CG Contractors (Herts) Limited

# 73 Constantine Road, Hampstead, London

*Basement Impact Assessment*

November, 2014

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# 1. INTRODUCTION

CG Contractors (Herts) Limited is proposing to undertake development works at 73 Constantine Road in the London Borough of Camden. The works comprise the excavation of a lower ground floor level beneath the existing structure. The new lower ground floor slab will be formed at a formation level of generally 3.6 metres below ground level (mbgl). Card Geotechnics Limited (CGL) has been instructed to undertake a Basement Impact Assessment (BIA), including a detailed ground movement analysis for the proposed development to determine its potential effect on nearby structures and services, surface water runoff and groundwater flow.

The London Borough of Camden's guidance document *"CPG4, Basements and Lightwells*[1]*"*, requires a BIA to be undertaken for new basements in the Borough and sets out 5 stages for a BIA to "enable the Borough to assess whether any predicted damage to neighbouring properties and the water environment is acceptable or can be satisfactorily ameliorated by the developer". The five stages are set out below:

1. Screening
2. Scoping
3. Site investigation
4. Impact assessment
5. Review and decision making

This report is intended to address the screening, scoping, site investigation and impact assessment stages of the BIA. It identifies key issues relating to land stability, hydrogeology and hydrology as part of the screening process (Stage 1). Site investigations have been carried out by others, and the scoping process herein critically reviews the adequacy of the physical investigations. This report also forms a review and interpretation of existing site investigation data to establish a conceptual site model (Stages 2 and 3).

[1] Camden Planning Guidance, CPG4, Basements and Lightwells, September 2013.

The report provides an impact assessment (Stage 4) of potential ground movements on adjacent structures and the hydrogeology of the surrounding area for the purposes of planning.

# 2. SITE CONTEXT

## 2.1 Site location

The site is located at 73 Constantine Road, Hampstead, London, NW3 2LP. The National Grid Reference for the approximate centre of the site is 527541E, 185649N.

The site location is shown in Figure 1.

## 2.2 Site layout

The site is broadly rectangular in plan with dimensions of 23m in length and 6m in width, with the length orientated in the north-west to south-east direction. The site covers an area of approximately 140m$^2$ and currently comprises a Victorian mid-terraced two story residential building in its southern extent with a two storey addition projecting into the rear garden.

An enclosed hard surfaced garden with soft borders is located to the southern extent of the site and is bounded by dwarf walls approximately 0.4m in height. Beyond this, a pavement some 2m in width separates the site from the carriageway of Constantine Road. The ground floor level of the building is accessed by a small stair of approximately 1.4m in height.

To the east the site is bounded by the party wall with 75 Constantine Road, a 6m wide three storey residential Victorian residential building with front and rear gardens. The ground floor of 75 Constantine Road is reduced in level by some 1.4m to that of 73 Constantine Road, and generally concordant with the surrounding ground level.

The west of the site is bounded by a party wall of some 8.0m in length with 71 Constantine Road, a 5.5m wide two storey mid-terraced residential building, with principal structure and gardens of similar dimension to 73 Constantine Road. The ground floor level is concordant with that of 73 Constantine Road.

The site is bounded to the north by a wall, behind which lies open green space adjacent to South End Close.

A brief review of local planning applications records the adjoining structures are without a lower ground floor or basement level.

The site lies approximately 45m south of a Network Rail mainline.

A site layout plan is presented in Figure 2.

## 2.3 Topography

Ordnance Survey topographical mapping records a spot height elevation of 57.5 metres above Ordnance Datum (mOD) approximately 10.0m south of the site adjacent to the front elevation. The ground floor level of the existing building and rear gardens beyond is recorded at approximately 1.4m above this, at a level of approximately 59.0mOD.

Local topographical mapping indicates the site is located on a wider hillslope with levels reducing to the south-east at a typical gradient of 1 in 25.

Locally the highest point is 95mOD recorded at Parliament Hill 500m to the north, with local ground levels increasing towards this point. The topography reduces in level to the south and south-east of the site towards the Regent's Canal, located 1.8km away.

Figure 16 of the Camden Geological, Hydrogeological and Hydrological Study[2] (CGHHS) records that the site is not located on a slope of greater than 7 degrees. Figure 17 of the CGHHS records the site as not being located within an area of significant landslide potential.

Shallow valleys are recorded towards the southern extent of Hampstead Heath some 500m north and north-west of the site, representing relict river channels of the *River Fleet, River Tyburn* and the *River Westbourne* and associated tributaries.

## 2.4 Proposed development

It is proposed to excavate beneath the property to form a new lower ground floor level at approximately 3.6m below existing rear garden and ground floor level, an approximate level of 55.4mOD. The proposed lower ground floor formation level is approximately 2.1m below street level recorded at the front elevation of the property.

[2] Ove Arup and Partners. (2010) Camden Geological, Hydrogeological and Hydrological Study: Guidance for subterranean development. London Borough of Camden.

The excavation will extend approximately 1.5m beyond the rear elevation into the rear garden, which is to be reprofiled to form a sunken terrace incorporating stair access to the rear garden.

The perimeter of the proposed excavation including party walls to Nos. 71 and 75 Constantine Road is to be retained by traditional underpinning techniques.

It is understood that no trees are to be removed as part of the proposed works.

Plans of the proposed development provided by the structural engineers are provided in Appendix A.

## 2.5 Site History

A brief review of the site's historical development has been undertaken using available literature and CGL's in-house resources. The findings are summarised as follows:

The site is recorded as being occupied by green fields labelled 'Southend Green' c.1870. The *River Fleet* is recorded approximately 100m to the south originating from a spring some 160m south-west. A railway cutting is shown some 60m to the north.

Mapping dated c.1890 records the partial construction of Constantine Road. The site remains undeveloped, however a row of terraced properties on Constantine Road is located some 30m to the south east. The River Fleet is no longer a surface feature, and is likely to have been culverted prior to ongoing residential development.

The property of 73 Constantine Road is recorded as occupying the site c.1910, with terraced housing constructed upon the remaining green space surrounding the site.

73 Constantine Road is not recorded as having sustained damage during Second World War bombings[3]. Several properties opposite the front elevation located some 15m to the south east are recorded as having sustained 'serious damage' and two properties are categorised as 'damaged beyond repair'. The risk of unexploded ordnance (UXO) remaining on site is considered to be low.

[3] London Topographical Society (2005). *Bomb Damage Maps 1939-1945*. The London City Council.

## 2.6 Published geology

The British Geological Survey (BGS) sheet[4] of the area indicates the site to be underlain by the London Clay Formation with no record of superficial deposits.

The London Clay Formation is an overconsolidated firm to very stiff, becoming hard with depth, fissured, blue to grey silty clay of low to very high plasticity. The upper and lower parts may contain silty or fine grained sand partings. The stratum may also contain laminated, structured, nodular claystone and rare sand partings. Crystals of gypsum (Selenite) are often present within the weathered London Clay Formation. The stratum is generally horizontally bedded.

BGS basal contour mapping demonstrates the base of the London Clay Formation is present below the site to an elevation of approximately -15.0mOD, suggesting an overall thickness of approximately 70.0m. The surface of the Upper Chalk is recorded at -40.0mOD, suggesting a cumulative thickness of the Lambeth Group and underlying Thanet Formation of approximately 25.0m.

The overlying Claygate Member is recorded at 450m north and west of the site at approximately 25m above the level of the site (80.0mOD).

Alluvial deposits may be present to the south and south-west, along the route of the historic *River Fleet* and associated tributaries. If present, these are likely to comprise silty sandy clays and gravels and will directly overlie the London Clay.

Due to a regional hillslope setting, it is considered Head Deposits may be present on site, formed by solifluction and hill creep in a periglacial environment. These are likely to comprise clay dominated soils formed from the reworking of the London Clay Formation with overlying clays and sands of the Claygate Member and River Terrace Gravels from the locally overlying Stanmore Gravel Formation. Head Deposits are typically less than 2m in thickness and described as clays incorporating occasional angular frost shattered flints, often with basal gravelly clays of approximately 0.2m in thickness derived from local outcrops of high-level gravels[5].

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[4] British Geological Survey Sheet 256 (1993) *North London – Solid and Drift Geology* 1:50,000. Keyworth, BGS.
[5] Ellison, R.A. et al. (2004). *Geology of London*. Memoir of the British Geological Survey, Sheets 256 (North London), 257 (Romford), 270, (South London) and 271 (Dartford). British Geological Survey, Keyworth, Nottingham.

## 2.7 Unpublished geology

A number of historical British Geological Survey (BGS) borehole records exist within 300m of the site boundary. Selected records and an indicative location plan are provided in Appendix B.

Borehole TW28NE277 some 300m to the south west was excavated from a surface level of 59.3mOD to a depth of 177.0mbgl. The strata encountered within the borehole are summarised in Table 1:

***Table 1. Summary of BGS Borehole Record TW28NE277***

| **Stratum** | **Level at top of stratum (mOD) [mbgl][a]** | **Typical thickness (m)** |
|---|---|---|
| London Clay Formation | 57.5<br>[0] | 69m |
| Lambeth Group | -11.5<br>[69] | 21m |
| Thanet Formation | -32.5<br>[90] | 11m |
| Upper Chalk | -43.5<br>[101] | Proven to 76m |

a. mbgl = metres below ground level

This borehole indicates the geology of the surrounding area to consist of the London Clay Formation, underlain by the Lambeth Formation, Thanet Sand and Upper Chalk at depth, confirms strata thicknesses in the local area are in accordance with BGS mapping.

A series of three boreholes at surface levels between 52.3mOD and 54.5mOD were excavated in Cressy Road some 60m south-east of the site. Borehole TQ28NE77 at 52.3mOD was excavated to a depth of 15.25mbgl and recorded 0.3m of Made Ground, comprising concrete and hardcore over the London Clay Formation. The London Clay was encountered at 52.0mOD and was described as firm brown and blue clay with selenite crystals, becoming fissured and stiff below 3.9mbg (48.0mOD). A standing water level was recorded at 12.2mbgl (40.1mOD) and is likely to represent seepage from sand partings within the London Clay Formation.

Borehole TQ28NE78 at 54.5mOD recorded approximately 3.0m of Made Ground which comprised sandy clay with brick fragments. The London Clay was encountered at

51.45mOD and was described as a firm brown and blue clay with selenite crystals, becoming fissured and stiff below 4.9mbgl (49.1mOD). A standing water level was recorded at 2.2mbgl (52.3mOD) and may represent a shallow perched groundwater within Made Ground.

Borehole TQ28NE79 at 54.5mOD recorded 1.8m of Made Ground comprising concrete and hardcore over firm brown and grey silty clay. Underlying this, a 0.35m thick deposit of 'orange brown sandy clay with stones' was encountered and may be an alluvial deposit from the *River Fleet*. The London Clay Formation was encountered at 52.38mOD and was described as a stiff brown and blue clay with selenite crystals, becoming fissured and very stiff below 7.0mbgl (47.5mOD). A standing water level was recorded at 1.5mbgl (53.0mOD) and may represent a shallow perched groundwater within Made Ground.

CGL has recently undertaken a site investigation in Cressy Road. some 45m east of the site, which comprised two window sample boreholes (WS1 and WS2) excavated to 7.0mbgl. The investigation recorded between 0.65m and 0.8m of Made Ground comprising dark brown gravelly silty clay. Underlying this, a 0.75m thick stratum comprising soft becoming firm light brown and orange mottled silty sandy clay was encountered and is interpreted as a potential Head Deposit, with sands originating from the overlying Claygate Member. It is possible this deposit may be a fluvially derived floodplain deposit, noting the nearby location of the former watercourse of the *River Fleet*. The London Clay Formation was encountered at a depth of 1.4mbgl as a firm becoming stiff light brown silty clay with fine selenite crystals. A slight seepage was noted in Made Ground at 0.4mbgl in WS1.

In-situ testing was conducted with Standard Penetration Test (SPT) values recorded generally at N = 14 between 2.0mbgl and 4.0mbgl, increasing to N = 30 at 6.0mbgl. These correlate to undrained shear strengths (Cu) of between 68kPa and 135kPa[6]. Hand Shear Vane testing was undertaken, and recorded undrained shear strengths, ranging from Cu = 90kPa at 3.4mbgl to Cu = 140kPa at 6.6mbgl.

[6] Stroud, M.A. (1974). The standard penetration test in insensitive clay and soft rock. *Proceedings of the European symposium on Penetration Testing, 2, 367-375.*

## 2.8 Hydrogeology and hydrology

The Environment Agency[7] (EA) has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology and are based on the importance of aquifers for potable water supply, and their role in supporting surface water bodies and wetland ecosystems.

The site does not overlie a designated superficial or bedrock aquifer and is noted as being underlain by The London Clay Formation, designated a 'non-productive stratum' by the Environments Agency.

The site does not fall within a Groundwater Vulnerability Zone as indicated by EA mapping. The site is not located within a groundwater protection zone (SPZ). The closest SPZ is located some 2km south at Barrow Hill Reservoir and relates to the licensed abstraction of groundwater from the Upper Chalk.

The closest significant body of surface water is Hampstead No.1 Pond located 300m to the north-west. The site is not located within the Hampstead Chain Catchment zone. Environments Agency mapping indicates the site is within a zone at of risk of flooding from reservoirs.

The site lies approximately 100m north and east of a major tributary of the historical *River Fleet*. Reference to Barton's 'Lost Rivers of London'[8] indicates that the historical *River Fleet* previously flowed south and south-east from Hampstead Heath into the River Thames at Blackfriars. The former watercourse of the *River Fleet* is no longer open having been culverted and constrained, however owing to local topography, it is considered that surface waters will drain towards the line of watercourse in a general southeast trend. This is illustrated in Figure 11 of the Guidance for Subterranean Development[3].

The boundary between the impermeable London Clay Formation and the overlying permeable sands, silts and clays of the Claygate member is recorded as producing spring lines which are identified as the source of the *River Fleet*. These are located some 400m to the north and do not affect the site.

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[7] http://www.environment-agency.gov.uk (accessed October 2014)
[8] Barton, N. (1983) *The Lost Rivers of London* Hertfordshire Historical Publications

As the London Clay Formation is identified below the site, it is assumed this forms an impermeable boundary and will form the base of an overlying groundwater table where any permeable superficial deposits permit the transit of groundwater.

The EA website[5] indicates that the site is not situated within a zone at risk from surface water flooding. Furthermore Constantine Road is not identified as at risk of flooding from surface waters, and Figure 15 of the Guidance for Subterranean Development[3] indicates the street was not flooded during extreme rainfall events in 1975 and 2002.

# 3. STAGE 1 - SCREENING

## 3.1 Introduction

A screening assessment has been undertaken based on structured guidance presented in Camden Borough Council's Planning Guidance Document 4 (CPG4). Responses to the questions posed by the flowcharts are presented below. Explanations to answers of 'yes' or 'unknown' . A response of 'No' requires no analysis.

## 3.2 Subterranean (Groundwater) Screening Assessment

This section answers questions posed by Figure 1 in CPG4:

***Table 2. Responses to Figure 1, CPG4***

| **Question** | **Response** | **Action required** |
|---|---|---|
| *1a.* Is the site located directly above an aquifer? | No.<br>The site is underlain by the London Clay Formation, designated an unproductive stratum. | None |
| *1b.* Will the proposed basement extend beneath the water table surface? | No.<br>The proposed lower ground floor will extend to approximately 3.6mbgl. Local historical borehole data records the presence of shallow perched groundwater within the Made Ground or as seepage from within sand partings in the London Clay Formation. | None |
| *2.* Is the site within 100m of a watercourse, well or potential spring line? | No.<br>The former watercourse of the historical *River Fleet* is located some 100m to the south and west of the site. The nearest spring line is located over 400m to the north and north west. | None |
| *3.* Is the site within the catchment of the pond chains on Hampstead Heath? | No. | None |
| *4.* Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas? | No.<br>The proposed lower ground floor will extend into the rear garden by some 1.5m forming a hard surfaced sunken terrace. The existing rear garden is hard paved, and a proposed lawn is likely to increase the surface water attenuation characteristics of the site. | None |

| **Question** | **Response** | **Action required** |
| --- | --- | --- |
| *5.* As part of site drainage, will more surface water than at present be discharged to ground (e.g. via soakaways and/or SUDS)? | No.<br>Soakaways are not likely to prove effective in the London Clay due to low infiltration rates. It is anticipated that surface waters will be discharged through the existing public drainage network. | None |
| *6.* Is the lowest point of the proposed excavation close to or lower than, the mean water level in any local pond or spring-line? | No. | None |

The proposed development is underlain by the London Clay Formation, designated an 'unproductive stratum' by the Environments Agency. A review of available data has been conducted to determine groundwater conditions on site and suggests that shallow perched groundwater may be encountered within Made Ground or resting above the surface of the London Clay Formation. This is not expected to be laterally pervasive.

The former watercourse of the *River Fleet* is recorded some 100m to the south and south-west. This has been culverted at this location into the Fleet Sewer, and is considered unlikely to affect the proposed development.

## 3.3 Slope/Land Stability Screening Assessment

This section answers questions posed by Figure 2 in CPG4.

