60m^2 of ground surface at the rear and side of the property could cause a slight reduction in subsurface moisture. However, as the subsurface beneath these proposed features is very stiff unweathered London Clay in which the extended building would be founded, any change in subsurface moisture is likely to be negligible. Based on the opinion of Michael Chester and Partners structural engineers, this is not considered likely to affect the stability of no.85. The nearest wall of neighbouring buildings is approximately 3m away from the area of additional hard surface, hence the local minor reduction in

[6] The road elevation at no.65 is (based on OS contours) at least 2m lower than at no.85, while the underground culvert at no.65 appears to be more than 2.5m below the road surface. The no.85 basement is over 2.5m lower than the road surface at no.85, i.e. likely to be at least 2m higher than the elevation of the underground culvert at no.65.

subsurface moisture at no.85 is also not considered likely to affect stability of neighbouring buildings, based on the opinion of Michael Chester and Partners structural engineers;

- the basement could divert any seepages of perched water towards other nearby cellars or basements by partially blocking the pathway for perched water – any such seepages are likely to be negligible due to the low permeability of the London Clay.

Mitigation Measures

As no potential groundwater impacts of any significance have been identified, it is concluded that no mitigation measures are required in relation to groundwater flows.

3.0 SURFACE FLOW AND FLOODING

3.1 Surface Flow and Flooding Screening Flowchart Questions

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

SLR Response: **NO,** as indicated in Figure 14 of 'Guidance for Subterranean Development' (LBC, 2010).

Q2: As part of the site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?

SLR Response: **NO.** Currently, surface water drainage from the application site enters Thames Water combined sewers under Greencroft Gardens. Whilst some minor amendments may be made to the routing of surface water runoff via the private drains at the side of the property, no material effect would be anticipated at the receiving combined sewer.

As discussed in **Groundwater Flow Q4**, it is proposed to increase the extent of hard surfaced/paved areas. Without mitigation, the potential impact of this increase is evaluated below.

The effective areas of increased hard surfaced areas are as follows:

- side lightwell – although rainfall on the areas of the side lightwell to be covered in structural glass would drain to the gravel path, the side basement terrace in the uncovered areas would form an additional 14m^2 of hard surfaced area;
- rear basement patio – this would form an additional 12.5m^2 of hard surfaced area;
- basement roof under proposed ground floor main decked terrace – this area would be an additional 32m^2 of hard surfaced area;
- roof of master bedroom extension – this would be an additional 8m^2 of hard surfaced area; and
- basement roof under proposed ground floor decking patio behind master bedroom – this area would be an additional 6.5m^2 of hard surfaced area.

CIRIA SUDS Manual C697 recommends that the Wallingford Modified Rational method (WMRM) is applied to areas of hardstanding to determine the discharge rate, Q in l/sec. The WMRM specified is given as:

$$Q = C_v \times C_r \times (2.78 \times i \times A)$$

where:

C_v = Volumetric Runoff Coefficient taken as 0.75

C_r = Constant routing factor taken as 1.3

i = rainfall intensity taken as 98.5mm hr^{-1} for a 30 minute rainfall event with an annual probability of occurrence of 1% (1 in 100) based on the Flood Estimation Handbook CD-ROM Depth Duration Frequency model.

A = Additional total net impermeable area = 0.0073ha

Applying the WMRM results in a potential uplift in peak flow of 1.92 ls^{-1}.

However, Sur 1 of the Code for Sustainable Homes (CfSH) states:

> '*Where the pre-development peak rate of run-off for the site would result in a requirement for the post-development flow rate (referred to as the limiting discharge) to be less than 5 l/s at a discharge point, a flow rate of up to 5 l/s may be used where required to reduce the risk of blockage.'*

Guidance contained in the CfSH therefore suggests that attenuation of the additional runoff is not required. Nevertheless, it is proposed that the following mitigation measures are provided to reduce the rate of runoff from additional areas of hard surface:

- side and rear basement terrace areas (total 26.5m^2) – it is proposed to pump rainwater from these areas to current drains, however to compensate for this it is proposed that runoff from the existing ground floor flat roof of the master bedroom area (approximately 30m^2) would no longer drain to site drains, but to an oversized rainwater harvesting unit, with adequate storage to stop stormwater runoff being immediately discharged to drainage, and rainwater being used for irrigation and flushing toilets. SLR understands that this oversized rainwater harvesting unit would be located beneath the landscaped area between the steps behind the proposed ground floor main decked terrace;
- additional roof area of master bedroom extension (8m^2) - it is proposed that runoff from this area would also drain to the oversized rainwater harvesting unit beneath the landscaped area as mentioned above;
- basement roof under proposed ground floor main decked terrace (32m^2) – it is proposed that runoff from this area would also drain to the oversized rainwater harvesting unit beneath the landscaped area as mentioned above. The total oversize spare capacity of the rainwater harvesting unit should be enough to take a 1 in 100 year 30 minute rainfall event falling on a total area of 70m^2 i.e. 3.5 m^3 ;
- basement roof under proposed ground floor decking patio behind master bedroom (6.5m^2) – it is proposed to drain this area via a gravel attenuation pathway to a small rain garden soakaway.

Therefore, whilst there would be an increase in the hard surfaced/paved area at the rear of the property, the proposed mitigation measures would ensure that the proposals would have no material impact on the current surface water drainage to combined sewers beneath Greencroft Gardens.

Q3: Will the basement development result in a change in the proportion of hard surfaced/paved areas?

SLR Response: **YES.** The proposed basement development would result in the loss of approximately 73m^2 of sidepath gravel/soil and rear garden lawn/soil which would be replaced by hard surfaces. However, it is proposed in mitigation that additional stormwater runoff would be attenuated by oversized rainwater harvesting units, and a gravel attenuation pathways leading to a small rain garden soakaway as described in response to **Surface Flow Q2**. As detailed in the response to Q2 above, the proposed mitigation measures would ensure that the proposals would have no material impact on the current drainage arrangements.

Q4: Will the 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?

SLR Response: **NO.** Please refer to the response to **Surface Water Q2** above.

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

SLR Response: **NO.** The pumping of rainfall incident on basement terrace areas to site drainage, and the temporary storage of runoff from flat roof areas to oversized rainfall harvesting units before being discharged to site drainage, are not likely to result in changes to the quality of surface water received by downstream watercourses.

Q6: Is the site in an area known to be at risk from surface water flooding?

SLR Response: **UNKNOWN.** The table on page 29 of CPG4 indicates that Greencroft Gardens flooded in 1975 and 2002, however this does not necessarily mean that the whole length of the road flooded. The EA website indicates that the nearest area to no.85 at risk of surface water flooding is approximately 100m north-east along Greencroft Gardens, designated as 'low risk'.

3.2 Surface Flow and Flooding Scoping

As the response to Q3 in the Surface Flow and Flooding Screening regarding hard surfaced areas is YES, it is necessary to proceed to further stages of the BIA.

3.2.1 Potential Impacts related to Change in the Proportion of Hard Surfaced Areas

Appendix F1 of LB Camden's 2010 'Guidance for Subterranean Development' states the following in relation to potential impacts due to changes in the proportion of hard surfaced areas:

'*A change in the proportion of hard surfaced or paved areas of a property will affect the way in which rainfall and surface water are transmitted away from a property. This includes changes to the surface water received by the underlying aquifers, adjacent properties and nearby watercourses. Changes could result in decreased flow, which may affect ecosystems or reduce amenity, or increased flow which may additionally increase the risk of flooding'*.

Calculations presented in the response to Surface Flow Q2 above indicate that the potential uplift in peak runoff for a 1 in 100 year rainfall event would be 1.92 l/sec. Guidance contained in the Code for Sustainable Homes (CfSH) suggests that attenuation of additional runoff less than 5 l/sec is not required.

Nevertheless, it is proposed that the proposed additional ground floor and basement roof areas would be drained to oversized rainwater harvesting units and a small rain garden soakaway, which would attenuate stormwater runoff and ensure that there is no additional discharge to public drains. Additional discharge to public drains from the proposed basement terraces would be compensated by a larger area of existing ground floor flat roof being drained to oversized rainwater harvesting units rather than discharging immediately to public drains.

Therefore, whilst there would be an increase in the hard surfaced/paved area at the side and rear of the property, the proposed mitigation measures would ensure that the proposals would have no material impact on the current surface water drainage to combined sewers beneath Greencroft Gardens.

3.3 Flood Risk Assessment

As the response to question Q6 above was UNKNOWN, a Flood Risk Assessment is required.

It is recognised that developments that are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. Current guidance on development and flood risk[7][8] identifies several key aims for a development to ensure that it is sustainable in flood risk terms. These aims are as follows:

- the development should not be at a significant risk of flooding and should not be susceptible to damage due to flooding;
- the development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, are threatened;
- normal operation of the development should not be susceptible to disruption as a result of flooding;
- safe access to and from the development should be possible during flood events;
- the development should not increase flood risk elsewhere;
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences;
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk. The responsibility for any operation and maintenance required should be clearly defined;
- future users of the development should be made aware of any flood risk issues relating to the development;
- the development should not lead to degradation of the environment; and
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change.

To achieve the aims outlined above, a staged approach has been adopted in undertaking this Flood Risk Assessment (FRA), in accordance with current best-practice guidance. A screening study has initially been undertaken to identify whether there are any potential sources of flooding to the application site which may warrant further consideration. Any potential flooding issues identified in the screening study have subsequently been considered in a scoping study. The aim of the scoping study is to define the input data requirements and study methodologies required to technically assess each of the flood risks and if appropriate include within the development proposals suitable measures to mitigate these..

[7] CIRIA, 2004, Funders Report CP/102 Development and Flood Risk – Guidance for the Construction Industry
[8] National Planning Policy Framework and Technical Guidance to the National Planning Policy Framework, (CLG March 2012)

The FRA has been completed with due regard to the EA's Flood Risk Standing Advice (FRSA) for use by planning applicants and their agents[9].

3.3.1 Site Location

The application site is approximately 0.05ha in size and is located in a densely built-up area with a slight topographic slope to the south-east with an average slope[10] of approximately 1 in 50. As shown in Drawing 001, the site is bounded to the east and west by dwellings with gardens, to the south by a garden, and to the north by the road Greencroft Gardens. The road slopes slightly down from west to east, with a gradient immediately downslope of no.85 of approximately 1 in 50. The property immediately west (no. 87) is at a slightly higher elevation (approximately 0.2m higher) than no.85, while the property immediately east (no.83) is at the same elevation. The site to the south is at an elevation approximately 0.5m lower.

The nearest watercourse, as indicated in Drawing 001, is a culverted underground watercourse most likely to be approximately 100m to the north-east. There is no EA flood zone[11] associated with these underground watercourses, and the site lies within a Zone 1 – low probability flood risk area (Flood Zone 1) as defined by Table 1: Flood Zones of the Technical Guidance (TG) to the National Planning Policy Framework (NPPF). Flood Zone 1 is defined as land where the annual risk of fluvial and/or tidal flooding is less than 1 in 1,000 (0.1%) As the site is less than 1ha and in a Flood Zone 1, it would not normally require a FRA, however, Camden Planning Guidance CPG4 'Basements and Lightwells' requires in Section 2.41 that all applications for basement developments in streets where there was surface water flooding in 1975 or 2002 (as listed on page 29 of CPG4) should include a FRA. This list includes Greencroft Gardens.

3.3.2 Basement Development

The basement development involves the construction of a basement beneath the whole of the property as shown in Drawing 13-499-P-010, and includes deepening the current shallow cellar which is beneath the western side of the property only, as shown in Drawing 13-499-SK-402. The proposed basement would include lightwells at the front and western side of the property outside the current building footprint. The proposed basement would also extend to the rear beneath current areas of decking and soft garden.

3.3.3 Screening Study of Potential Flood Risk

All potential sources of flooding must be considered for any development. A summary of the potential sources of flooding and a review of the potential risk posed by each source at the application site is presented in Table 1.

Table 2 - Potential Risk Posed by Flooding Sources

Potential Source	Potential Flood Risk at Site?	Justification
Fluvial flooding	No	EA Flood Mapping shows Flood Zone 1. Distance

[9] Environment Agency, April 2012, FRSA for use by planning applicants and their agents, http://www.environment-agency.gov.uk/research/planning/82587.aspx accessed 24 April 2013.
[10] Based on spacing of 2m OS contours
[11] EA website http://maps.environment-agency.gov.uk/ reviewed on 9th April 2013

		from nearest surface watercourse >1km
Tidal flooding	No	Site location is 'inland' and topography > 40mAOD.
Flooding from rising / high groundwater	No	Site is located on low permeability London Clay.
Surface water (pluvial) flooding	Yes	Recorded in unspecified part of Greencroft Gardens in 1975.
Flooding from infrastructure failure	Yes	Drainage at or near the site could potentially become blocked or cracked and overflow or leak. Drainage of the basement terrace areas may rely on pumping.
Flooding from reservoirs, canals and other artificial sources	No	There are no reservoirs, canals or other artificial sources in the vicinity of the site that could give rise to a flood risk.

3.3.4 Scoping Study

The screening study indicates that the only significant flood risk to the new development arises from a surface water (pluvial) flooding and/or a failure (principally blockage) of the existing public sewers and/or culverted watercourses in the vicinity of the site. Additional information has therefore been gathered to evaluate the flood risk from these sources, including completion of a site visit by SLR on 14th February 2014.

3.3.5 Surface Water (Pluvial) Flooding

Potential Surface Water Flooding affecting the Application Site

Any surface water runoff generated along the length of Greencroft Gardens west of the site could cause overland flow to occur down Greencroft Gardens along the road past the front of no.85 to the lower part of the road further north-east. The low point of the road is a 150m long portion (over 100m north-east of no.85) drained by gully pots, where the road elevation is approximately 2m lower than outside no.85 (based on OS contours). This lowpoint 100m north-east of the site is shown on the draft Camden West Area surface water flood risk map[12] (included in the Appendix to this letter) as a blue polygon, indicating potential standing water due to surface water flooding, and is also indicated as a small localised area of 'low risk' on the EA website map of surface water flood risk.

It is recorded in CPG4 that Greencroft Gardens suffered surface water flooding in 1975 and 2002, although there are no records to indicate which part of the road was affected. Discussions[13] with drainage staff at LB Camden indicate that the surface water flooding is likely to have been caused by the limited capacity of the local storm relief sewer network at the time. It is understood that the storm relief sewer running from north to south crossing beneath Greencroft Gardens at no.65 (approximately 150m north-east of no.89, as indicated on Drawing 001) drained at that time into a 250mm diameter pipe beneath the railway line to the south. During extreme rainfall events in 1975 and 2002 it is understood that the 250mm pipe had insufficient capacity to drain the upstream network of sewers including those serving Greencroft Gardens. Hence both the storm relief sewer and combined trunk sewers in surrounding roads backed up resulting in temporary surface water flooding at localised low points on surrounding roads such as the low point[14] between no.65 Greencroft Gardens and the junction of Greencroft Gardens and Fairhazel Gardens over 100m further north-east.

[12] Provide by Nick Humfrey (LB Camden, Sustainability Officer) in email on 25th April 2013
[13] Telephone conversation between Graham Jasper (LB Camden) and Phil Slater (SLR) on 26th March 2013
[14] This lowpoint can also be seen from the OS contours on Drawing 1.

It is understood[13] that in 2005 the 250mm diameter pipe beneath the railway line was upgraded to 1.5m diameter, hence the likelihood of the local network backing up during extreme rainfall events in the future is considered to be much reduced.

Most adjacent areas have a similar or lower elevation to the no.85 site, however surface water runoff could potentially reach the site from the following external areas:

- the front drive of no.87 Greencroft Gardens is approximately. 0.3m higher than that at no.85, however the current boundary wall would divert runoff from the drive to the road;
- the sidepath of no.87 (surface area approximately 40m^2) is approximately 0.1m higher than the sidepath of no.85, but there is a boundary restricting runoff towards no.85;
- additional runoff from the no.87 sidepath could develop if roof drainage water overspilled in the event of a blockage at the base of any of the three downpipes (draining a total roof area of approximately 200m^2) which feed into drains beneath the sidepath of no.87, however the boundary should feed this runoff away from no.85 and towards the rear garden.

During basement construction, it is recommended that rainwater entering the excavation from above be pumped out to the existing site surface water drainage system, with a settlement tank as necessary to remove excessive suspended fines.

Potential Surface Water Flooding caused by Development

The basement development is unlikely to cause increased surface water flooding at adjoining properties. As discussed in Q3 of section 3.1 of the Surface Water Flow Screening above, the net runoff from the site would not be increased by the basement development.

3.3.6 Flooding from Infrastructure Failure

Public Sewer Failure

The Sewer Flooding Incidents map[15] in the North London Strategic Flood Risk Assessment indicates that in the South Hampstead area there were approximately 5 sewer flooding incidents between 1997-2007.

If either the Greencroft Gardens combined trunk sewer or the storm relief sewer crossing beneath Greencroft Gardens were in the future to be blocked, or the capacity of the drainage were to be exceeded, the following sequence of events would be likely to occur:

- the storm relief sewer itself would reach capacity and surcharge;
- the combined trunk sewer along Greencroft Gardens would similarly reach capacity and surcharge ;
- excess flow from the storm relief sewer would start to spill out through gullys and manholes onto Greencroft Gardens in the vicinity of no. 65, and initially flood the low point area from no.65 north-eastwards towards Fairhazel Gardens;
- excess flow from the Greencroft Gardens combined trunk sewer would start to spill out of gullys along the lowest area of the road between no.65 and Fairhazel Gardens;
- excess flow would then drain from the lowest area of Greencroft Gardens down the slope of Fairhazel Gardens to the south.

[15] Map 13 Sewer Flooding Incidents by Postcode 1997- 2007 in 'North London Strategic Flood Risk Assessment', Mouchel, 2008

It is therefore considered unlikely that floodwaters would accumulate to sufficient depth at the low point in Greencroft Gardens near no. 65 to reach the threshold level of no.85 Greencroft Gardens which is at least 2m higher (based on OS contours). The general rise along Greencroft Gardens to the west and the rise from the kerb line to the threshold of no.85 are shown by Figures 1 and 2 respectively.