***Table 3. Responses to Figure 2, CPG4***

| **Question** | **Response** | **Action required** |
|---|---|---|
| *1.* Does the site include slopes, natural or man-made, greater than about 1 in 8? | No. | None |
| *2.* Will the proposed re-profiling of the landscaping at site change slopes at the property boundary to greater than about 1 in 8? | No. | None |
| *3.* Does the development neighbour land including railway cuttings and the like with a slope greater than about 1 in 8? | No. | None |
| *4.* Is the site within a wider hillside setting in which the general slope is greater than about 1 in 8? | No. | None |
| *5.* Is the London Clay the shallowest stratum on site? | Yes.<br>The site is directly underlain by the London Clay Formation | Heave Impact Assessment |
| *6.* Will any trees be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained? | No.<br>No trees are to be felled as part of the proposed works. The works have been amended to consider the root protection radius of a neighbouring cherry tree. | None |
| *7.* Is there a history of shrink/swell subsidence in the local area and/or evidence of such at the site? | Unknown.<br>The underlying London Clay Formation creates the potential for such movements due to the loading and loading of soils during construction. | Heave Impact Assessment |
| *8.* Is the site within 100m of a watercourse or a potential spring line? | No.<br>The former watercourse of the historical *River Fleet* (culverted) is located some 100m to the south and west of the site, however this is not considered to impact local groundwater. The nearest spring line is located over 400m to the north and north west. | None |

| Question | Response | Action required |
|---|---|---|
| *9.* Is the site within an area of previously worked ground? | No. | None |
| *10.* Is the site within an aquifer? | No.<br>The site is underlain by an unproductive stratum. | None |
| *11.* Is the site within 50m of the Hampstead Heath ponds? | No. | None |
| *11.* Is the site within 5m of a highway or pedestrian right of way? | Yes.<br>Constantine Road is present immediately to the south of the site. | Impact Assessment |
| *12.* Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties? | Yes.<br>It is understood that the neighbouring properties do not currently have basement levels. | Impact assessment |
| *13.* Is the site over (or within the exclusion zone of) any tunnels? | No. | None |

A review of local topography and reference to Figure 16 of CGHHS[3] suggests that local and wider hillslopes do not exceed a gradient of 1 in 8 (approximately 7˚).

Figure 17 of the study indicates the site is not located in an area of landslide potential. No trees are to be felled as part of the proposed works. An arboricultural report[9] has been undertaken and identifies a root protection zone around a Category B mature cherry tree neighbouring the site. The proposed works have been designed to consider the Tree Protection Plan so as not to cause damage to the roots of the tree.

In summary, an impact assessment is required to investigate the magnitude of ground movements resulting from the lower ground floor excavation. The excavation will result in an unloading of the London Clay Formation at depth which without significant structural reloading may result in heave movements.

[9] Crown Consultants. (2014). Arboricultural Report: Impact Assessment and Method Statement. For planning purposes at 73 Constantine Road, Hampstead, London, NW3 2NG.

The impact assessment will assess potential damage caused by ground movements to adjacent properties and public highway and will recommend measures to mitigate such potentially damaging movements.

## 3.4 Surface Flow and Flooding Screening Assessment

This section covers the main surface flow and flooding issues as set out in Figure 3, CPG4.

***Table 4. Responses to Figure 3, CPG4***

| **Question** | **Response** | **Action required** |
|---|---|---|
| *1.* 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.<br>Existing drainage routes are unchanged | None |
| *2.* Will the proposed development result in a change in the proportion of hard surfaced/paved external areas? | No.<br>The proposed development will be conducted on a site that currently offers no attenuation. External spaces are covered by hardstanding with the exception of a small green space to the northern extent of the site. This is directly underlain by London Clay therefore attenuation characteristics are expected to be limited. | None |
| *3.* Will the proposed basement result in a change to the profile of the inflows of surface water being received by adjacent properties or downstream watercourses? | No. | None |
| *4.* Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses? | No.<br>The proposed excavation would remove the majority of any Made Ground that may be present on site and as such will not impact on water quality. | None |
| *5.* Is the site in an area known to be at risk from surface flooding, or is it at risk from flooding because the proposed basement is below the static water level of a nearby surface water feature? | No. | None |

The proposed development will remain a residential property, therefore no significant change of use is anticipated that may increase discharge loads to the existing sewer and drainage systems. The proposed lower ground floor is to be excavated beneath the existing structure and projects into the rear garden by some 1.5m beyond the rear façade. The existing garden is hard paved therefore it is considered there is no net increase in area of impermeable surfaces overlying the site. A proposed lawn to the rear garden is likely to increase attenuation and infiltration characteristics for the site.

## 3.5 Summary

On the basis of this screening exercise, further stages of BIA are required for this site. These should address the following:

***Table 5. Summary of Basement Impact Assessment requirements***

| Item | Description |
|---|---|
| 1. | *Groundwater flow*<br>None. |
| 2. | *Slope (land stability)*<br>Impact assessment to determine the effect of construction on neighbouring properties and infrastructure. |
| 3. | *Surface flow and flooding*<br>None. |

The outcomes of the screening assessment are carried forward into the Basement Impact Assessment in the following report sections.

# 4. STAGE 2 - SCOPING

## 4.1 Introduction

On the basis of requirements set out during the screening process, the previously commissioned Basement Impact Assessment Report[10] and Site Investigation by Ground and Water Ltd[11] have been provided to establish the underlying geological sequence, groundwater levels, and to derive preliminary geotechnical design parameters to support ground movement assessment calculations.

This intrusive investigation has:

1. Logged the underlying strata to BS5930:1999 to a depth of 8.3mbgl and installed groundwater monitoring standpipes to determine groundwater levels and conditions on site;

2. Undertaken in-situ testing to assess the strength of the ground and to support geotechnical assessment and;

3. Obtained soil samples for geotechnical laboratory testing in order to classify the soils on site and to support geotechnical design.

Details of the site investigation are provided in Section 5 of this report.

[10] BC Consultants. (2014) Basement Impact Assessment. 73 Constantine Road. Report No.BIA/14/73CRD/01
[11] Ground and Water Ltd. (2014). Ground Investigation Report. 73 Constantine Road. Report No.GWPR824

# 5. STAGE 3 - CURRENT GROUND INVESTIGATION

## 5.1 Fieldwork

An intrusive investigation was undertaken by Ground and Water Ltd on the 14th January 2014 comprising two window sample boreholes (WS1 and WS2) to 8.3mbgl and 6.0mbgl respectively.

Borehole WS1 was located at the southern extent of the site in the front garden and Borehole WS2 was located in the northern extent of the site in the rear garden. Groundwater monitoring wells were installed in both boreholes with response zones of between 1.0mbgl and 5.0mbgl. The boreholes were reinstated with flush covers concreted at existing ground level.

Dynamic Probe Testing was undertaken adjacent to borehole WS1 to a depth of 8.2mbgl, using a standard weight ‘heavy’ dynamic probing rig.

Small disturbed samples were taken at regular intervals for geotechnical laboratory testing, and the results have been used in part to determine parameters for geotechnical design. The Ground Investigation Report produced by Ground and Water Ltd[11] should be referred to for full details, and is provided in Appendix C.

## 5.2 Ground and groundwater conditions

The ground conditions encountered on site during the Ground and Water Ltd site investigation are summarised in Table 6:

***Table 6. Summary of ground conditions***

| Stratum | Depth to top (mOD) [mbgl] | Thickness (m) |
|---|---|---|
| MADE GROUND:<br>Dark grey to dark brown gravelly clay. Gravel is occasional fine to coarse subangular to subrounded of brick, concrete and flint. Becoming dark brown sandy gravelly clay below 0.3m (WS2). | 57.5 to 59.0<br>[0.0] | 1.4m WS1<br>2.4m WS2 |
| Brown and grey mottled silty CLAY with pockets of selenite crystals.<br>[WEATHERED LONDON CLAY FORMATION] | 56.1 to 56.6<br>[1.4 to 2.4] | Proven to 6.9m thickness |

Further details of the ground conditions encountered are set out in the following sections. A plot of Dynamic Probe blowcounts to achieve 300mm penetration (DP300) against level is presented as Figure 3. Correlated undrained shear strength against level is presented in Figure 4.

### *5.2.1 Made Ground*

Made Ground was encountered in all locations to between 1.4mbgl and 2.4mbgl (56.1mOD and 56.6mOD). This was recorded as dark brown gravelly clays to a depth of 0.4mbgl in borehole WS1. Gravels are recorded as rare to occasional to a depth of 1.4mbgl. WS2 recorded 2.4m of Made Ground, which comprised dark brown sandy very gravelly clay.

### *5.2.2 London Clay Formation*

The London Clay Formation was encountered in boreholes WS1 and WS2 at a level of 56.1mOD and 56.6mOD respectively. The soil was described as brown and grey mottled silty clay with pockets of pyrite crystals, consistent with descriptions of a weathered horizon of the London Clay Formation. No relative consistencies were recorded during the site investigation.

Geotechnical laboratory testing indicated the following classification parameters:

- Moisture contents: 31% to 34%;

- Liquid Limit: 79% to 87%;
- Plastic Limit; 28% to 30%
- Plasticity Index; 50% to 58%

Is noted that a London Clay sample taken from 1.5mbgl in WS1 contained fine brick fragments. These may have been driven down from the overlying Made Ground into the London Clay which is present to 1.4mbgl. In addition, a sample of London Clay taken at 2.5mbgl in WS2 recorded flint gravels.

As flint gravels are not naturally occuring within the London Clay Formation, these may be present as a result of percussive driving of gravels within Made Ground into the London Clay by the sampler tube. However, there remains the potential for the gravelly clays to indicate the presence of head deposits.

### *5.2.3 Groundwater*

Groundwater was encountered within Made Ground in borehole WS2 at a depth of 1.8mbgl (57.2mOD). No access was available to record the standing water level some 2 weeks later during a monitoring visit. Groundwater was not recorded during drilling in borehole WS1, however a subsequent monitoring visit recorded groundwater at a depth of 1.23mbgl (56.27mOD).

Groundwater encountered within the Made Ground is likely to represent a local perched groundwater created by infiltrating surface water and runoff migrating through and stored within voids of the sandy gravelly clays. These are not anticipated to be laterally pervasive, however must be considered by the contractor prior to excavation.

## 5.3 In-Situ Testing

Dynamic probe testing conducted adjacent to WS1 to a depth of 8.3mbgl (49.2mOD), recorded values of DP100 = 1 at depths less than 2.1mbgl to DP100 = 29 at 8.3mbgl. An approximately linear increase in soil strength is recorded below 4.0mbgl (53.5mOD), indicating the presence of unweathered clays below this level.

Dynamic probe results are correlated to empirically derived SPT'N' values after Card and Roche (1988)[12], where SPT'N' = 1.5 DP300. On this basis, correlated SPT'N' results for the London Clay Formation ranged from N=4.5 at 1.6mbgl to N=>50 at 6.3mbgl, corresponding to a calculated undrained shear strength of typically Cu = 20kPa at depths less than 2.0mbgl increasing to 41kPa between 2.0mbgl and 4.0mbgl.

The in-situ testing results are not typical of the weathered London Clay Formation, and is based upon the limited site investigation data available. The Dynamic Penetration Testing conducted on site is typically undertaken within cohesionless soils from which the empirical parameters are derived, and may not provide a representative indication of the ground strength profile beneath the site. Nonetheless, the results demonstrate a consistently low blow count from 1.3mbgl (56.2mOD) to 4.0mbgl (53.2mOD) and an increasing strength below this depth.

## 5.4 Geotechnical design parameters

Geotechnical design parameters for the proposed development are summarised in Table 8. These are based on the ground conditions encountered during the investigation, results of laboratory and in-situ testing and published data for the well-studied London geology.

***Table 8. Geotechnical design parameters.***

| Stratum | Design Level mOD [mbgl] | Bulk Unit Weight $\gamma_b$ (kN/m$^3$) | Undrained Cohesion $c_u$ (kPa) [c'] | Friction Angle $\phi$'crit (°) | Young's Modulus $E_u$ (MPa) [E'] |
|---|---|---|---|---|---|
| Made Ground (cohesive) | 57.5 [0] | 19 | 20 [0] | 25[a] | 15 [10] |
| Weathered London Clay Formation | 56.1 [1.4] | 20 | 20 [5] | 24[a] | 12[c] [9][d] |
| Weathered London Clay Formation | 53.5 [4.0] | 20 | 30 + 8z [5] | 24[a] | 24.6 + 4.8z[d] [18.5 + 3.6][e] |
| London Clay Formation | 51.0 [6.5] | 20 | 110 + 8z [5] | 24[a] | 66 + 4.8z [50 + 3.6z] |

*a. BS 8002:1994 Code of practice for Earth retaining structures, British Standards institution.*

[12] Card, G.B. and Roche, D.P. (1988) The use of continuous dynamic probing in ground investigation. *Penetration testing in the UK*. Thomas Telford, London.

*b. z = depth below surface of the London Clay*
*c. Based on 600 Cu*
*d. Based on 0.75Eu*

The parameters in Table 8 are unfactored (Serviceability Limit State) and considered to be 'moderately conservative' design values.

## 5.5 Allowable bearing pressure

Based on the detailed drawings and ground conditions encountered, the proposed lower ground floor slab and underpins will be bearing into the weathered London Clay Formation at approximately 55.4mOD.

However, the bearing capacity of the London Clay at levels above 53.5mOD is typically 40kPa or less. This is unusual for the London Clay Formation and is based upon DPT results as discussed in Section 5.3.

On the basis of the available data, it is recommended the underpins are formed at a level of 52.5mOD, and the excavated trench is backfilled to a level of 55.4mOD to form the basement slab. The founding level of the underpins is equivalent to 5.0mbgl at the front of the property.

Based on a factor of safety of 3 to control settlements (i.e. <25mm) and a relative footing depth of 3.0m adjacent to the proposed basement excavation, an allowable bearing pressure of 120kPa is recommended for the London Clay Formation at a level of 52.5mOD.

This is a considerable excavation depth of a maximum of 6.5m below the existing ground floor level. It is recommended that a further ground investigation is undertaken to refine the shear strength parameters of the London Clay formation and reduce conservatism of the proposed design.

# 6. STAGE 4 π GROUND MOVEMENT ASSESSMENT

## 6.1 Introduction

This section provides calculations to assess ground movements that may result from the excavation of the lower ground floor to generally 3.6mbgl (55.4mOD) and how these may affect the adjacent structures. It is understood that traditional underpinning constructed in a single stage lift are proposed to support party walls.

Ground movements are derived from:

- Underpin Settlement: Construction of underpins beneath existing foundations can lead to settlement. The amount of settlement depends primarily on the quality of workmanship in constructing the underpins, in particular in dry-packing between the existing foundation and the new underpins. In addition, there may be settlement as structural loads are transferred to greater depth on to soils that have not previously been loaded.

- Underpin deflection: Underpins act as stiff concrete retaining walls, which limits the potential for wall deflection. Appropriate temporary works are critical in controlling such deflections.

- Heave movements: The London Clay is susceptible to short term heave and time dependant swelling on unloading, which will occur as a result of the proposed excavation, generating upward ground movements.

## 6.2 Conceptual Site Model and critical sections.

A conceptual site model (CSM) of the proposed site conditions has been developed based on the available data to illustrate the conceptual understanding of the ground model. Several critical sections are identified for assessment, shown on Figure 2:

- Critical Section A-A: Represents a line of section of some 4.0m in length orientated perpendicular to the proposed excavation, spanning the rear double storey structure of 75 Constantine Road. The assessment focuses on a section through the adjoining terraced property between party wall footings spaced at 3.5m and formed at an assumed level of 1.0mbgl (56.5mOD). The section is taken mid span along the excavation, considered as worst case along the underpinned party wall.

- Critical Section B-B: Represents a line of section of some 5.5m in length orientated perpendicular to the proposed excavation, spanning the rear elevation of 71 Constantine Road. The assessment focuses on a section through the adjoining terraced property party wall footings spaced at 5.5m, formed at an assumed depth of 1.0mbgl (56.5mOD). The section is taken mid span along the excavation, considered as worst case along the underpinned party wall.

- Critical Section C-C: Represents a line of section of some 17.0m in length orientated perpendicular to the proposed excavation, spanning the façades of Nos. 71, 73 and 75 Constantine Road. The assessment focuses on sections through the adjoining terraced facades some 5.5m in width, with footings formed at an assumed depth of 1.0mbgl (56.5mOD).

## 6.3 Underpin construction sequence

The lower ground floor beneath the existing property will be constructed using traditional underpinning techniques with pins excavated in sequence in bays typically 1.0m wide. It is assumed that the underpins will be constructed in a single lift within supported trenches. It is recommended that temporary propping be installed at the top, middle and bottom of the excavation to resist sliding and rotation of the wall prior to casting the lower ground floor slab.

The underpins will be generally supported in the permanent condition by the ground floor and proposed lower ground floor slab, which should be cast before removing the temporary propping.

Due to the low bearing capacity of the soil at the proposed formation level, it is considered the underpins will need to be formed at a level with a suitable bearing capacity. This is considered to be approximately 6.5 metres below the existing ground floor level (52.5mOD), some 3.0m below the lower ground floor slab formation level.

It is recommended that hand shear vane testing is conducted at regular intervals to determine the undrained shear strength (and bearing capacity) of the London Clay prior to casting the concrete underpins and floor slab.

### *6.3.1 Underpin loading*

The proposed development gives rise to a net unloading of the underlying strata both during construction and over the long term. The excavation will unload the soils at the lower ground floor slab formation level (55.4mOD) by some -70kPa. This value assumes a total excavation depth of 3.6m and a typical bulk unit weight of $19kN/m^3$ for the excavated soils to 1.5mbgl and $20kN/m^3$ thereafter.

The new underpins will generate line loads of 39kN/m, assuming 300mm thick underpins are formed from 2.5m below ground floor level (56.5mOD) to 6.5m below ground floor level (52.5mOD) with a 1.5m wide base with concrete of unit weight at approximately $25kN/m^3$.

A line load of 128kN/m for party walls has been provided by the structural engineers (SAT INC Ltd) and is presented as Appendix D. This generates a pressure of 111kPa at the base of the 1.5m wide underpin.

A line load of 30kN/m (as agreed with structural engineers) is applied to the underpins along the north-western extent of the excavation representing a glass conservatory structure proposed for the rear garden adjacent to the main structure. Line loads of 39kN/m are also applied to this location to represent loadings generated by underpins. This generates a pressure of 46kPa at the base of the underpins.

A load of $7.5kN/m^2$ has been applied in the long term at a level of 55.4mOD to represent loads exerted by the ground floor slab upon underlying soils. This is based on an assumed thickness of 0.3m and a unit weight of concrete of $25kN/m^3$.