Road Drainage Failure

During an extreme event, the capacity of the gullys that drain the road surface may be exceeded, in which case surface water runoff would flow along the surface of the road following the local topography. As discussed above, such flows would drain to the north-east towards the low point at no. 65 Greencroft Gardens. It is considered highly unlikely that any such flow would be of sufficient depth to reach the threshold of no. 85 Greencroft Gardens which is approximately 0.3m above the road surface. It is noted that the draft Camden West Area surface water flood risk map indicates a localised area of potential surface water flooding due to a local topographic low point at houses 90m north-west of the site, however, this has no bearing on the flood risk to the new basement construction at no.85.

Figure 1
Looking up towards 85 from Lowpoint

Figure 2
Threshold of no.85 above Road

In the event of underground leakage from the trunk sewer discussed in section 3.3.5 above, there could be significant leaks into the ground in the immediate vicinity. However, any such leaks are not likely to result in significant underground water seepages from the trunk sewer to the vicinity of the basement at no. 85 Greencroft Gardens as the underground pathway for any such seepages is formed of low permeability clay, as discussed in section 2.2.2 above. In the event of a blockage or capacity exceedance in the trunk sewer, the sewer would surcharge spilling onto the road and any flow would be down the road to the north-east as described in section 3.3.5 above.

Site Drainage Failure

As pumping would be required to pump rainfall from basement terrace areas up to the site drains shortly after storm events, there is a risk that the pumping system could fail and the units could overflow if there was more heavy rain soon after the storm event. In such a case, the depth of flooding would increase slowly and water would not be flowing, therefore the risk to life would be minimal however the risk to the property may be considerable.

It is recommended that the following flood resilience measures be considered around the basement terrace areas:

- a dual pumping system to ensure that pumping can continue when necessary, even if one pump breaks down - it is understood that a remote alarm system would be in place to ensure that prompt action is taken when necessary if a pump malfunctions;
- the levels of all thresholds into the property should be set at least 300mm above the exterior ground levels to offer protection against floodwater ponding outside the building;
- all electrical and communications services to be routed from ceiling down rather than floor up; and
- tiles are recommended rather than carpets for flooring in the basement rooms.

It is proposed to check and service the pumping system on a regular basis. As the basement terrace areas are not likely to flood quickly to significant depth, regular checking of the pumping system should be adequate to avoid the risk of flooding the basement.

In the event of blockage of site drainage, it is possible that water could pond in subsurface weathered London Clay immediately around the basement. As most of the proposed basement would have no external windows or doors and it is understood that the basement would be completed with adequate tanking, the only area where drainage leaks could enter the basement is likely to be the side basement terrace areas. As discussed above, any additional water entering the side basement terrace area would be collected by the proposed pumping system. Any water ingress from blocked site drainage reaching the basement side terrace through weathered London Clay is likely to be limited due to the low permeability of the weathered London Clay.

To summarise, it is considered unlikely that the failure of any existing drainage systems would result in a significant flood risk to the new basement development.

3.3.7 Summary of Flood Risk Assessment

In summary, it is considered unlikely that surface water runoff is a significant flood risk to the new basement and the development itself would not increase the risk of flooding elsewhere.

3.4 Mitigation Measures

As detailed in section 3.3.5 above, it is considered that the development would not increase the risk of flooding elsewhere, hence no management of off-site impacts is required.

4.0 SUMMARY AND CONCLUSIONS

This letter report has presented the Basement Impact Assessment screening responses for groundwater flow and for surface flow / flooding.

As the responses to Q2 and Q4 of the groundwater flow screening were UNKNOWN and YES respectively, it was considered necessary to proceed to develop a groundwater flow scoping and impact assessment as required by the Basement Impact Assessment methodology laid out in CPG4. The groundwater flow impact assessment examined three potential risks revealed by the groundwater flow scoping. The potential risk of significant changes in seepages to or from the nearest culverted underground watercourse due to the basement was found to be negligible due to the low permeability of the weathered London Clay. Similarly, the potential risk of the basement diverting significant seepages towards other nearby basements was also found to be negligible due to the low permeability of the weathered London Clay. The risk of stability impacts was found to be negligible as the proposed extended no.85 building would be founded in very stiff unweathered London Clay (in which no significant change in moisture content is likely), and the nearest wall of neighbouring buildings which could theoretically be affected by local minor reduction in moisture content in weathered London Clay due to the area of additional hard surface at no.85 is approximately 3m away, hence stability is unlikely to be affected.

As the response to Q3 of the surface flow screening was YES, it was considered necessary to proceed to develop a surface flow scoping. The risk of increased surface water flows due to an increase in the hard surfaced/paved area was assessed, but the proposed mitigation measures would ensure that the proposals would have no material impact on the current surface water drainage to combined sewers beneath Greencroft Gardens.

As the response to Q6 was UNKNOWN due to previous surface water flooding in Greencroft Gardens in 1975 and 2002, it was considered appropriate to undertake a FRA. The Flood Risk Assessment examined two potential risks. The potential risk from surface water (pluvial) flooding or flooding from the failure and/or blockage of existing drainage systems was found not to be significant. However, as a precaution the basement is to undergo waterproof tanking. Regular checking and servicing of any overflow pumps for the basement terrace sumps is recommended as a mitigation measure to avoid the possibility of basement terrace overflow after heavy rains causing flooding of the basement. Provision should also be made during excavation for rainwater entering the excavation from above to be pumped out to the existing site surface water drainage system, with a settlement tank as necessary to remove excessive suspended fines.

The FRA therefore demonstrates that the basement development would be safe for its lifetime and would not increase the risk elsewhere as required by the National Planning Policy Framework and associated Technical Guidance[8].

5.0 CLOSURE

This report has been prepared by SLR Consulting Limited with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Rob van der Valk; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

Yours sincerely
SLR Consulting Limited

P. M. Slater

Phil Slater CGeol	**Derek Armitage**
Associate Hydrogeologist	Technical Director - Hydrologist

Enc Drawing 13-499-SK-402– Proposed Basement Plan
Drawing 13-499-P-010: Existing Ground Floor and Cellar Plans
Drawing 001 – Local Geology and Hydrology
February 2014 Site Investigation Key Plan and Logs
Camden West Area 1 in 75 Year Surface Water Flood Risk Map (Draft)

Stub stack installed in corner to allow future conversion to en-suite.

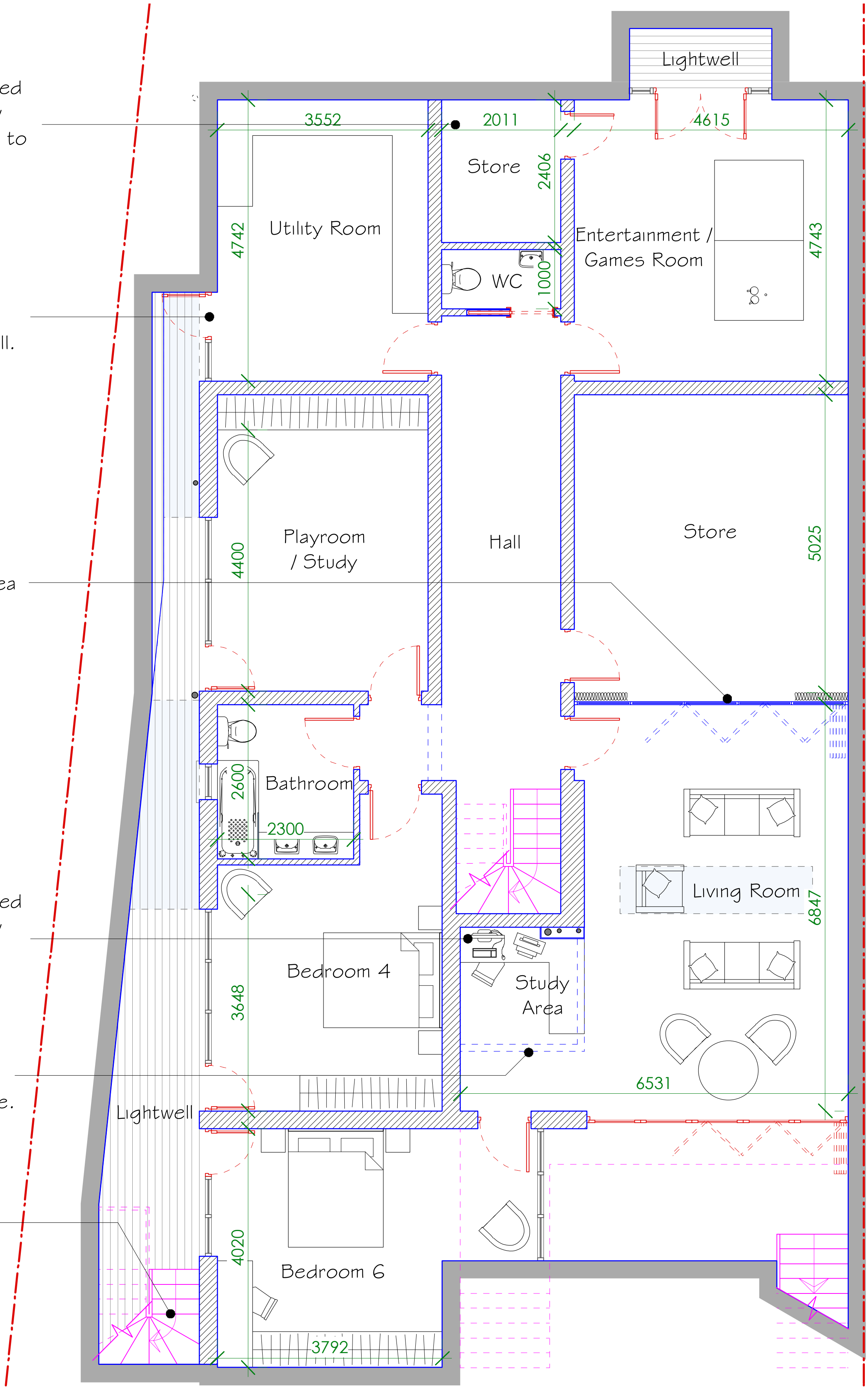
Utility Room with direct access to sheltered lightwell.