## 6.4 Ground movements arising from lower ground floor excavation

A ground movement assessment has been undertaken using OASYS Limited *VDISP* (***V**ertical* ***DISP**lacement*) analysis software. *VDISP* assumes that the ground behaves as an elastic material under loading, with movements calculated based on the applied loads and the soil stiffness ($E_u$ and E’) for each stratum input by the user. *VDISP* assumes perfectly flexible loaded areas and as such tends to overestimate movements in the centre of loaded areas and underestimate movements around the perimeter. To account for this, the structure has not been modelled as an evenly loaded flexible raft and the loads from the underpins around the perimeter, as summarised in the previous sections, have been accounted for and modelled in the analysis.

It has been assumed in the analysis that the lower ground floor construction will be undertaken in one lift. During the analysis, the underpin loads are applied to the perimeter of the lower ground floor and the loads due to excavation (i.e. unloading of the ground) have been applied to the whole site, including below the underpins.

The heave/settlement assessment undertaken within *VDISP* assumes perfect workmanship in the underpin construction and does not allow for settlement of the dry pack between existing footings and the new concrete. With good construction practice, actual settlements would be expected to not exceed 5mm. This value has been applied to the overall ground movement and corresponding impact assessment to calculate a predicted damage category for the adjacent properties.

The results of the settlement analysis are summarised in Table 9, showing predicted heave or settlement values beneath the perimeter underpins, which is represented visually as short term and long term displacement contours in Figure 6.

***Table 9. Summary of underpin settlements at underpin foundation level of 52.5mOD***

| **Location** | **Maximum predicted vertical displacement beneath underpin[a] (mm)** | | | **Total displacement allowing 5mm workmanship settlement (mm)** |
|---|---|---|---|---|
| | **Short term conditions** | **Long term conditions** | **Total displacement (mm)** | |
| Critical Section A-A: 75 Constantine Road | 0.2 | 0.9 | 1.1 | 6.1 |
| Critical Section B-B: 71 Constantine Road | -0.5 | -0.3 | -0.8 | 4.2 |
| Critical Section C-C: 71 Constantine Road facade | 0.5 | 1.0 | 1.5 | 6.5 |
| Critical Section C-C: 71 Constantine Road facade | 0.2 | 0.7 | 0.9 | 5.9 |

*a. A positive number denotes settlement and a negative number denotes heave*

Maximum short term heave at lower ground floor slab formation level (55.4mOD) is predicted to be approximately 10.0mm occurring in the central region of the proposed excavation. Up to approximately 3.0mm of settlement occurs at the perimeter of the excavation. Short term heave is an immediate elastic response of unloading of soils at formation level. It is expected heaved soils in the short term will be removed as excavation proceeds.

Maximum long term heave at lower ground floor slab formation level predicted to be approximately 14.0mm occurring in the central region of the proposed excavation. Up to approximately 2.5mm of heave occurs at the perimeter of the excavation.

It is noted that over the long-term, movements are likely to be restrained by the new structure and therefore, are unlikely to fully realise the predicted values. In addition, it may be considered that soils at formation level have been subject to an element of loading from the existing structure, and have already experienced some level of consolidation.

Full *VDISP* output can be provided upon request.

## 6.5 Ground movement due to underpin wall deflection

Due to the relatively shallow excavation depth and the high stiffness of the reinforced concrete underpins, long term deflection is likely to be negligible (i.e. <2mm). This is based on CGL's experience with similar underpinned basement developments in the area.

During the works, lateral displacements should be resisted by sequential propping of the underpinned foundations. Trench sheeting may be employed if required to prevent localised collapse of the soil and should be appropriately supported.

# 7. DAMAGE CATEGORY ASSESSMENT

The calculated ground movements have been used to assess potential 'damage categories' that may apply to neighbouring properties due to the proposed construction. The methodology proposed by Burland and Wroth[13] and later supplemented by the work of Boscardin and Cording[14] has been used, as described in *CIRIA Special Publication 200*[15] and *CIRIA C580*[16]. General damage categories are summarised in Table 10 below:

***Table 10: Classification of damage visible to walls (reproduction of Table 2.5, CIRIA C580)***

| Category | Description |
|---|---|
| 0 (Negligible) | Negligible – hairline cracks |
| 1 (Very slight) | Fine cracks that can easily be treated during normal decoration (crack width <1mm) |
| 2 (Slight) | Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm). |
| 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 (crack width 5 to 15mm or a number of cracks > 3mm). |
| 4 (Severe) | Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but also depends on number of cracks). |
| 5 (Very Severe) | This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks). |

For the critical neighbouring developments (i.e. critical sections) the combined impacts of short term heave, long term heave due to excavation and workmanship allowances have been combined to determine the overall ground movement and impact on adjacent properties due to the construction of the lower ground floor.

[13] Burland, J.B., and Wroth, C.P. (1974). *Settlement of buildings and associated damage*, State of the art review. Conf on Settlement of Structures, Cambridge, Pentech Press, London, pp611-654

[14] Boscardin, M.D., and Cording, E.G., (1989). *Building response to excavation induced settlement*. J Geotech Eng, ASCE, 115 (1); pp 1-21.

[15] Burland, Standing J.R., and Jardine F.M. (eds) (2001), *Building response to tunnelling, case studies from construction of the Jubilee Line Extension London*, CIRIA Special Publication 200.

[16] CIRIA C580 (2003) *Embedded Retaining Walls – guidance for economic design*

## 7.1 Damage Assessment of neighbouring structures

The maximum deflection ratio and horizontal strain of the neighbouring boundary party walls as derived from the ground movement assessment are summarised in Table 11. The method for calculating the deflection ratios for the structures of Nos.71 and 75 Constantine Road building is presented graphically in Figure 7 and Figure 8 respectively. Figure 9 presents vertical movements through the facades of Nos.71, 73 and 75 Constantine Road.

The deflection ratio is calculated by combining the ground movement profiles from heave due to excavation, settlement due to underpin loading and allowances made for workmanship (5mm settlement).

Lateral movements occur due to deflection (sliding or rotation) of the underpins, and are presented as maximum limiting values to achieve the lowest possible category of damage. These movements are taken at footing levels across the span of adjacent structure which are used to calculate lateral strains.

With reference to published data[13] the limiting horizontal strain for a structure constructed of brickwork/blockwork set in cement mortar should not exceed 0.075%[14] to constrain damage to the structure to within Category 1 (very slight damage). This limiting value is applied to Critical Sections A-A and B-B.

***Table 11: Summary of ground movements and corresponding damage category***

| Boundary Wall Reference | Maximum allowable underpin deflection (mm) | Maximum calculated deflection (mm) | Horizontal Strain $\Delta/L^b$ (%) | Deflection ratio $\delta_h/L^a$ (%) | Damage category |
|---|---|---|---|---|---|
| Section A-A | 2.1 | 1.0 | 0.06 | 0.029 | 1 – very slight |
| Section B-B | 3.8 | 0.6 | 0.069 | 0.011 | 1 – very slight |
| Section C-C 71 | 3.8 | 0.5 | 0.069 | 0.009 | 1 – very slight |
| Section C-C 75 | 3.9 | 0.4 | 0.071 | 0.007 | 1 – very slight |

a. *See Figure 2.18 (a) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (L = length of adjacent structure in metres, perpendicular to basement; Δ = relative deflection)*
b. *See Box 2.5 (v) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. ($\delta_h$ = horizontal movement in metres).*

In Critical Section A-A, combined ground movements are predicted to result in Category 1 ‘very slight’ damage to 75 Constantine Road (rear double storey portion of the structure at

3.5m in width) if lateral movements can be limited to 2.1mm. A further sensitivity analysis shows that Category 0 'negligible' damage may be achieved if lateral movements of the underpin can be limited to 1.2mm.

In Critical Section B-B, combined ground movements are predicted to result in Category 1 'very slight' damage to 73 Constantine Road (rear elevation) if lateral movements can be limited to 3.8mm. A further sensitivity analysis shows that Category 0 'negligible' damage may be achieved if lateral movements of the underpin can be limited to 2.4mm.

In Critical Section C-C, combined ground movements are predicted to result in Category 1 'very slight' damage to the facades of Nos. 71 and 73 Constantine Road if lateral movements can be limited to 3.8mm and 3.9mm respectively. A further sensitivity analysis shows that Category 0 'negligible' damage may be achieved if lateral movements of the underpins can be limited to 2.5mm.

The structure interaction chart is presented as Figure 10.

# 8. MONITORING STRATEGY

The results of the ground movement analysis suggest that with good construction control, damage to adjacent boundary walls generated by the assumed construction methods and sequence can be controlled to within Category 0 'negligible' damage.

A formal monitoring strategy should be implemented on site in order to observe and control ground movements during construction, and in particular movements of the adjacent properties.

The system should operate broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185[17]. Monitoring can be undertaken by installing survey targets to the top of the wall and face of the adjacent buildings. Baseline values should be established prior to commencement of works. Monitoring of these targets should be carried out at regular time intervals and the results should be analysed to determine if any horizontal translation of the wall or tilt/settlement of the neighbouring walls is occurring. Regular monitoring of these targets will allow ground movement trends to be detected in a timely manner such that mitigation strategies may be implemented if required.

Monitoring data should be checked against predefined trigger limits and reviewed regularly to assess and manage the damage category of the adjacent buildings as construction progresses.

It is recommended that a condition survey is undertaken on all adjacent walls and property façades prior to the works commencing and ideally when monitoring baseline values are established. Existing cracks or structural defects should be carefully recorded, documented and regularly inspected as construction progresses.

[17] Nicholson, D., Tse, Che-Ming., Penny, C., The Observational Method in ground engineering: principles and applications, CIRIA report R185, 1999.

# 9. NON-TECHNICAL SUMMARY

## 9.1 General

The findings of this Basement Impact Assessment are informed by site investigation data and proposed construction sequences and loadings provided by the structural engineer. The analysis is undertaken on the assumption of high quality workmanship during the construction of the lower ground floor.

- A screening and scoping assessment has been carried out for the basement. It is not anticipated that the basement will have an effect on surface run-off or groundwater flow, and the basement impact assessment therefore considers ground movement and the effect on party wall structures primarily.

- A ground investigation has been undertaken, which, strictly interpreted, suggests that the London Clay is very soft for considerable depth at the front of the property. This finding is inconsistent with the London Clay in general and indicates that very deep front underpinning is required. This data has been carried through within this report to provide a conservative analysis, however it is recommended that a further site investigation is undertaken prior to commencement of the works to ascertain a ground strength profile by a standard means to remove the conservatism inherent in the design.

- Further investigations should be supplemented with Hand Shear Vane testing at regular intervals during construction to record direct shear strengths of the soil. Such an investigation may remove conservatism from the recommended underpin foundation level adopted in this report, which is based upon Dynamic Penetration Testing correlations for granular soils. The resultant ground strength profile is not considered typical for the London Clay Formation.

- Due to the depths of the proposed underpins, it is recommended that a very cautious construction methodology must be adopted due to potentially high active pressures acting upon the rear of the underpin and suitable propping should be used to limit lateral sliding or rotation of the underpins.

- The ground strength profile is considerably lower than anticipated for the weathered London Clay Formation. A lower undrained shear strength equates to a much reduced deformation modulus of the soil, resulting in localised and increased predicted vertical displacements. It is not anticipated that heave movements of the predicted magnitude will be realised from such a soil, as it is considered the soil would compress against the base of the ground bearing slab. It is not considered therefore that the maximum predicted heave of 14mm at the centre of the excavation would be realised.

- For Critical Sections A-A , B-B and C-C the maximum damage category predicted based on combined lateral and vertical ground movement profiles is Category 1 'very slight' damage, equating to fine cracks that can easily be treated with normal decoration (crack width <1mm). It is possible to reduce this to Category 0 'negligible' damage if underpin movements can be suitably limited.

- Based on the results of the ground movement assessment, it is considered that the neighbouring terrace properties on Constantine Road positioned greater than 5.5m from the excavation are located outside the zone of influence from ground movements and will be subjected to negligible damage (i.e. Category 0) from the proposed lower ground floor development.

- Short term heave movements within the excavation will occur instantaneously upon unloading and will be removed during the excavation process. They should therefore be discounted from any anticipated heave movements beneath the sub lower ground floor slab at formation level, where only long term heave movements to a maximum of 14.0mm at centre decreasing to 2.5mm at excavation perimeter will occur.

- Groundwater is recorded in boreholes WS1 and WS2 representing shallow perched groundwater within Made Ground. These are not anticipated to be laterally pervasive in a principally cohesive soil. The contractor must be aware of this potential for groundwater to exist at a shallow level prior to excavation.

- An overall heave regime does not extend over the adjacent pavement into Constantine Road carriageway. It is considered the proposed works will have negligible impact upon the carriageway and underlying infrastructure.

- It is recommended that a condition survey is undertaken and an appropriate monitoring regime is adopted to manage risk and potential damage to the neighbouring structures as construction progresses onsite.

- The excavation is not expected to alter the local groundwater regime over the Long term due to presence of impermeable London Clay and based on the groundwater observation during the current site investigation.

- The proposed development is not considered detrimental to the attenuation and infiltration characteristics of the site. A proposed lawn in lieu of an existing hard standing to the rear garden is expected to positively affect the site in terms of surface water flow.

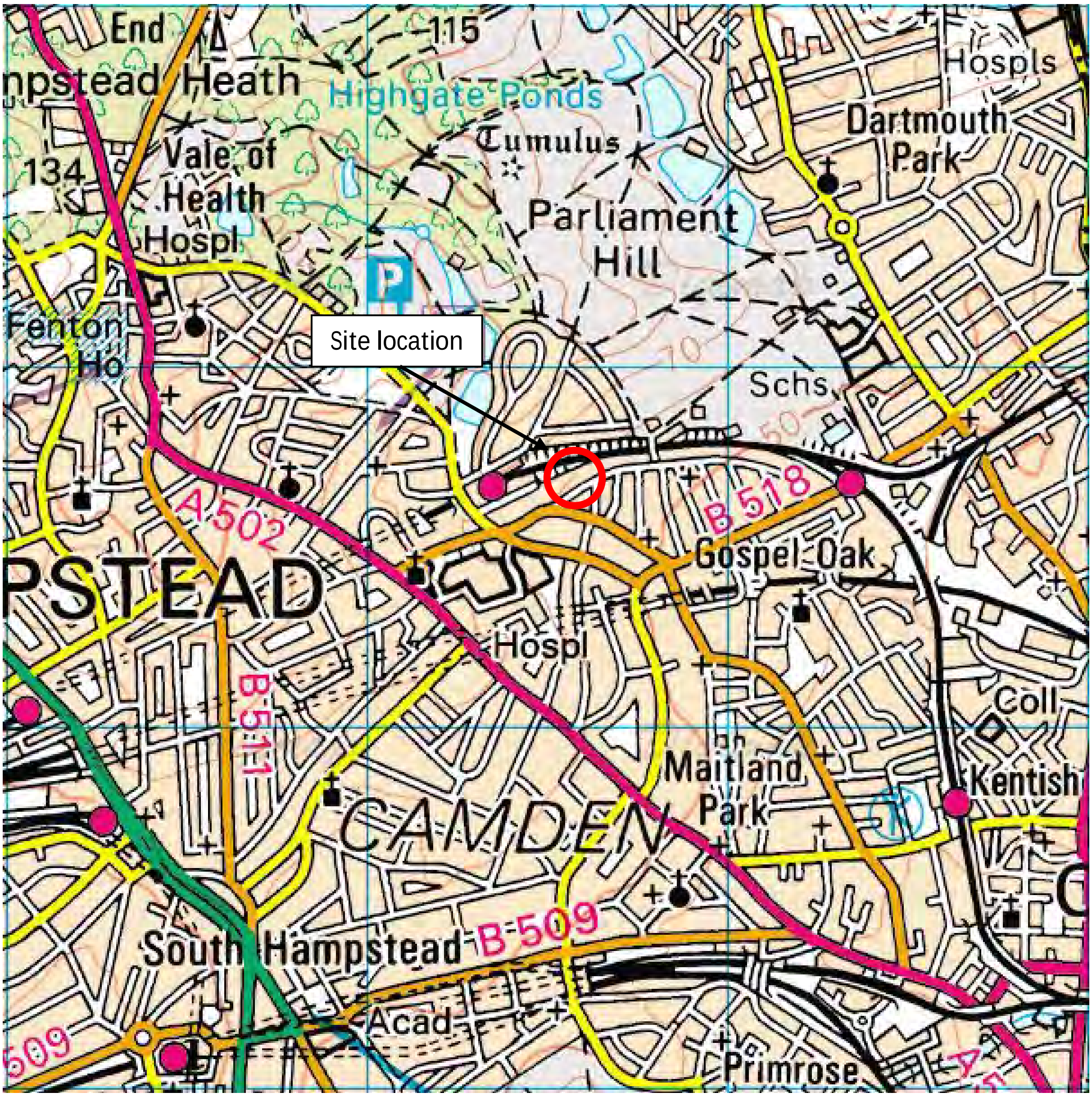
## 9.2 Cumulative impacts

Based on the available information, it is understood that the surrounding properties do not include basements. On this basis, it is considered that there are no significant cumulative impacts in respect of ground or slope stability due to the proposed development. Considering the site investigation data provided, underpinning to approximately 6.5m below the existing ground floor level is required to reach soils of a suitable bearing capacity.

The ground conditions beneath the site comprise Made Ground over cohesive London Clay. The proposed basement is to be founded within the London Clay. Groundwater has been encountered at a shallow level within the Made Ground, corresponding to a depth above the basement. On this basis, groundwater is free to flow around the proposed basement, and it is therefore considered that the proposed development would not contribute further to any cumulative effects.

The proposed development will not materially alter the proportion of hard standing across the site. It is understood that the existing and proposed surface water run-off is currently discharged to the drainage network through existing connections. The creation of a new lawn in the rear garden as replacement for hard standing is likely to increase the attenuation characteristics of the site. On this basis, the development is not considered likely to contribute to any significant cumulative impact with regard to surface flow or flooding.