Movable Wall between Cinema Room & Living Area with curtains to Cinema side

Stub stack installed in corner to allow future conversion to en-suite.

Partition can be installed in future to create En-suite.

Access steps to Ground Level.



Areas:
Total Existing Area = 141 sq/m
Proposed Ground Floor = 151 sq/m
Proposed Basement = 201 sq/m
Total Proposed Area = 352 sq/m

Proposed Basement Plan

Scale: 1:100 @ A4

scale bar 0 1 2 3 4 5 6 7 8 9 10m

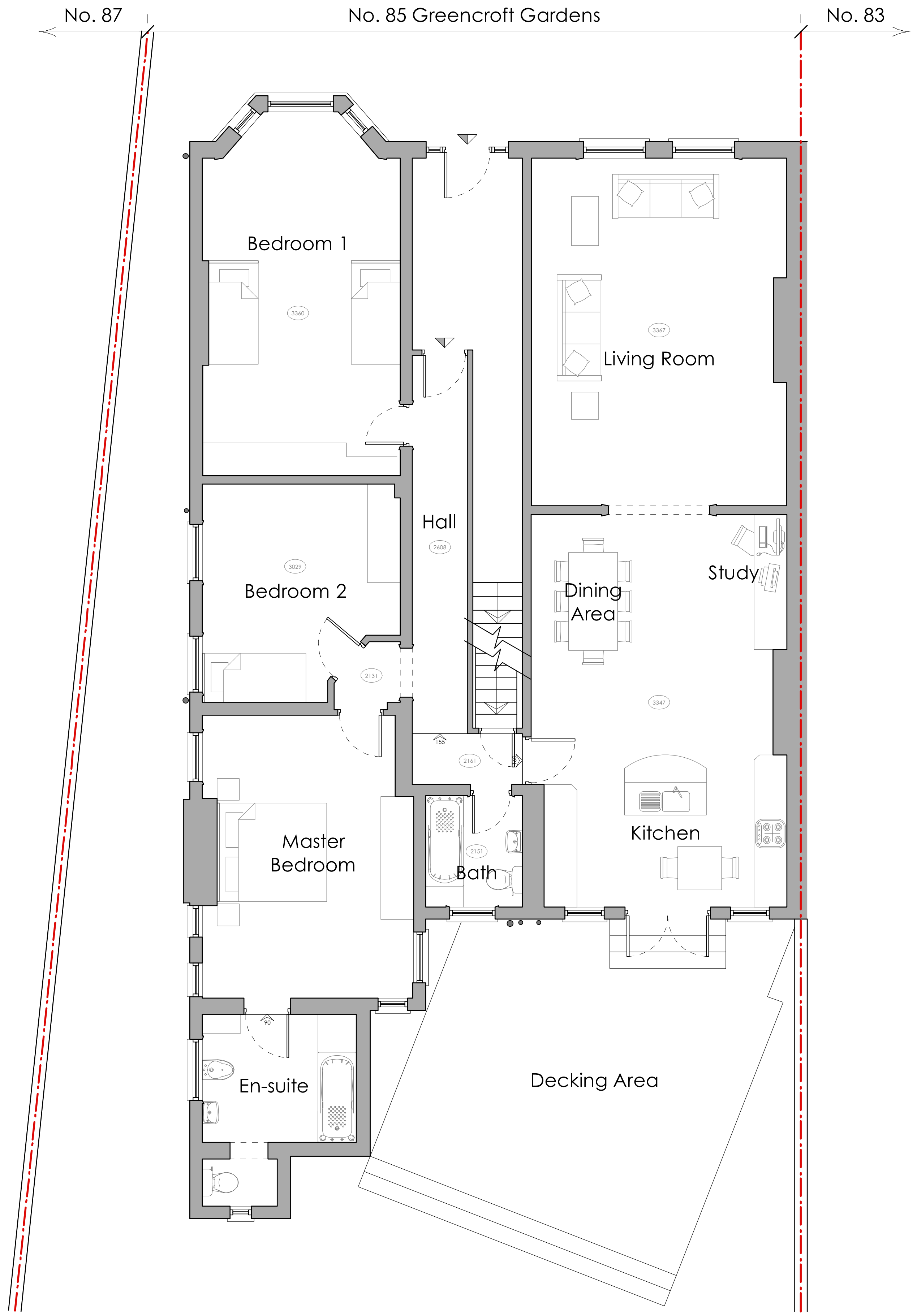
Flat 1, No. 85 Greencroft Gardens, London NW6 3LJ

13-499-SK-402

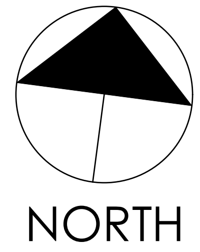
Proposed Basement Plan - Rev. F

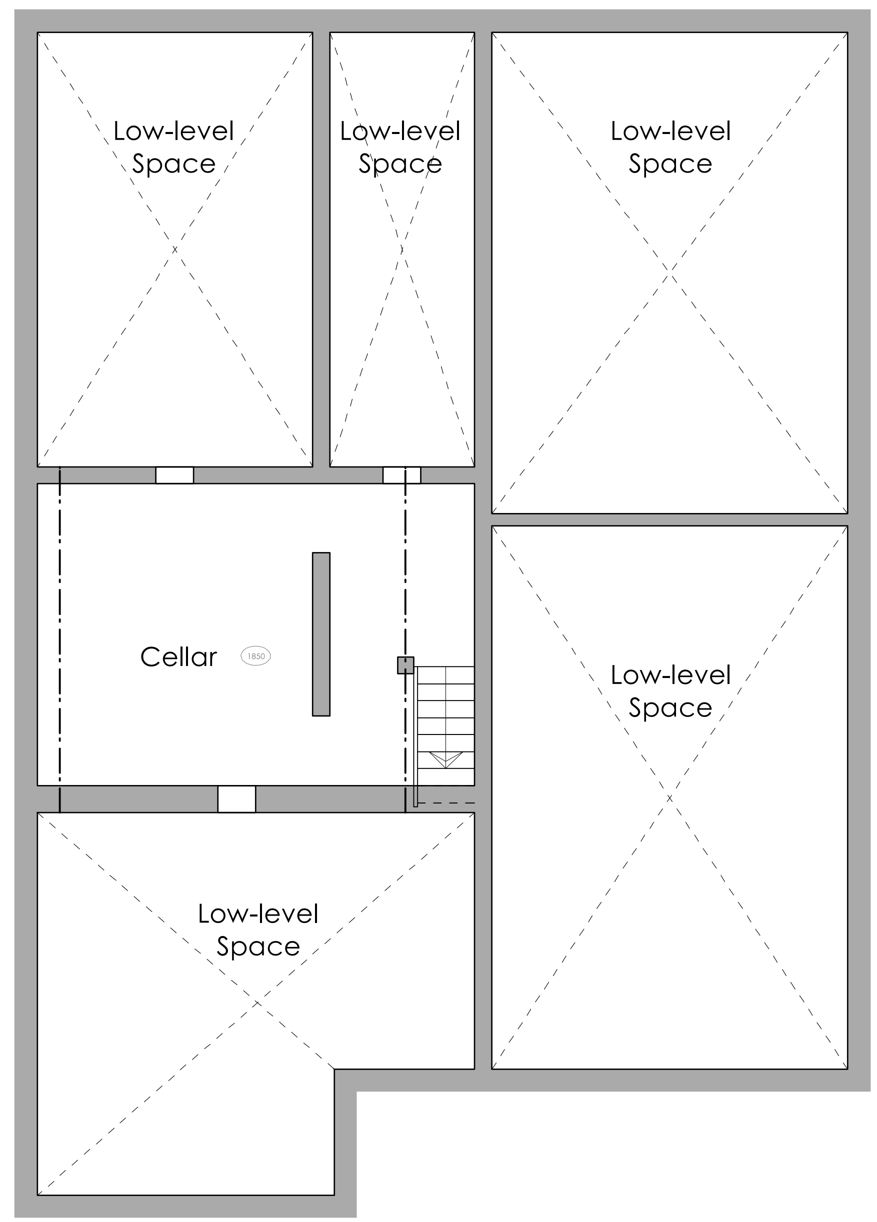
healycornelius design consultancy
5 St. John's Lane, London **EC1M 4BH**
020 7404 7771 info@healycornelius.com