# FIGURES

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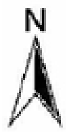
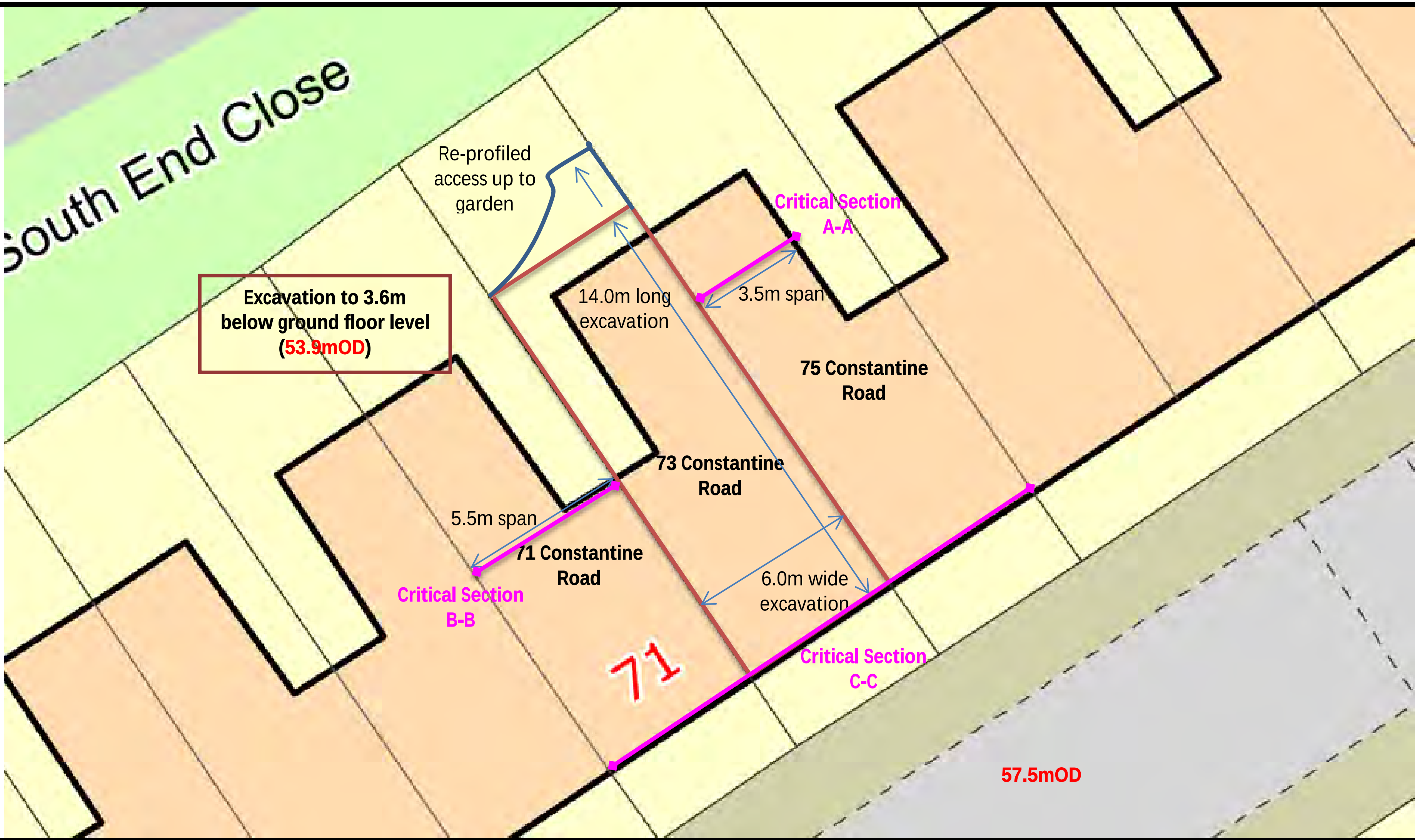
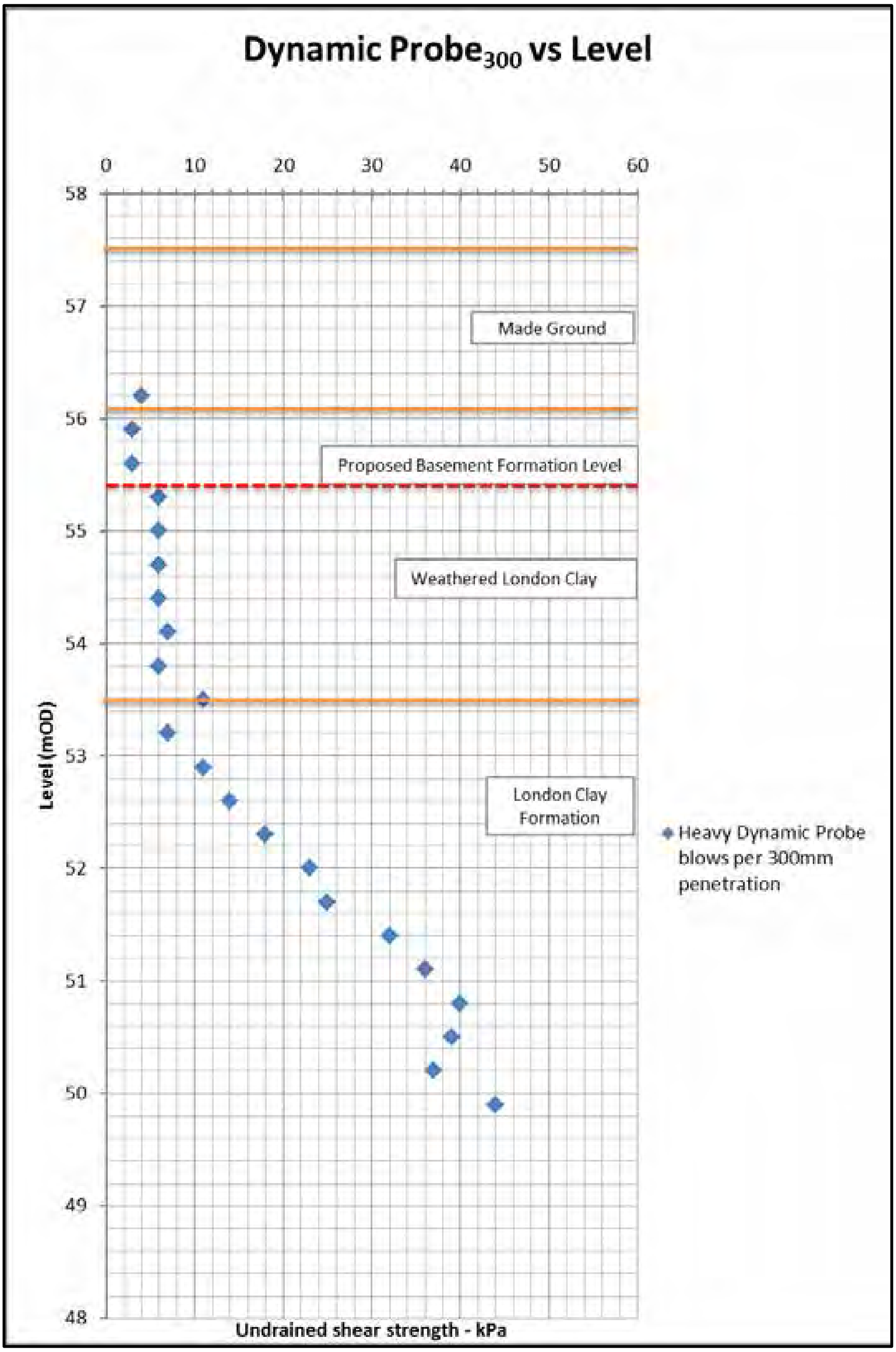


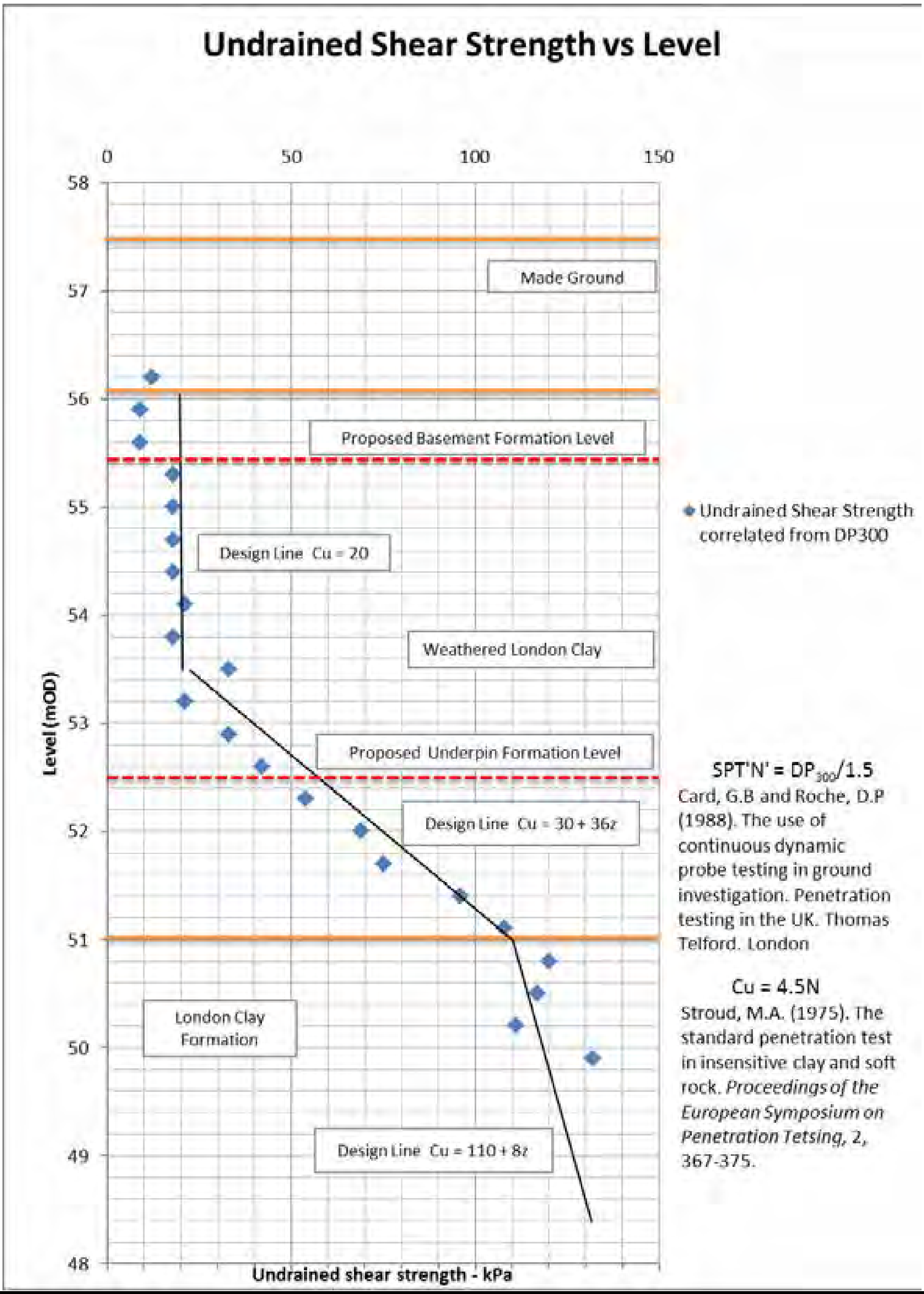

| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| | Title<br>**Site location plan** | **Figure 1** |



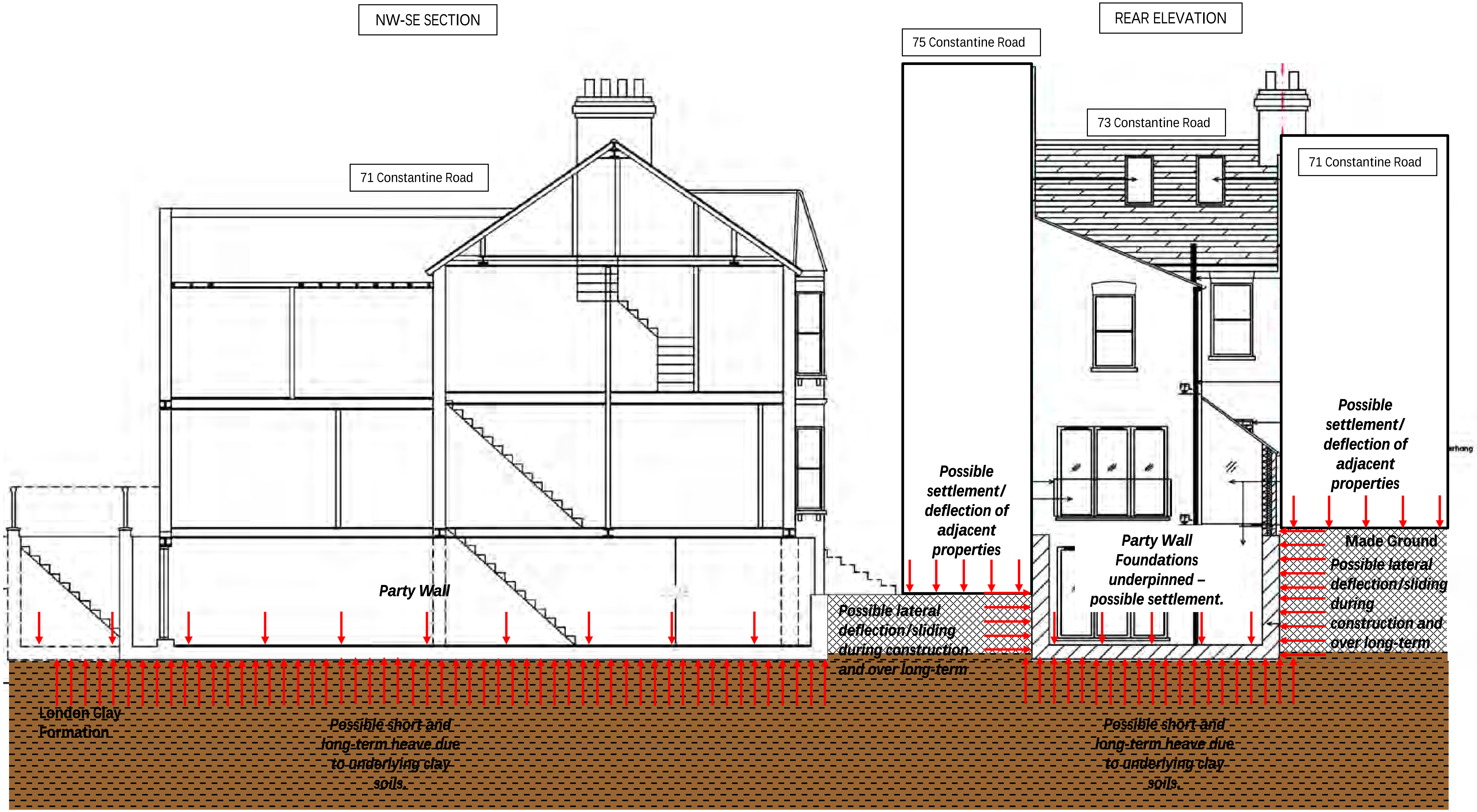

| Client | Project | Job No |
|---|---|---|
| CG Contractors (Herts) Limited | 73 Constantine Road, Hampstead, London | CG/18117 |
| CGL | Title: Site layout and critical sections plan | Figure 2 |




| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| | Title<br>**DP300 vs Level** | **Figure 3** |




| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| CGL | Title<br>**Undrained shear strength vs Level** | **Figure 4** |



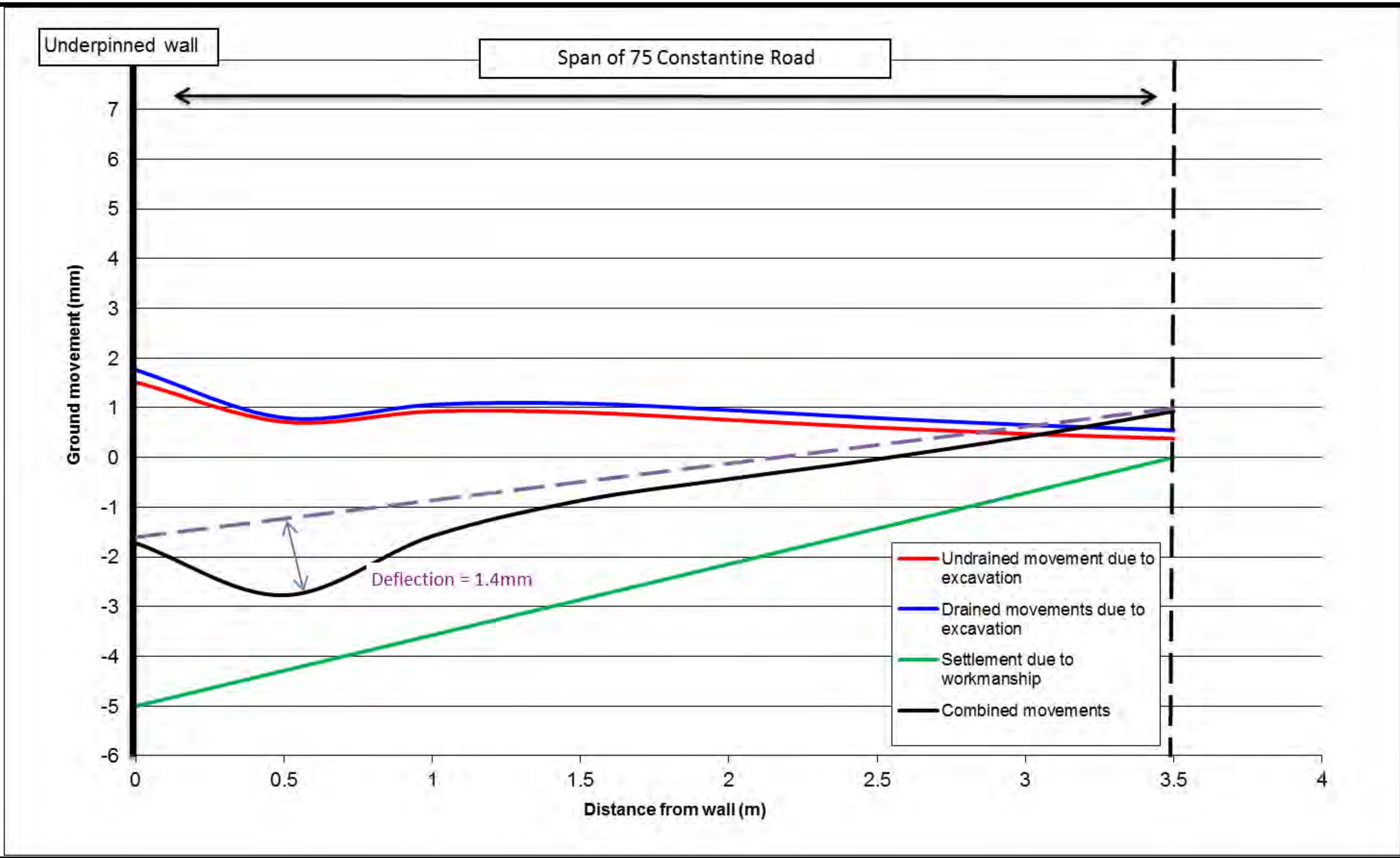

| Client | Project | Job No |
|---|---|---|
| CG Contractors (Herts) Limited | 73 Constantine Road, Hampstead, London | CG/18117 |
| CGL | Title: Conceptual Site Model | Figure 5 |


Short Term Heave

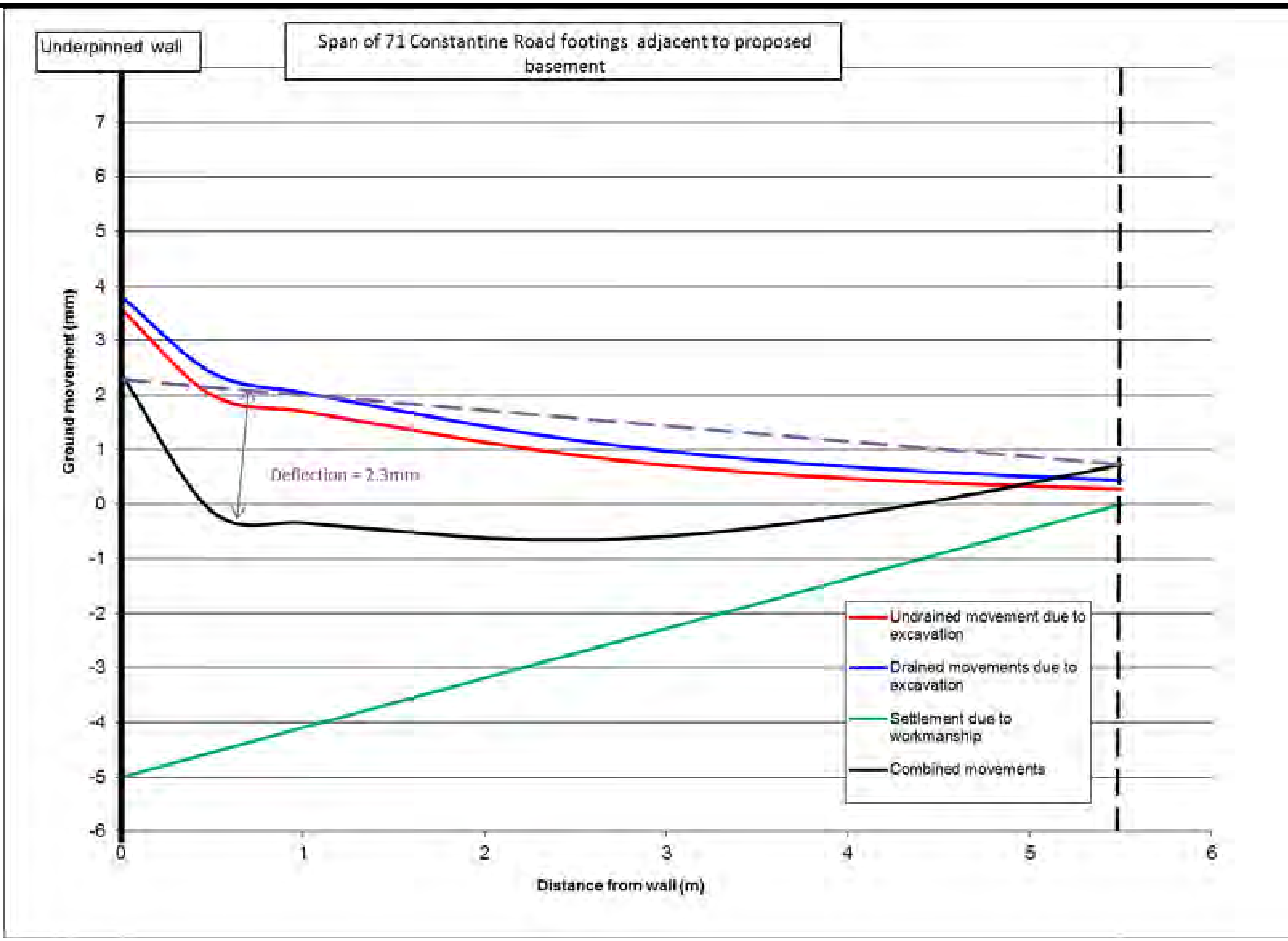

Long Term Heave

Negative values indicate heave, Positive values indicate settlement

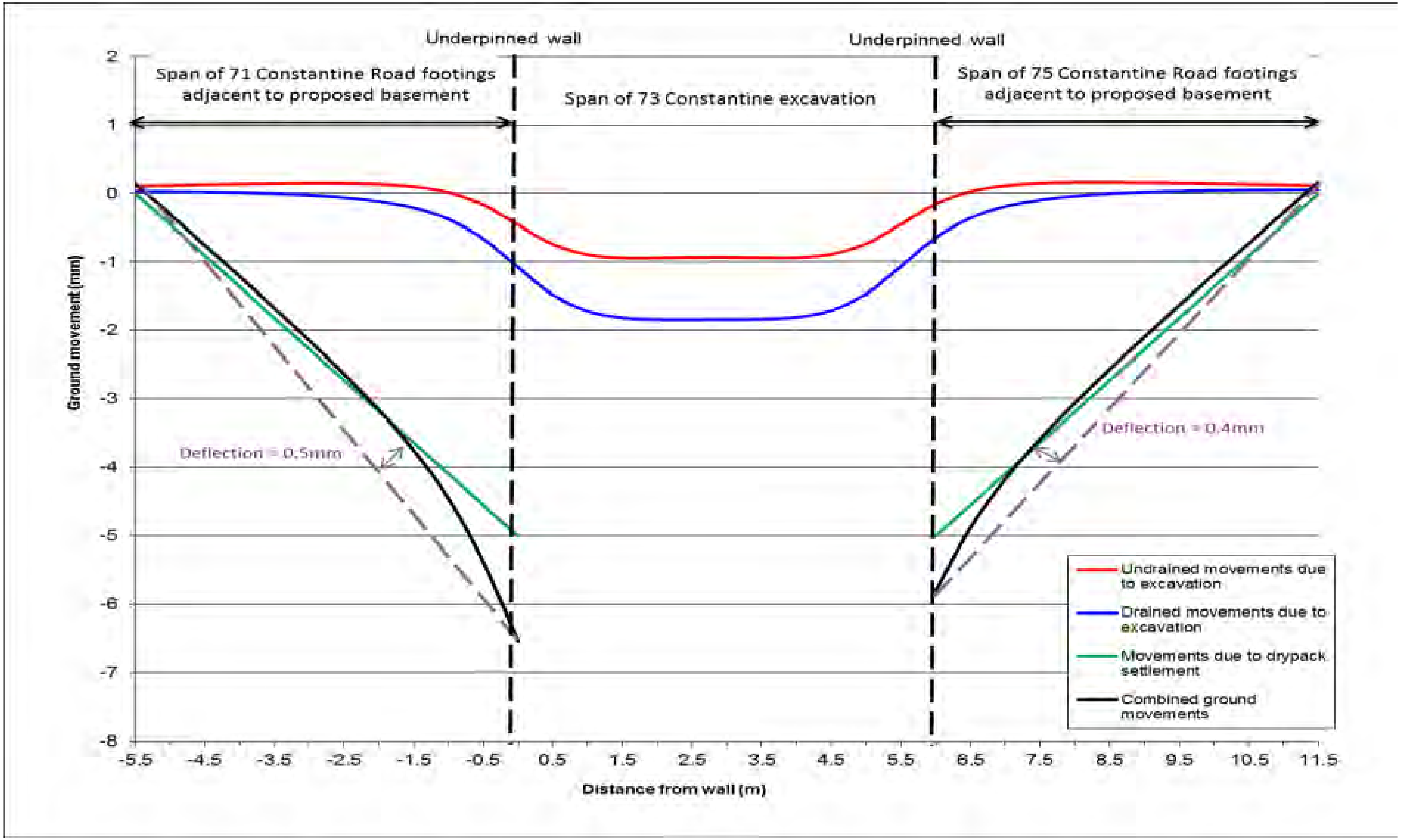
| Client | Project | Job No |
|---|---|---|
| CG Contractors (Herts) Limited | 73 Constantine Road, Hampstead, London | CG/18117 |
| CGL | Title: Short and Long Term vertical displacement contours | Figure 6 |



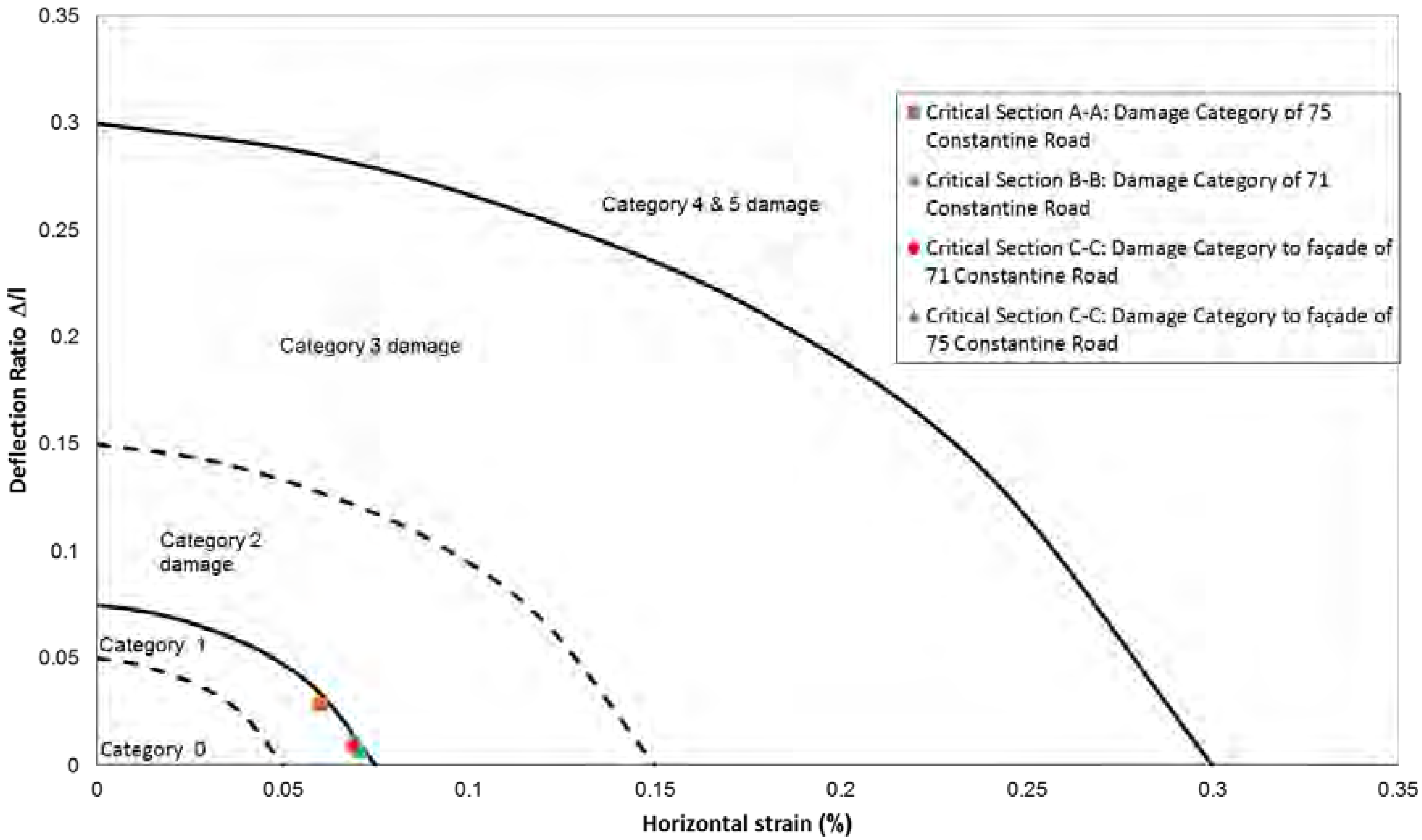

| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| CGL | Title<br>**Combined vertical displacements - Critical section A-A** | **Figure 7** |




| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| CGL | Title<br>**Combined Vertical Displacements - Critical Section B-B** | **Figure 8** |



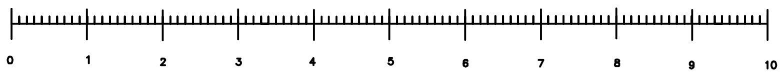

| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| | Title<br>**Combined Vertical Displacements Critical Section C-C** | **Figure 9** |



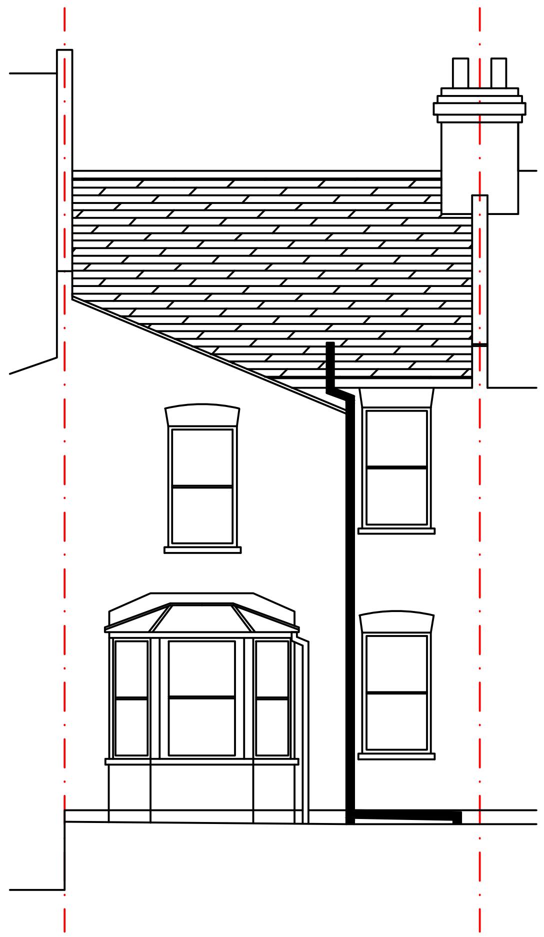

| Client | Project | Job No |
|---|---|---|
| **CG Contractors (Herts) Limited** | **73 Constantine Road, Hampstead, London** | **CG/18117** |
| CGL | Title<br>**Structural Interaction Chart** | **Figure 10** |

# APPENDIX A

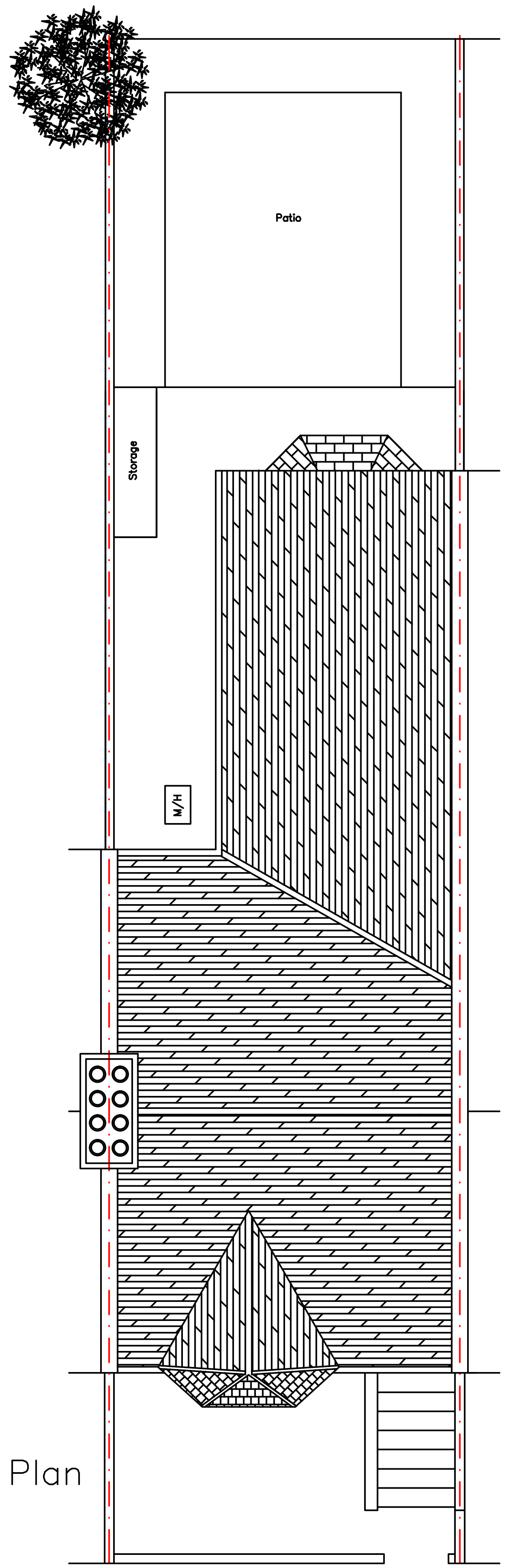
*Proposed development plans and sections*