November 2013



1 P-010 **Existing Ground Floor Plan**
scale 1:100 @ A3





2 P-010 **Existing Cellar Plan**
scale 1:100 @ A3

PLANNING

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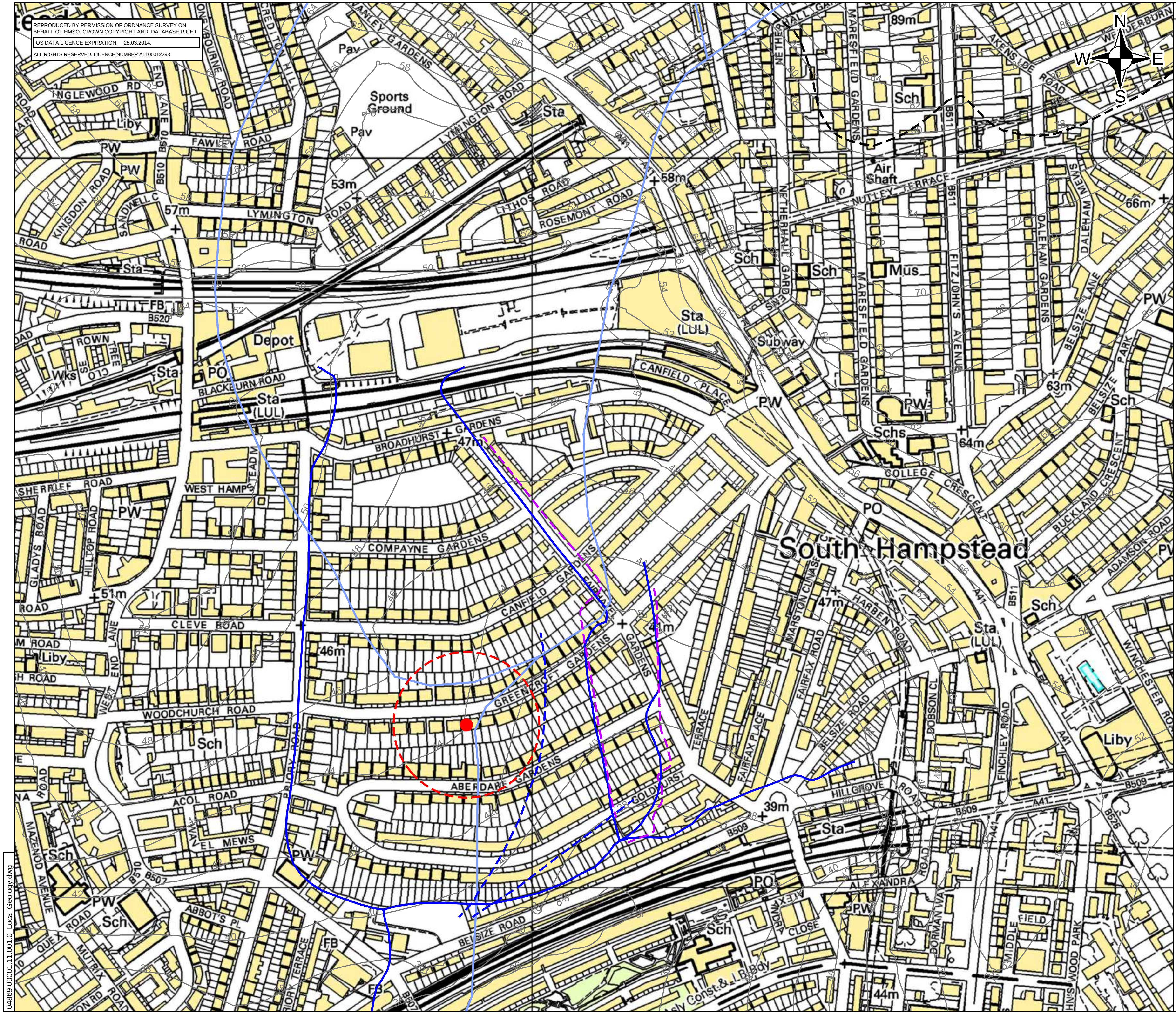
CIAT

Drawing Title:	**Existing Ground Floor & Cellar Plan**
Client:	Van Der Valk & de Bona
Job Title:	Flat 1, No. 85 Greencroft Gardens, London NW6 3LJ
Scale:	1:100 @ A3
Date:	13 Mar. 2014
Drawn:	MOK
Drawing Number:	**13-499-P-010**
Rev:	-



NOTES

●	SITE - 85 GREENCROFT GARDENS
red dashed line	100m OFFSET BOUNDARY
70	SURROUNDING OS LEVEL CONTOURS (mOAD)
blue line	WATERCOURSE LOCATION AS SHOWN 1920 GEOLOGICAL MAP IN RELATION TO ROADS
purple dashed line	WATERCOURSE LOCATION AS SHOWN 1871 MAP
blue dashed line	NEARBY STORM RELIEF SEWERS (INFORMATION FROM THAMES WATER WEBSITE)
light blue line	WATERCOURSE LOCATION AS PER BARTON - LOST RIVERS OF LONDON (ONLY UNDERGROUND WATERCOURSES FLOWING WITHIN 500m OF SITE SHOWN)
black dashed line	GEOLOGICAL BOUNDARY - AS PER BGS 1994 GEOLOGICAL MAP SHEET 256

Revision	By	Chk'd By	Date	Comments
0	KW	PS	02/14	

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Site
85 GREENCROFT GARDENS
LONDON. NW6 3LJ