Existing Front Elevation



Existing Rear Elevation




Existing Roof Plan

**General Notes**

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- Issue: Party Wall Agreement with Neighbouring Property

Loft Conversion Including Front & Rear Conservation Roof Lights Single Storey Side Extension & Formation of Basement Level with Associated Works

PLANNING DRAWING

| No. | Revision/Issue | Date |
|---|---|---|
| | | |
| | | |

Firm Name and Address

CG – Contractors Ltd
Office 8
Britannic House
Stirling Way, Herts
WD6 2BT

Project Name and Address

Mr & Mrs Jones
73 Constantine Road
Hampstead, London
NW3 2LP

| | |
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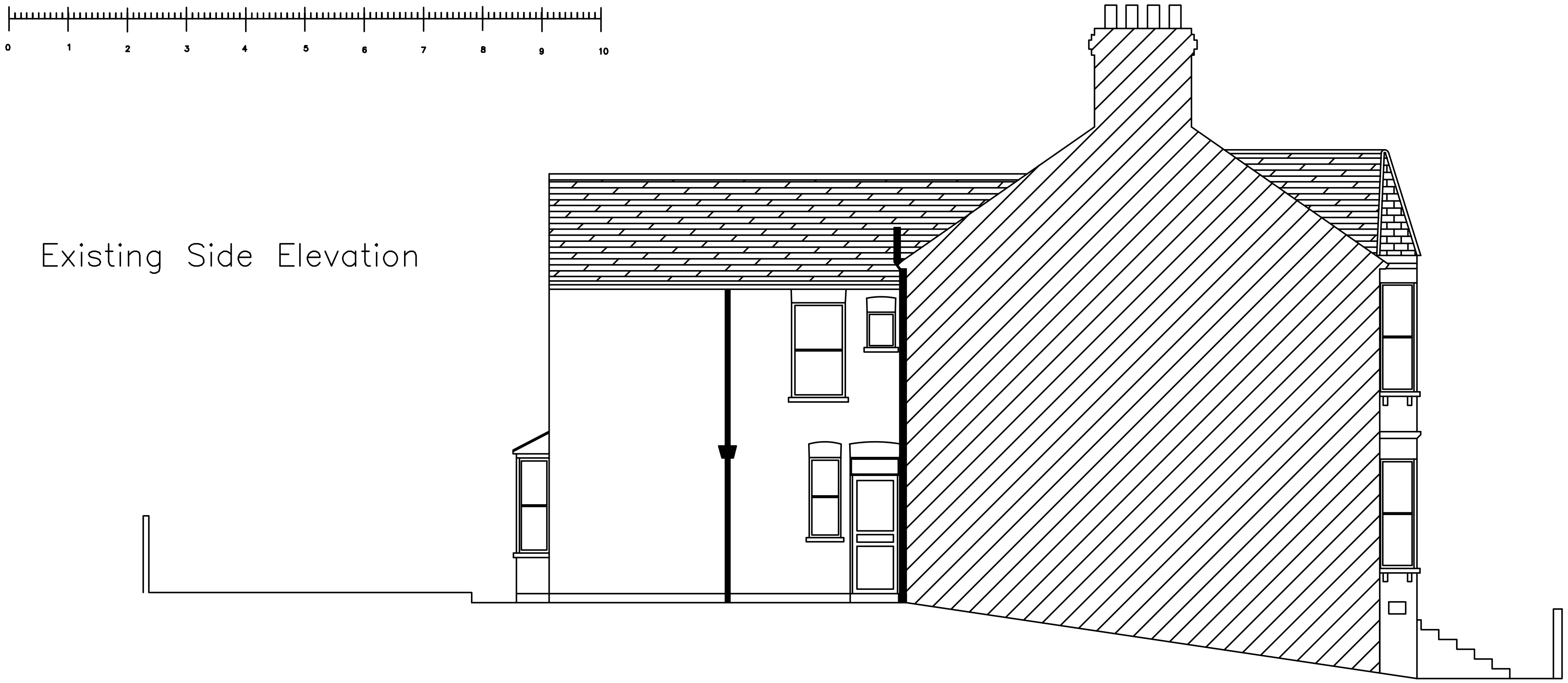
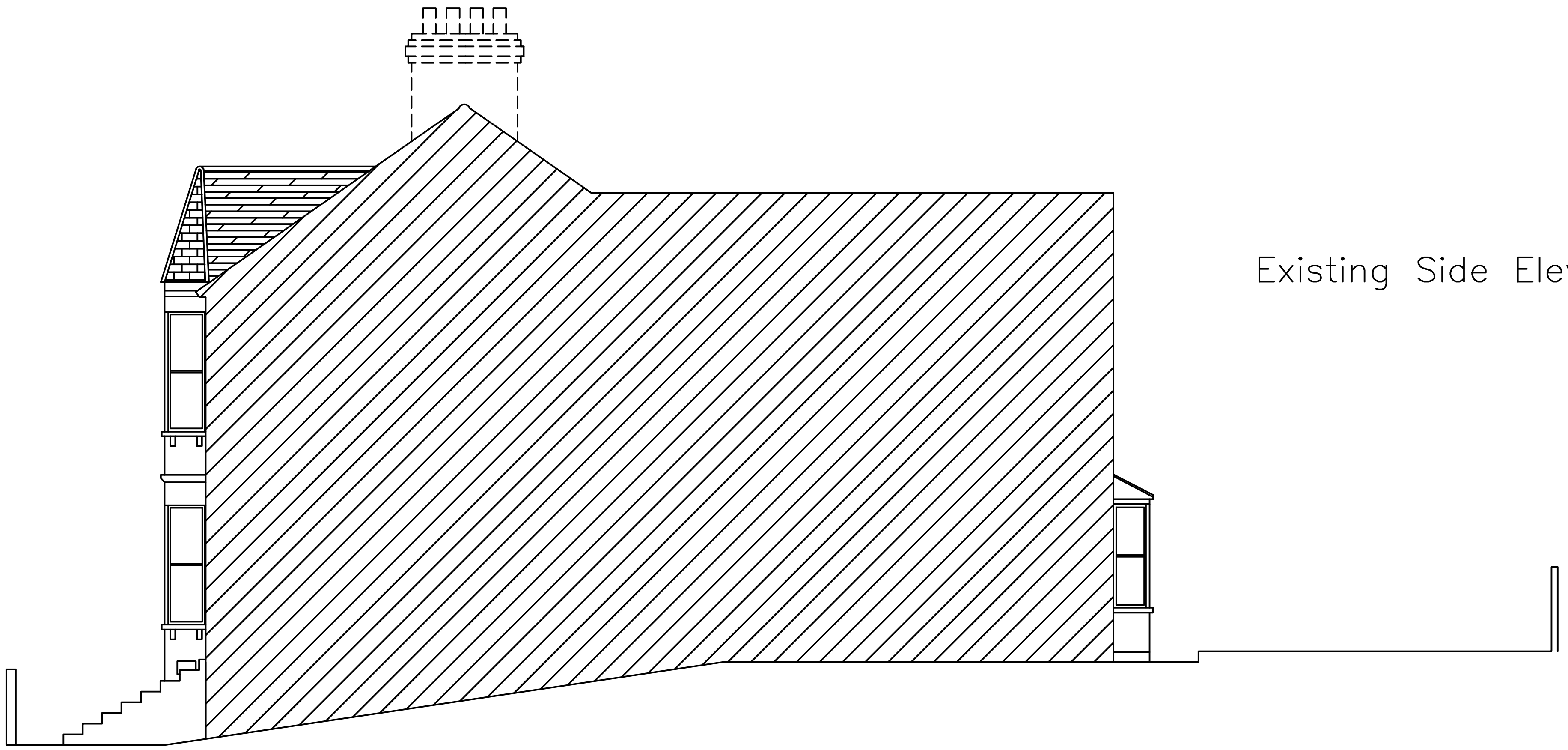
| Date: 14/01/2014 | |
| Scale: 1:100 | |




Existing Side Elevation



Existing Side Elevation

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Hampstead, London
NW3 2LP

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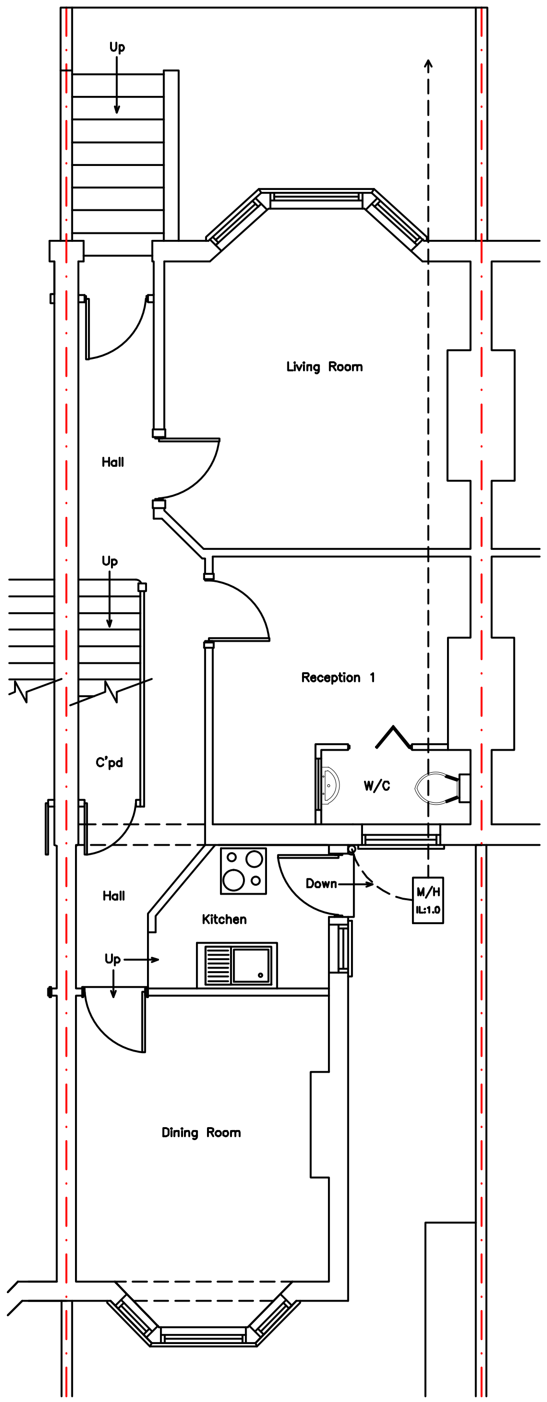
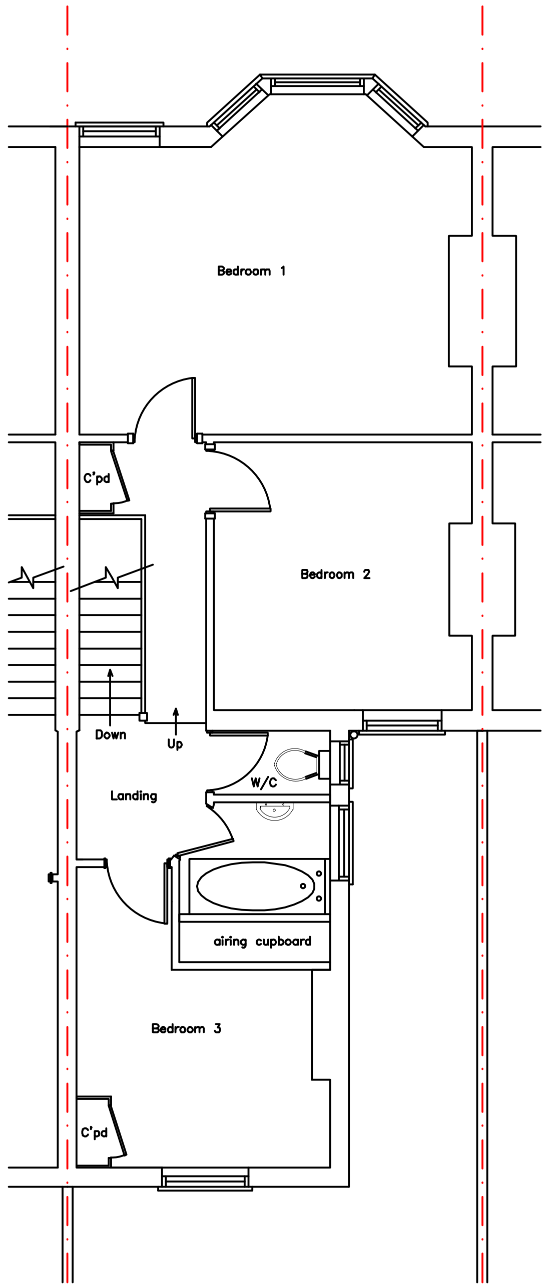
|---|---|
| Paper Size – A3 | Drawing No |
| Date 14/01/2014 | 73Cnstn/13/02 |
| Scale 1:100 | |

0 1 2 3 4 5 6 7 8 9 10

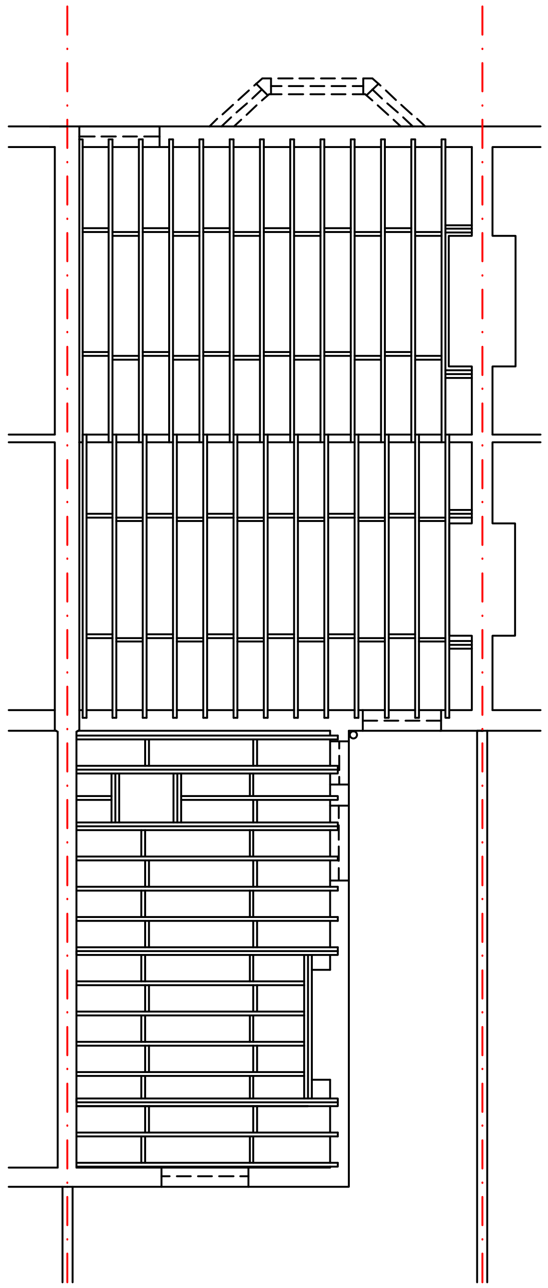
Existing Foul Drainage System




Existing Ground Floor




Existing First Floor



Existing Loft Plan

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|---|---|---|
| | | |
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| | |
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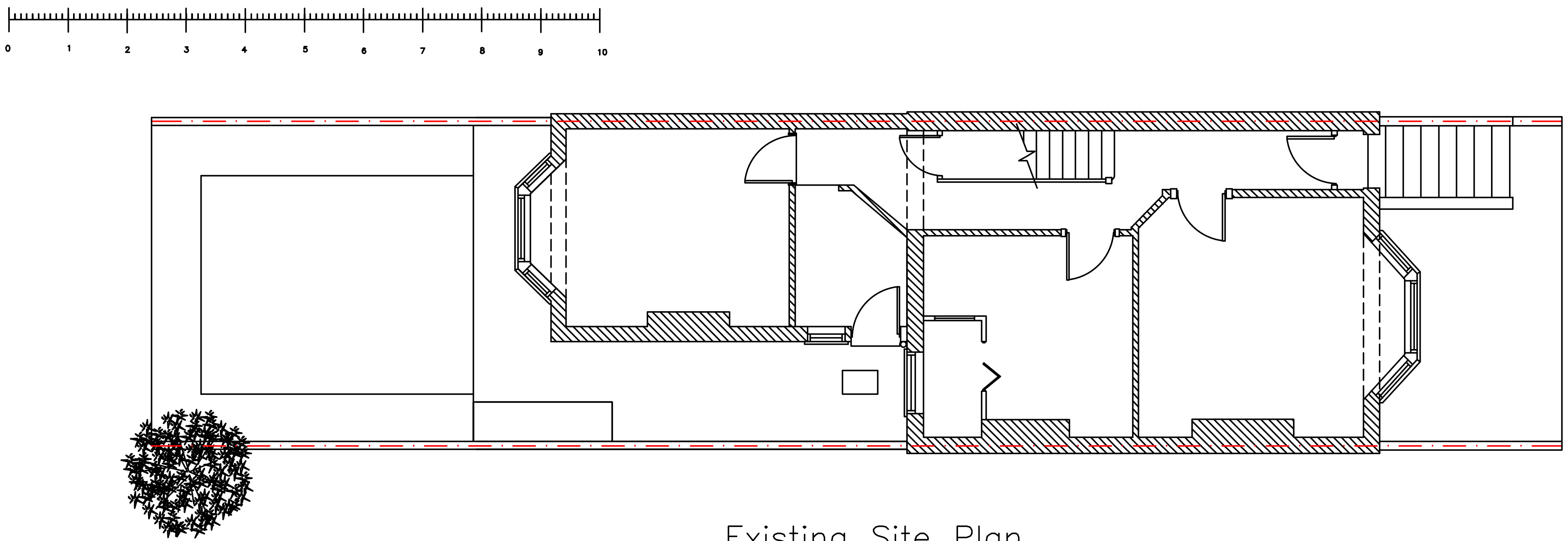
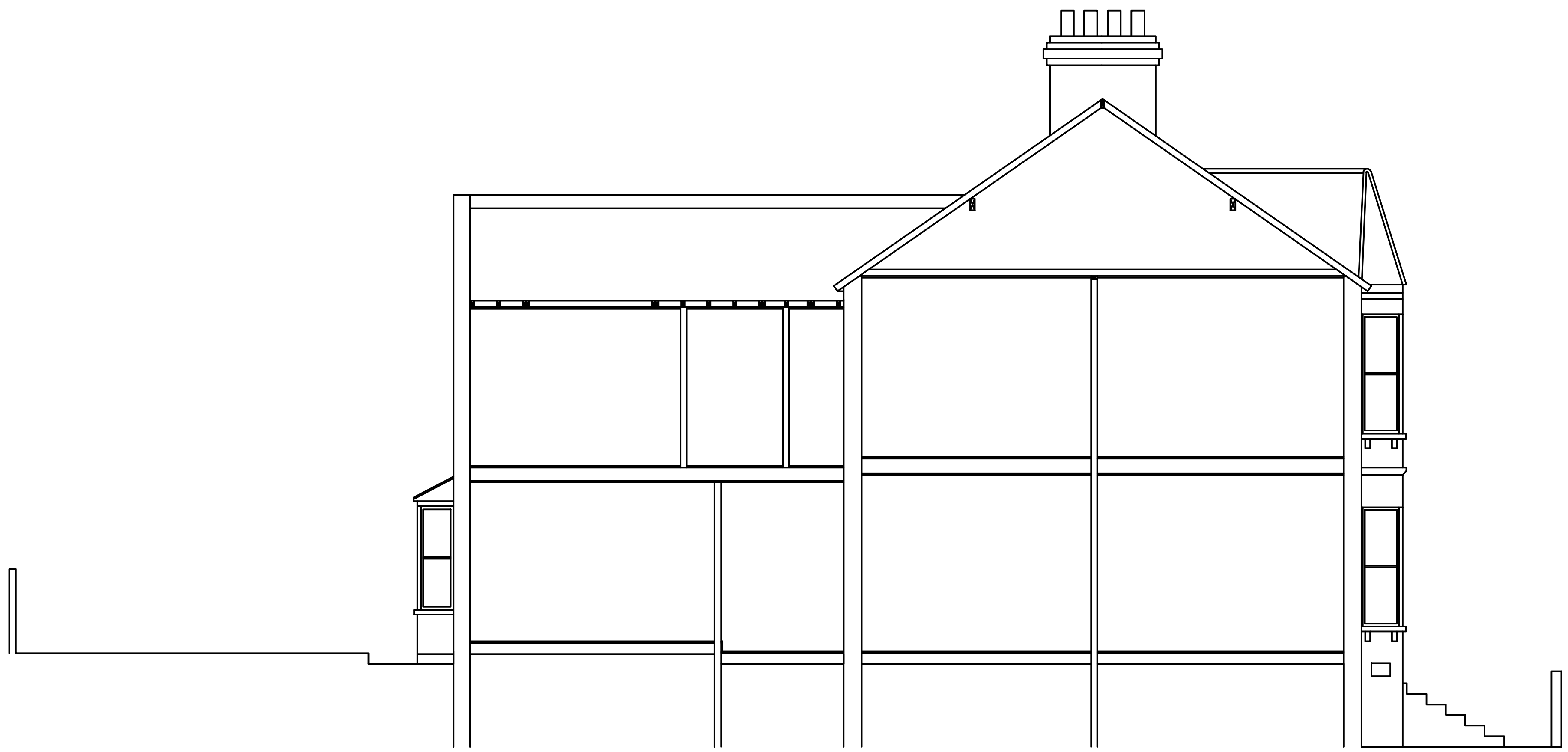



Existing Site Plan



Existing Section

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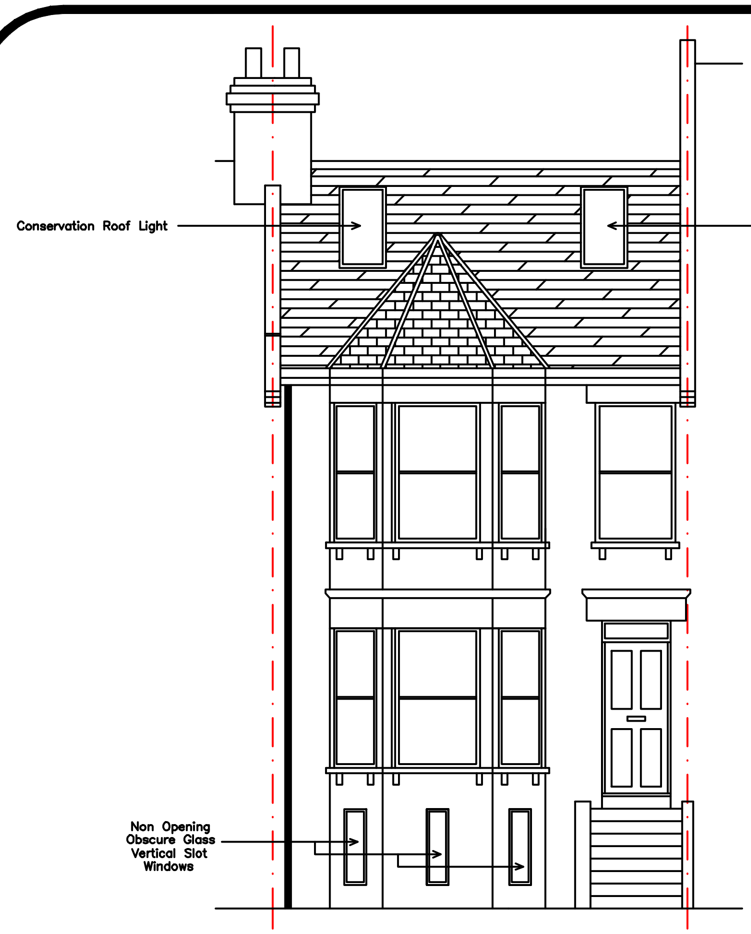
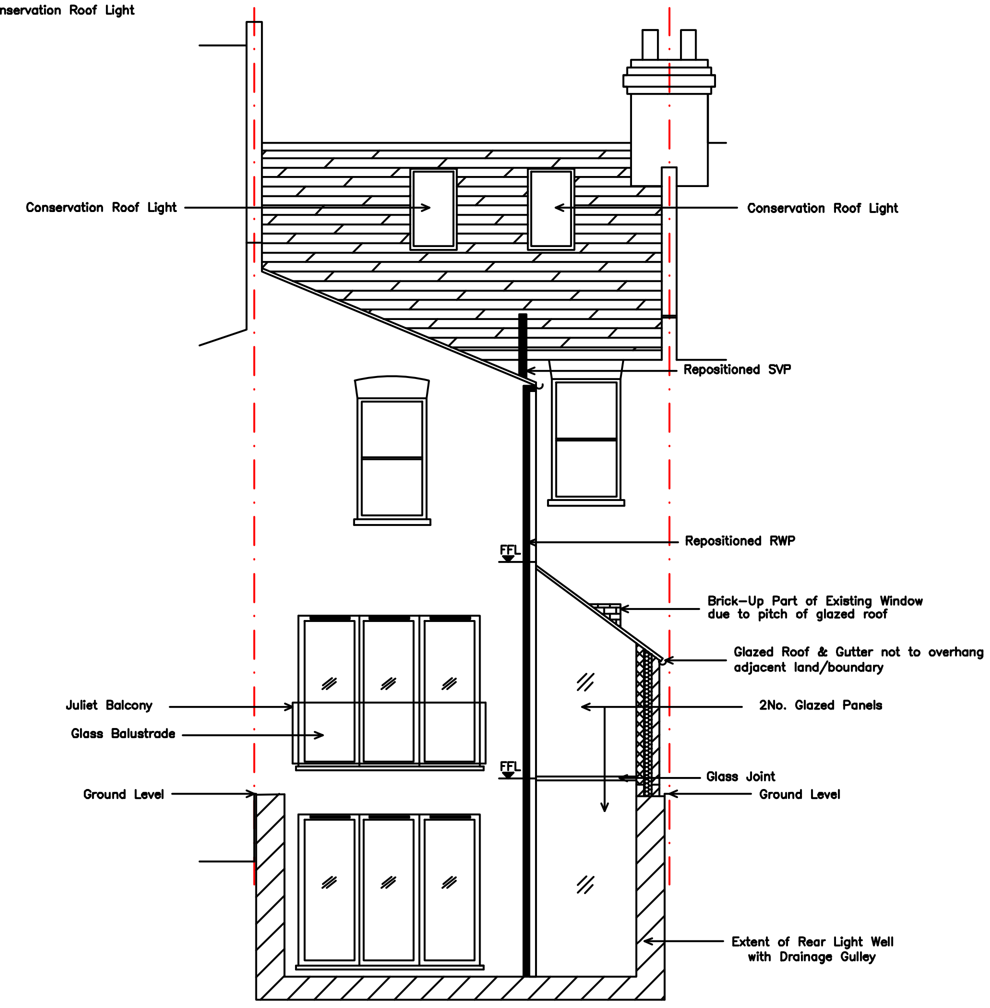
| | |
|---|---|
| Project: Paper Size – A3 | Sheet |
| Date: 14/01/2014 | Drawing No: 73Cnstn/13/04 |
| Scale: 1:100 | |

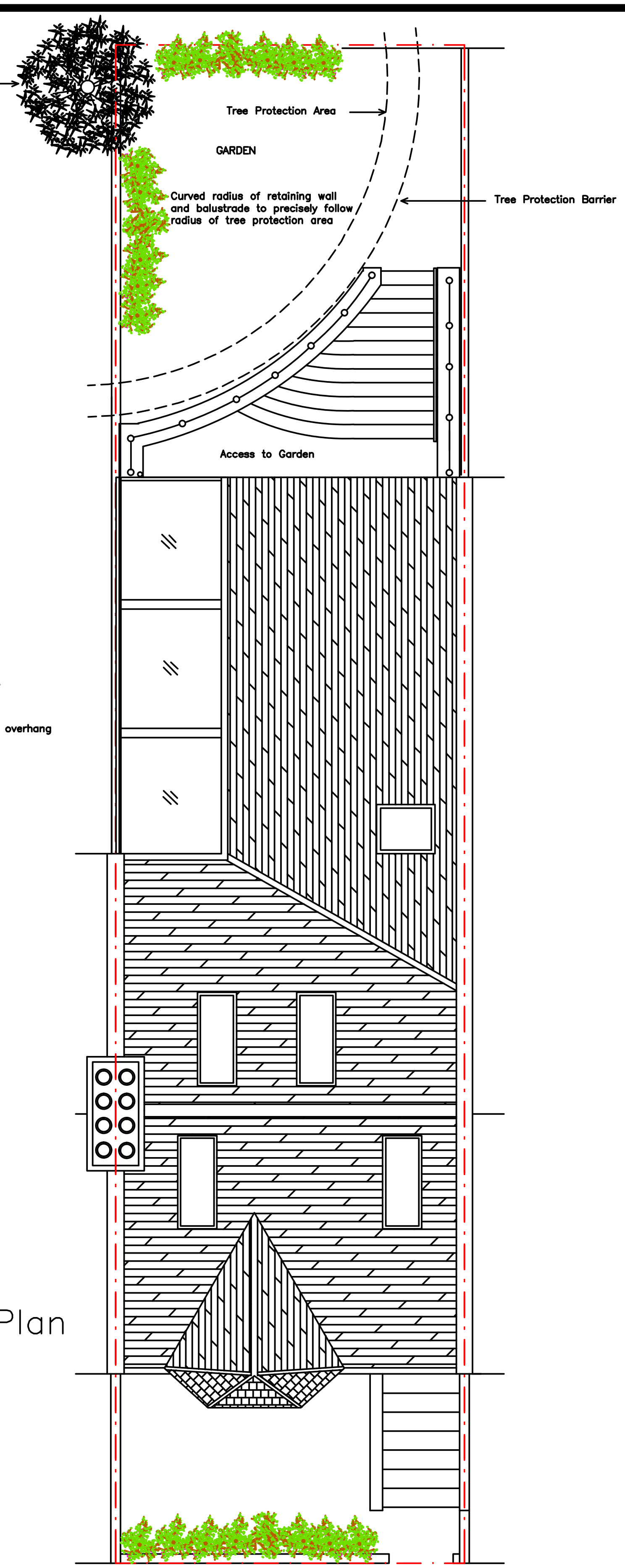
# Proposed Front Elevation



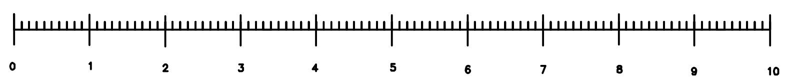

# Proposed Rear Elevation




# Proposed Roof Plan




# Proposed Street Scene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|---|---|---|
| | | |
| | | |

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WD6 2BT

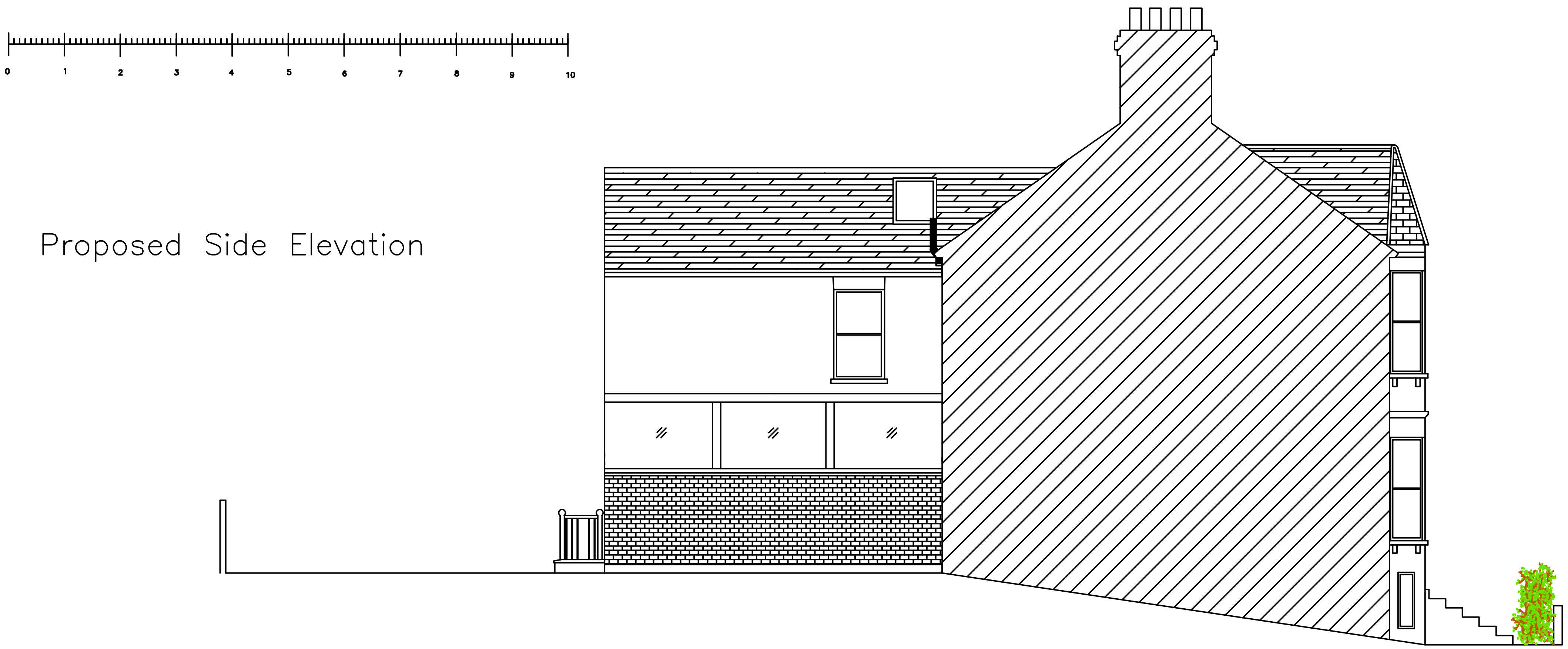
Project Name and Address

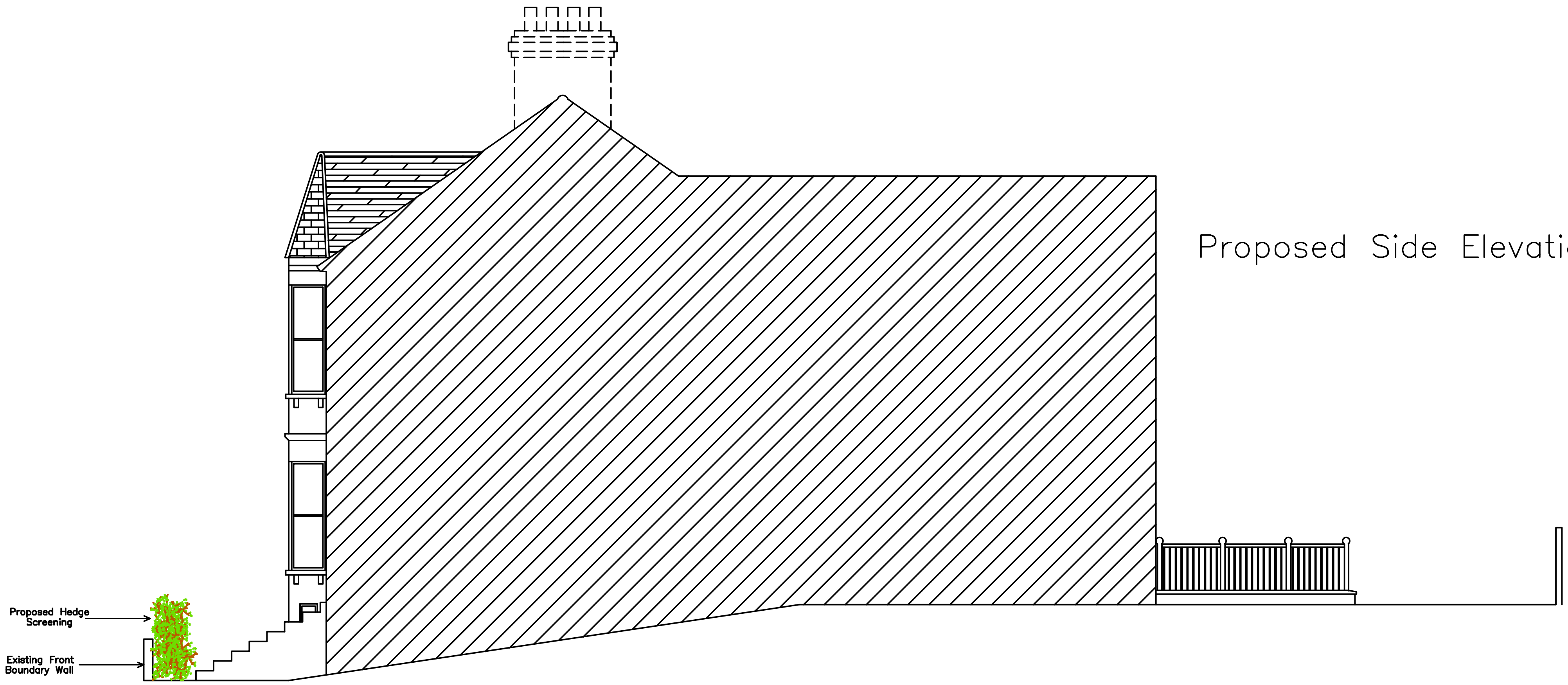
Mr & Mrs Jones

73 Constantine Road
Hampstead, London
NW3 2LP

Project: Paper Size - A3
Date: 14/01/2014
Scale: 1:100
Sheet: Drawing No 73Cnstn/13/05