Project
BASEMENT IMPACT ASSESSMENT

Drawing Title
LOCAL GEOLOGY & HYDROLOGY

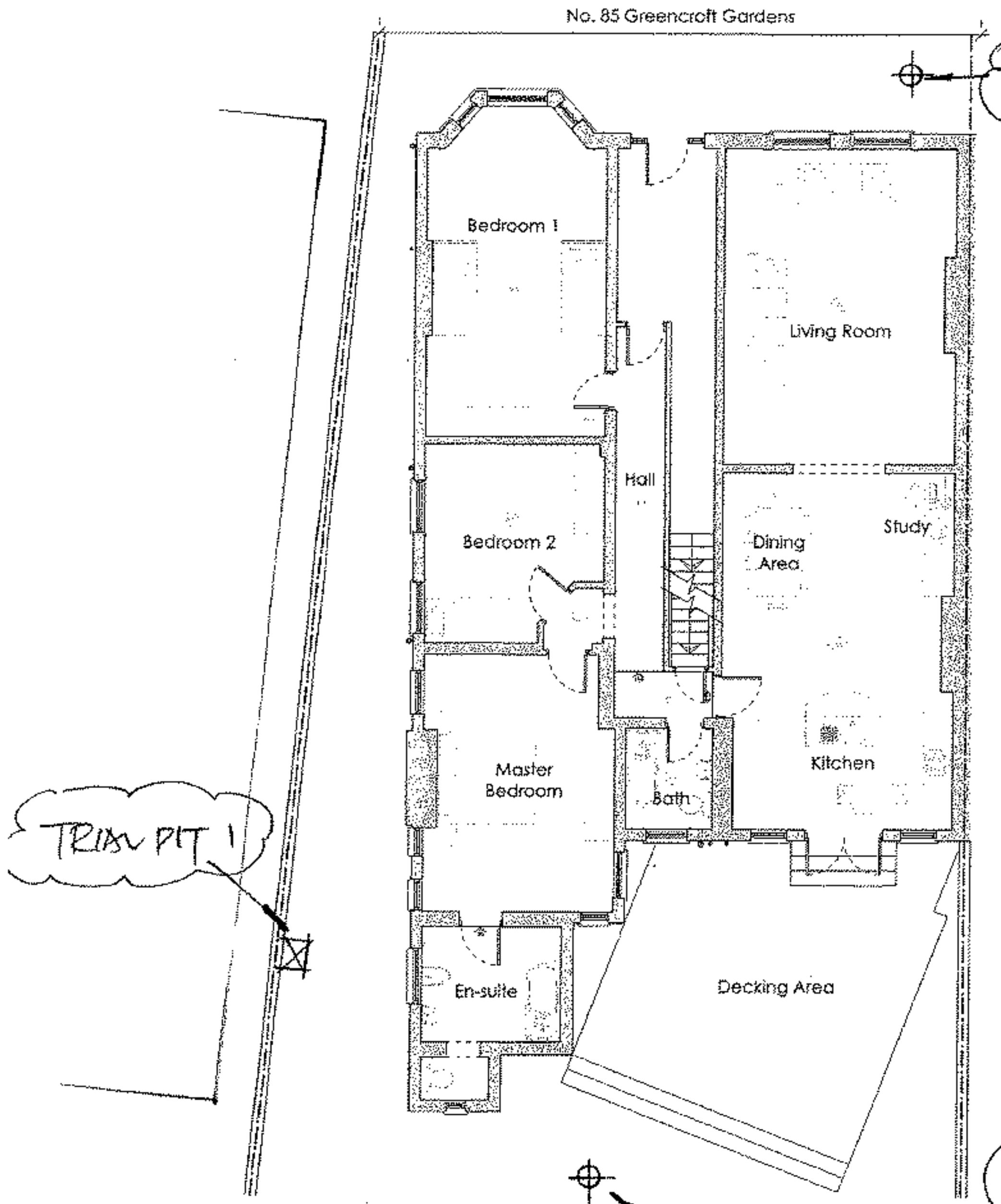
Scale	Date
1:5000 @ A3	FEBRUARY 2014

Drawing Number	Revision
001	0

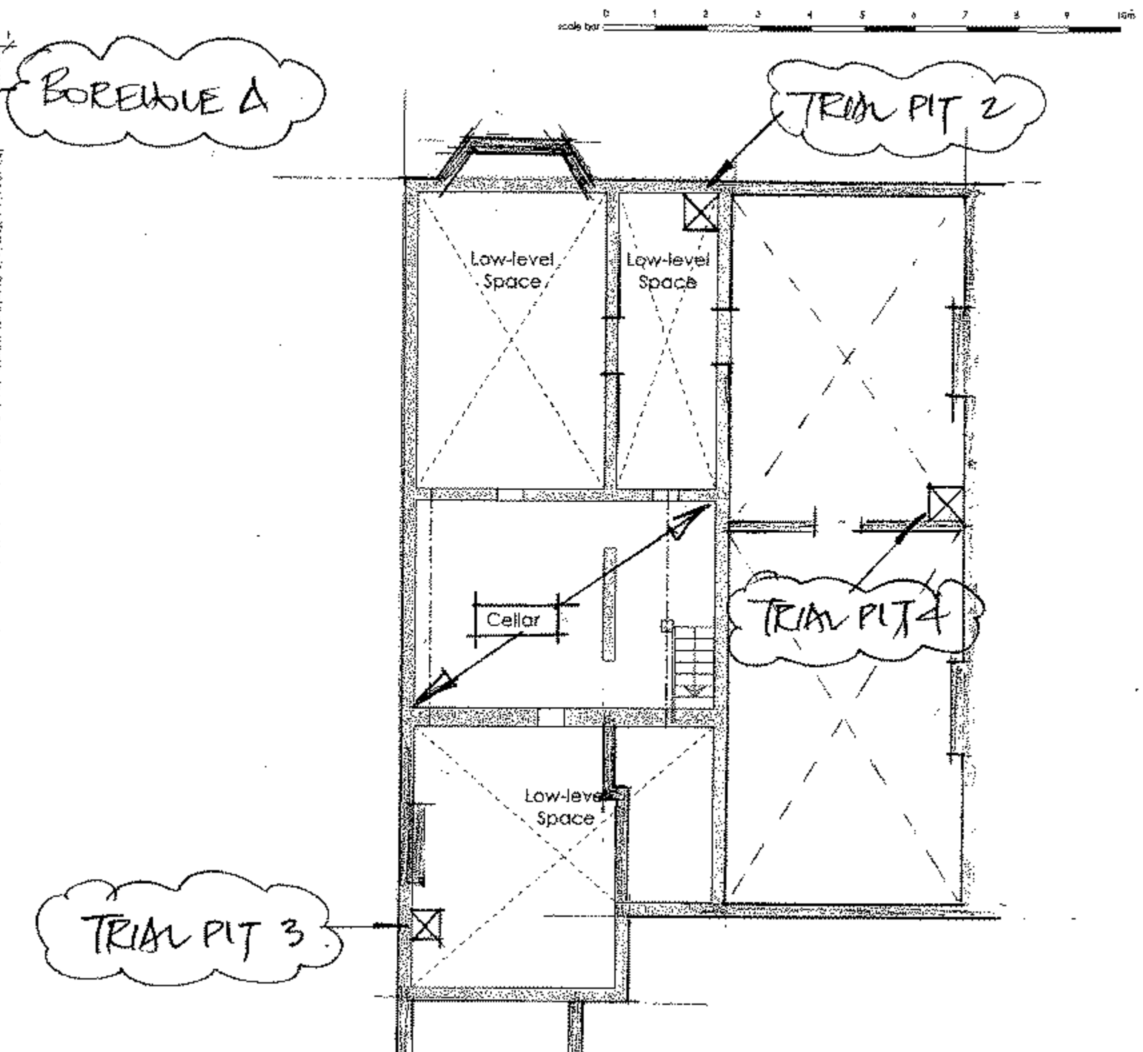
04869.00001.11.001.0_Local Geology.dwg

APPENDIX B:

FOUNDATION INVESTIGATION RESULTS BY S.CHICK INVESTIGATIONS



1 P-010 **Existing Ground Floor Plan**
scale 1:100 @ A3

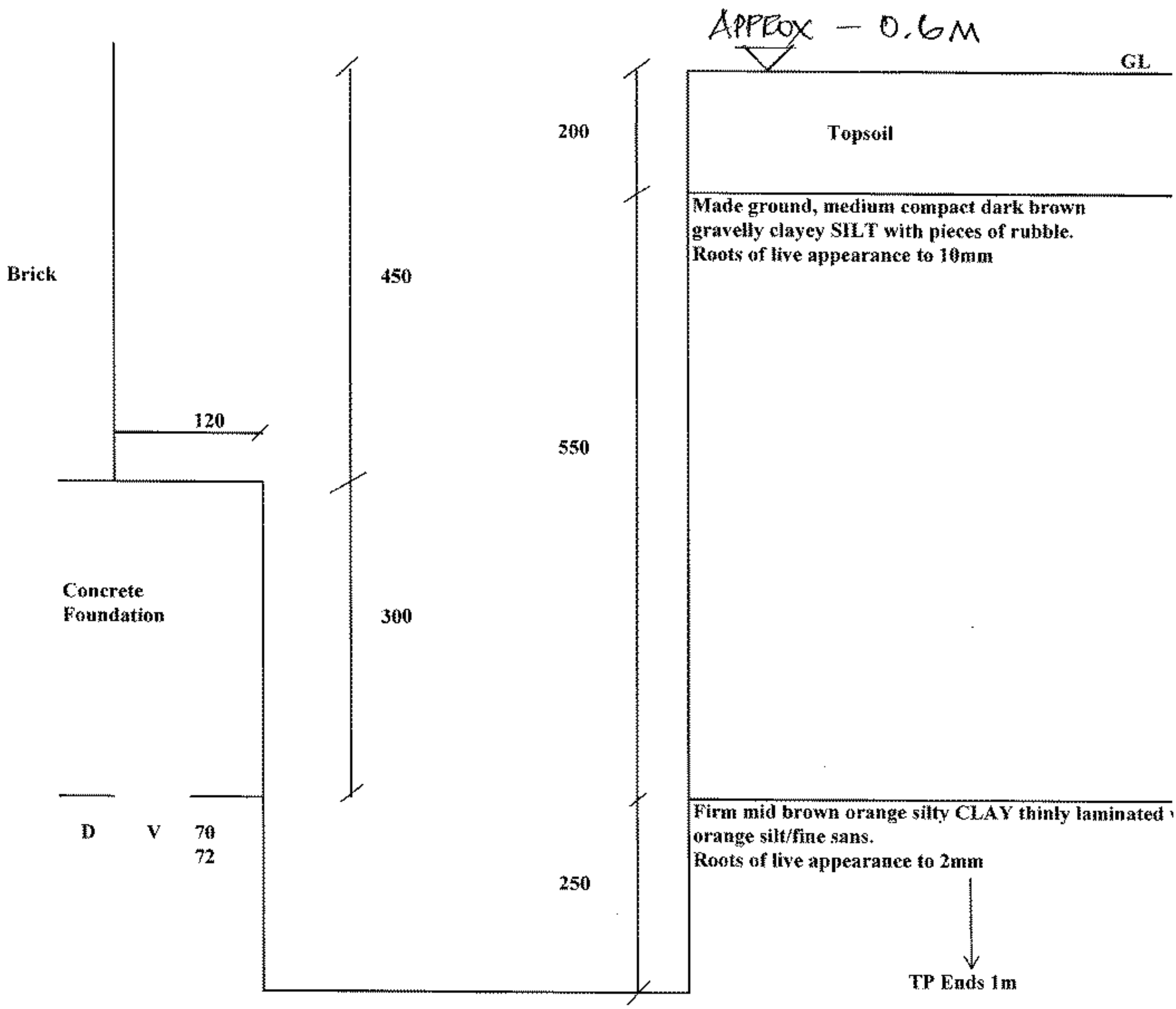


2 P-010 **Existing Cellar Plan**
scale 1:100 @ A3

FOUNDATION INVESTIGATION KEY PLAN.

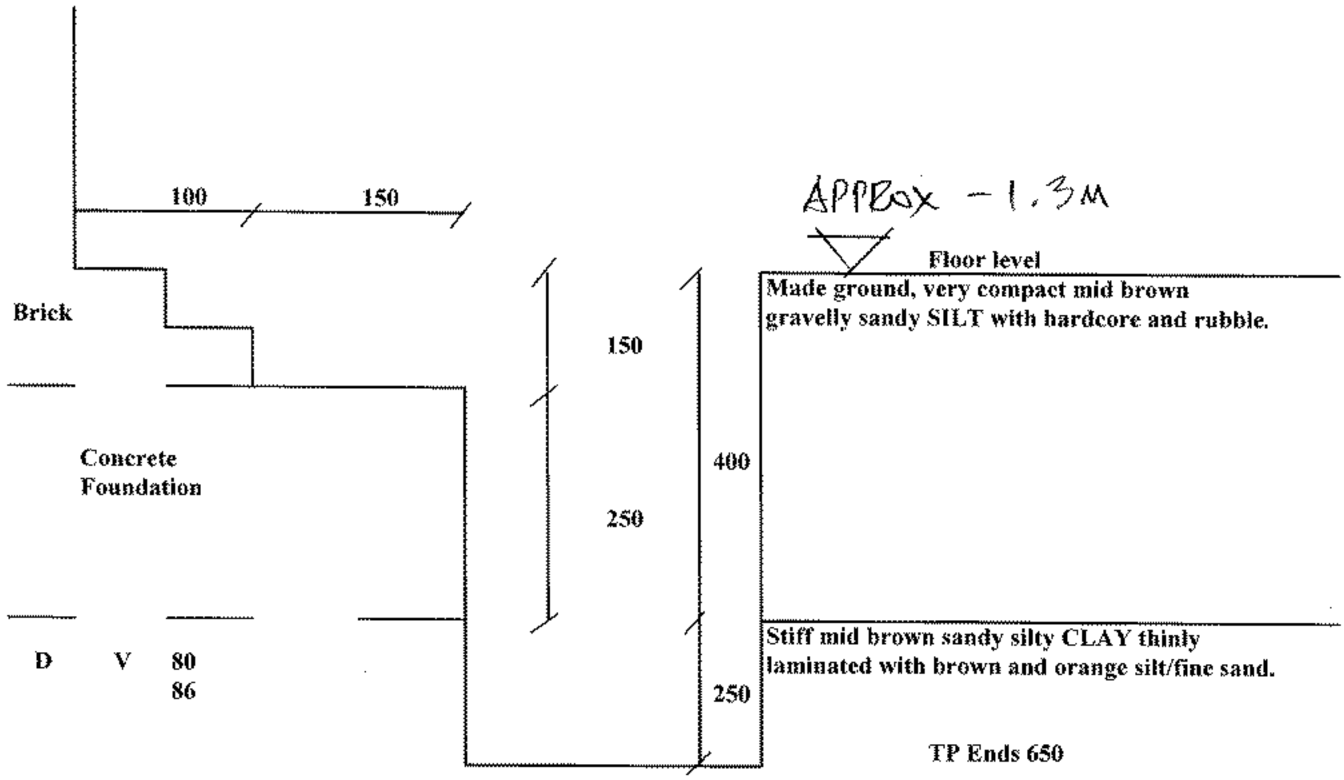
healycornelius INTERIORS ARCHITECTURE TECHNOLOGY — No. 5 St. John's Lane London EC1M 4BH T 020 7404 7771 F 020 7404 7772 — CIAT	Drawing Title: **Existing Ground Floor & Cellar Plans**		
Client: Van Der Valk & de Bona	Scale: 1:100 @ A3	Date: 08 Jan. 2013	Drawn: MOK
Job Title: Flat 1, No. 85 Greencroft Gardens, London NW6 3LJ	Drawing Number: **13-499-P-010**		Rev: -

TP No: 1	Sheet: 1 of 1	S Chick Investigations
Client: Chesters	Date: 06/02/2014	Site: 85 Greencroft Gardens, NW6



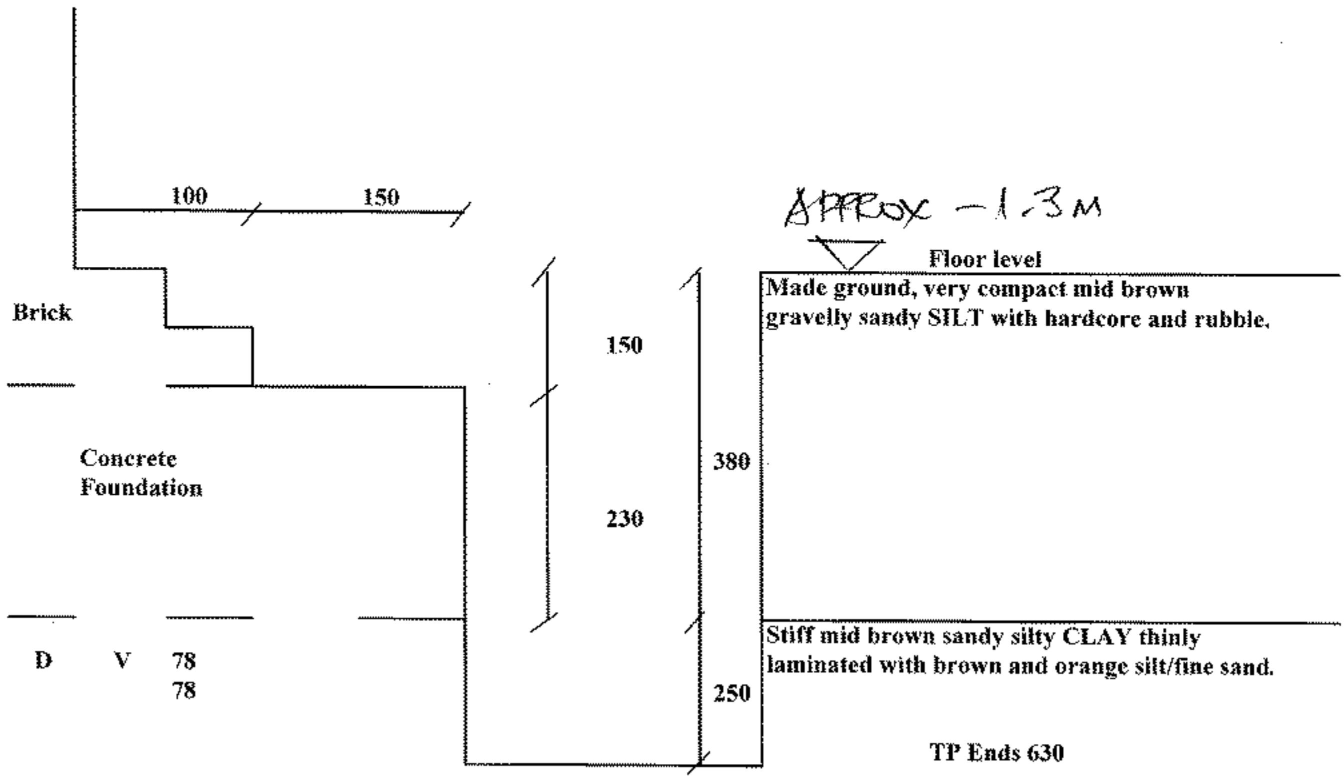
Remarks: X(Y) = X blows for Ymm penetration.			*Key:* T.D.T.D. Too Dense to Drive D Small disturbed sample B Bulk disturbed sample W Water sample	J Jar sample V Pilcon Vane (kPa) M Mackintosh Probe
Logged:	Checked:	Approved:	Scale: NTS	Weather:

TP No: 2	Sheet: 1 of 1	**S Chick Investigations**
Client: Chesters	Date: 06/02/2014	Site: 85 Greencroft Gardens, NW6



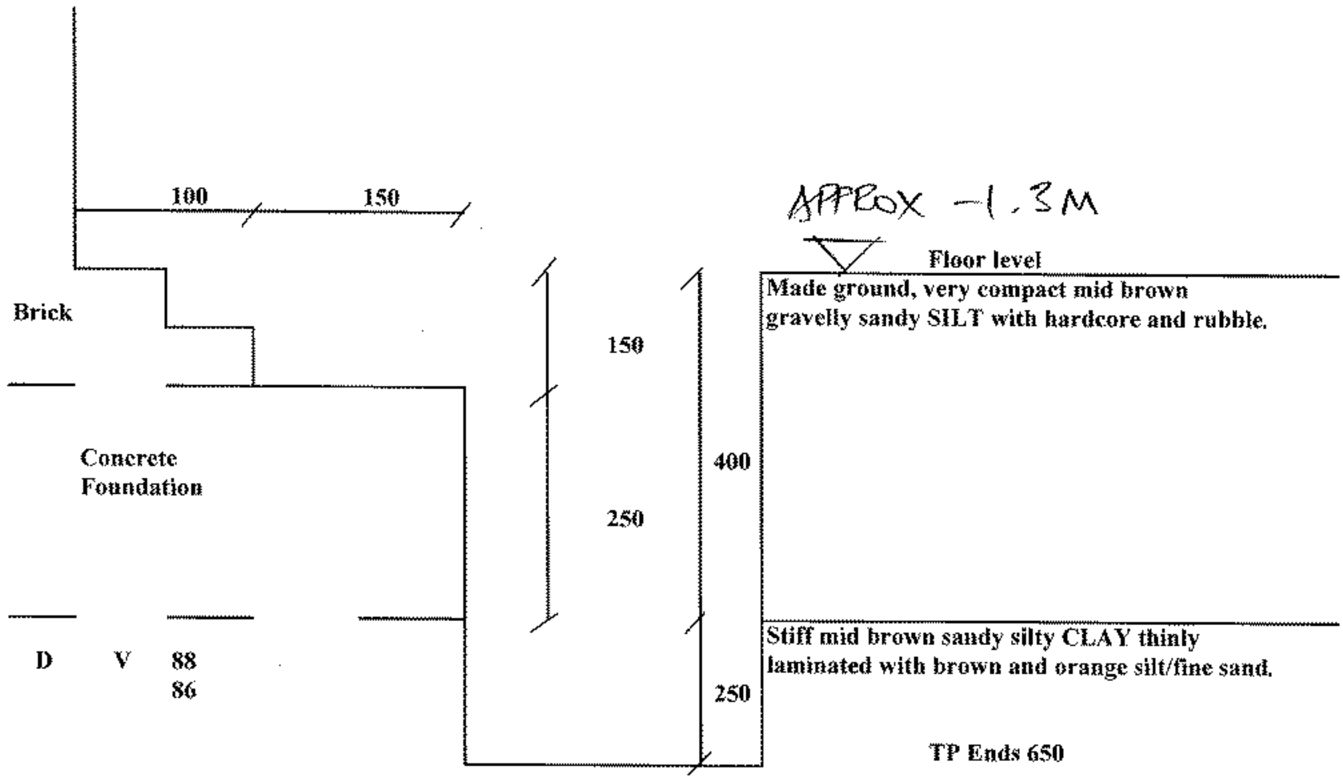
Remarks:			Key: T.D.T.D. Too Dense to Drive	
X(Y) = X blows for Ymm penetration.			D Small disturbed sample B Bulk disturbed sample W Water sample	J Jar sample V Pilcon Vane (kPa) M Mackintosh Probe
Logged:	Checked:	Approved:	Scale: NTS	Weather:

TP No: 3	Sheet: 1 of 1	S Chick Investigations
Client: Chesters	Date: 06/02/2014	Site: 85 Greencroft Gardens, NW6



Remarks:			Key: T.D.T.D. Too Dense to Drive	
			D Small disturbed sample	J Jar sample
			B Bulk disturbed sample	V Pilcon Vane (kPa)
X(Y) = X blows for Ymm penetration.			W Water sample	M Mackintosh Probe
Logged:	Checked:	Approved:	Scale: NTS	Weather:

TP No: 4	Sheet: 1 of 1	**S Chick Investigations**
Client: Chesters	Date: 06/02/2014	Site: 85 Greencroft Gardens, NW6



Remarks: X(Y) = X blows for Ymm penetration.			*Key:* T.D.T.D. Too Dense to Drive D Small disturbed sample B Bulk disturbed sample W Water sample	J Jar sample V Pilcon Vane (kPa) M Mackintosh Probe
Logged:	Checked:	Approved:	Scale: NTS	Weather:

Borehole No: A		Sheet: 1 of 1 Job No:	**S Chick Investigations** Site: 85 Greencroft Gardens NW6
Boring Method: C.F.A		Date: 06/02/2014	
Diameter: 100mm	Coordinates:	Ground Level mOD: −0.2M	Work Carried out for: Chesters

Depth (m)	Description of Strata	Thickness (m)	Sample	Test Type	Test Result	Depth (m)	Field Records/Comments	Depth to water (m)
GL	Block paving over sand	0.20					Roots of live appearance to 8mm to 1.2m	
0.20	Made ground, medium compact mid brown gravelly silty CLAY with pieces of rubble	1.20						
			D	M	14 14 16 18	1.00	Hair and fibrous roots observed to 2.2m	
1.40	Stiff mid brown grey veined silty CLAY with partings of brown silt/fine sand	1.10						
			D	V	122 132	2.00		
2.50	Very stiff mid brown silty CLAY with partings of brown silt/fine sand	2.50						
			D	V	140+ 140+	3.00		
			D	V	140+ 140+			
	BH Ends 5.0m		D	V	140+ 140+		BH dry and open on completion	

Remarks: X(Y) = X blows for Ymm penetration.			*Key:* T.D.T.D. Too Dense to Drive D Small disturbed sample J Jar sample B Bulk disturbed sample V Pilcon Vane (kPa) W Water sample M Mackintosh Probe	
Logged: SC	Checked:	Approved:	Scale: NTS	Weather:

Borehole No: B	Sheet: 1 of 1	**S Chick Investigations**
	Job No:	Site: 85 Greencroft Gardens
Boring Method: C.F.A	Date: 06/02/2014	NW6
Diameter: 100mm / Coordinates:	Ground Level mOD: − 0.6M	Work Carried out for: Chesters

Depth (m)	Description of Strata	Thickness (m)	Sample	Test Type	Test Result	Depth (m)	Field Records/Comments	Depth to water (m)
GL	Turf over topsoil	0.20					Occasional roots of live appearance to 2mm to 1m	
0.20	Made ground, medium compact mid brown gravelly clayey silt with pieces of rubble.	0.40						
0.60	Firm mid brown mottled orange silty CLAY with partings of orange silt/fine sand	0.70						
			D	V	72 72	1.00		
1.30	Stiff mid brown silty CLAY with partings of brown silt/fine sand	1.90						
			D	V	116 118	2.00		
			D	V	130 134	3.00		
3.20	Very stiff as above	1.80						
			D	V	140+ 140+			
	BH Ends 5.0m		D	V	140+ 140+		BH dry and open on completion	

Remarks:

X(Y) = X blows for Ymm penetration.

Key: T.D.T.D. Too Dense to Drive

D	Small disturbed sample	J	Jar sample
B	Bulk disturbed sample	V	Pilcon Vane (kPa)
W	Water sample	M	Mackintosh Probe

Logged: SC	Checked:	Approved:	Scale: NTS	Weather:

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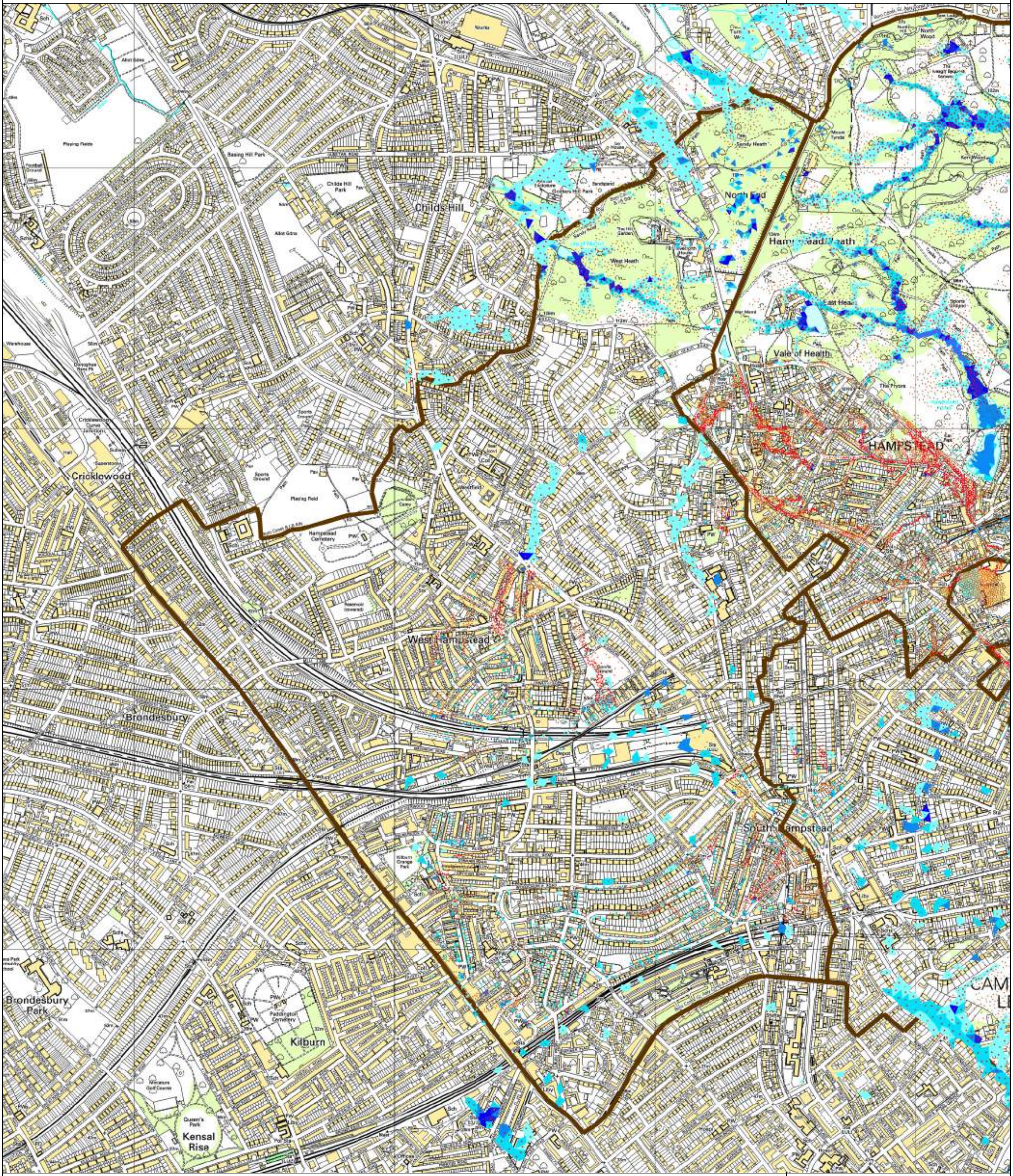
Date Printed: 18/07/2012
Scale 1:21000

500m



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Line Visibility/Line Colour/Arrow Length (a...
< 0
>= 0
>= 0.01
>= 0.02
>= 0.03
>= 0.05
>= 0.5
General line [3]

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