## Proposed Side Elevation






## Proposed Side Elevation

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| No. | Revision/Issue | Date |
| --- | --- | --- |
| | | |
| | | |

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Project Name and Address

Mr & Mrs Jones

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Hampstead, London
NW3 2LP

| Project | Sheet |
| --- | --- |
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| Date: 14/01/2014 | 73Cnstn/13/06 |
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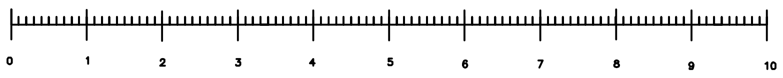


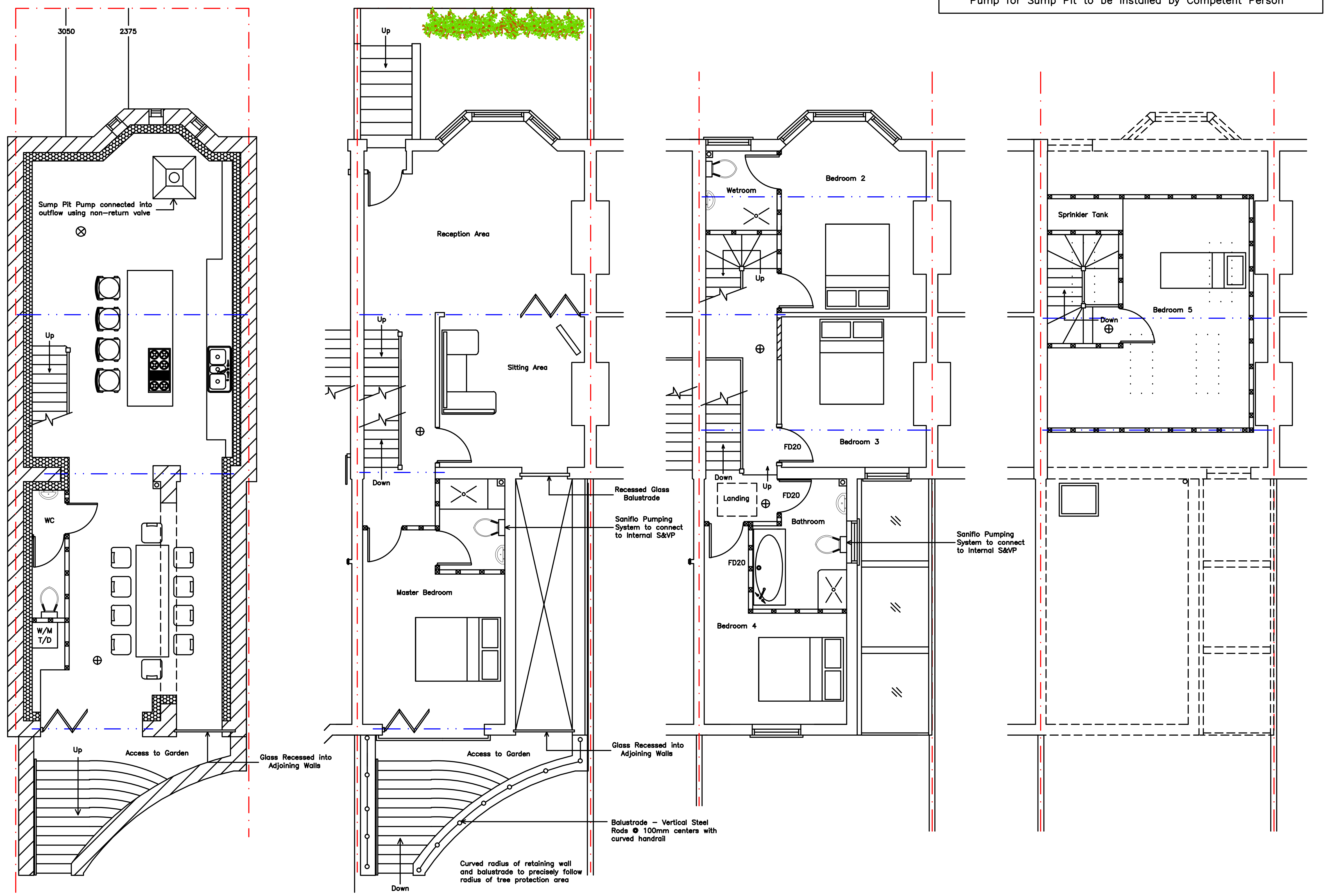

FD 20 Fire Door Resistant for 20 Minutes. Doors incorporated with intumescent strips and fitted with 3 No steel hinges

⊕ Smoke Detector Interlinked with Battery Back–up

⊗ Heat Detector with Battery Back–up

Due to Open Plan Ground Floor Sprinkler System will be required & Approved by Building Control

Pump for Sump Pit to be Installed by Competent Person




Proposed Basement Proposed Ground Floor Proposed First Floor Proposed Loft Plan

General Notes

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NW3 2LP

| Project | Sheet |
|---|---|
| Paper Size – A3 | Drawing No |
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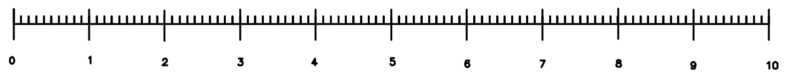


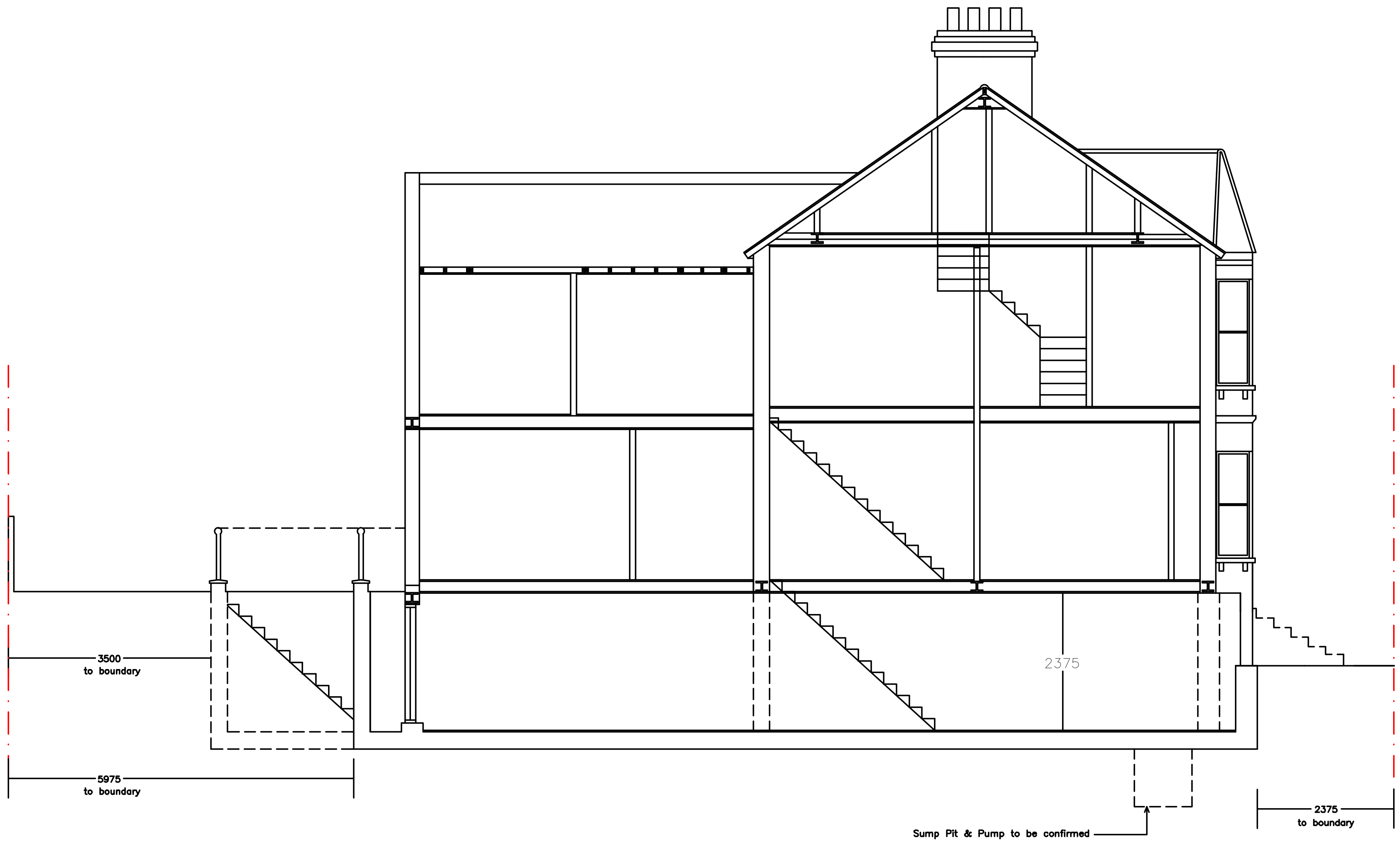


## Proposed Section

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|---|---|---|
| | | |

**Firm Name and Address**

CG – Contractors Ltd
Office 8
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WD6 2BT

**Project Name and Address**

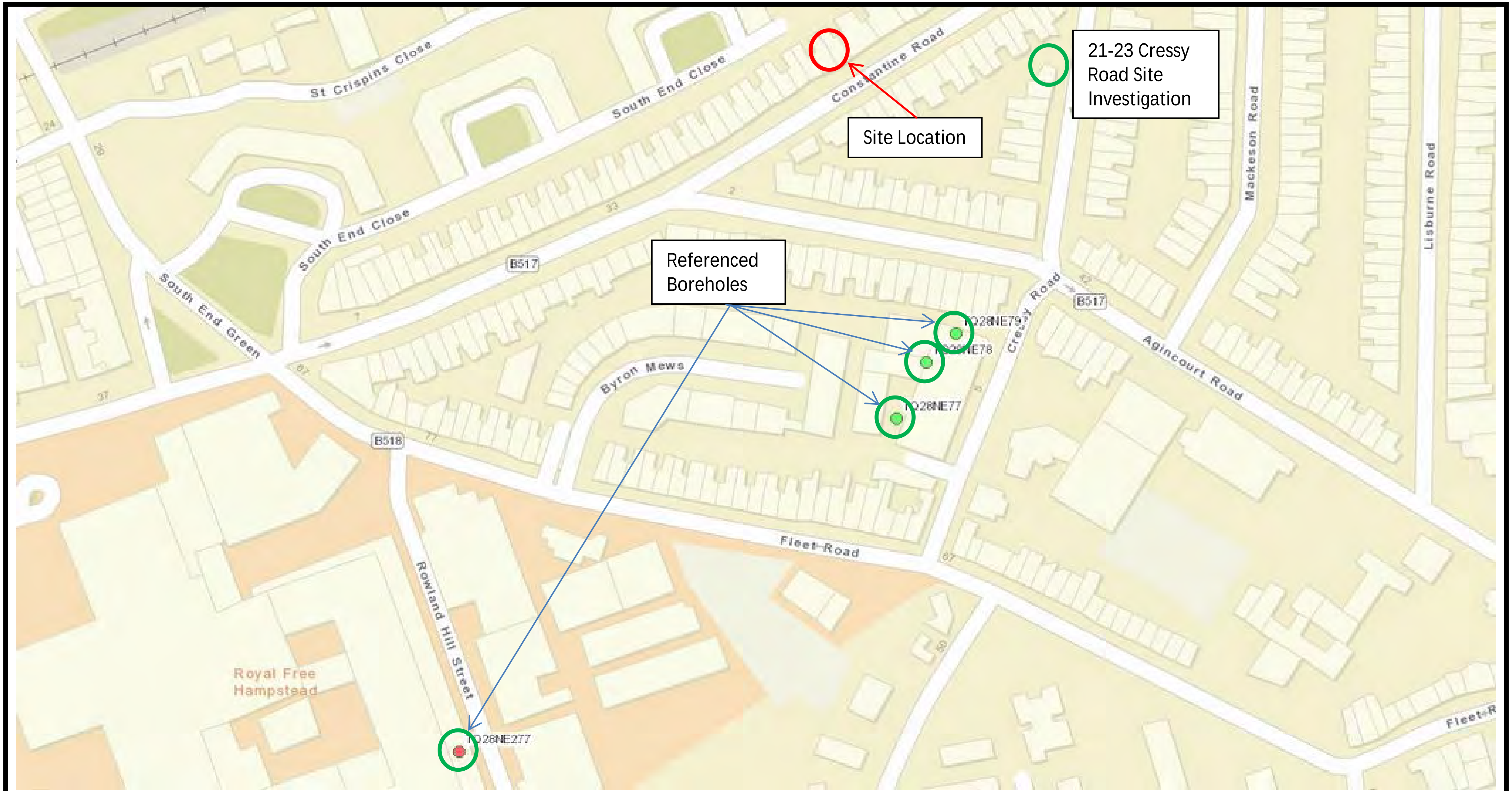
Mr & Mrs Jones

73 Constantine Road
Hampstead, London
NW3 2LP

| | |
|---|---|
| **Project** Paper Size – A3 | **Sheet** |
| **Date** 14/01/2014 | Drawing No 73Cnstn/13/08 |
| **Scale** 1:100 | |

# APPENDIX B

*BGS historical borehole records*




| | | |
|---|---|---|
| Client<br>**CG Contractors (Herts) Limited** | Project<br>**73 Constantine Road, Hampstead, London** | Job No<br>**CG/18117** |
| CGL | Title<br>**BGS boreholes and unpublished local site investigation location plan** | **Appendix B** |

Eastern-L.S. Thames E.A.

ROYAL FREE HOSPITAL 256 | TQ 28/198 | TQ28/NE 277

| | | | | | |
|---|---|---|---|---|---|
| Owner ROYAL FREE HAMPSTEAD NHT | | | Licence No. | | |
| Occupier " " | | | IGS Ref. No. | | |
| Ground Level | | m OD | | | ft. OD |
| Level of Well Top 59.280 | | m OD | | | ft. OD |
| Rest Water Level 95.65 | | m bwt | | | ft. bwt |
| (Date 26/7/99) | | m OD | | | ft. OD |
| Construction | | | | | |
| Depth bwt m | Dia. mm | Linings (below well top) From | To m | Dia mm | Type |
| 114 | 300 | 0 | 114 | 200 | plain |
| 177 | 200 | | | | |

Abstraction Rates gph / gpd

Type of Pump

Chem./Bact. Anal. YES NO

Well Driller Soil Mechanics

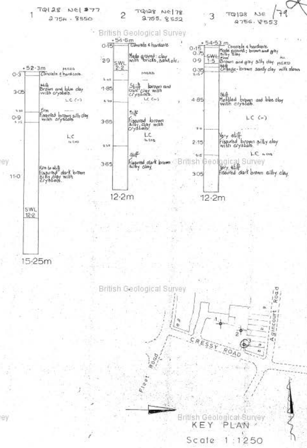
If insufficient space has been allowed, continue in 'Notes' overleaf.

Nat. Grid Ref. TQ 2739 8538

Status OBH

Aquifer UPPER CHALK

| Summary of Geological Section | Thickness m | Depth m |
|---|---|---|
| LONDON CLAY | 69 | 69 |
| W&RB | 21 | 90 |
| Thanet Sands | 11 | 101 |
| UPPER CHALK | 76 | 177 |






Size A2 16½" x 23⅜" — 420mm x 594mm

| div | job no. | drg. no. | rev. |
|---|---|---|---|
| G | 3287 SW | 01 | |

JOB D.M.E.S. OFFICES & WORKSHOPS CRESSY ROAD CAMDEN

TITLE TRIAL BORINGS 1-3
KEY PLAN & SECTIONS

scale VERTICAL 1:100

| date | drawn | checked |
|---|---|---|
| 21 . 7 . 1971 | | H.C.T. |

GLC ILEA
Dept of Architecture and Civic Design

Architect Roger Walters

01-633 5000 Ext. 8381

NOTES

1 Newlyn Datum Levels
2 ⌀ Denotes Trial Boring
3 WS Denotes Water Strike
4 SWL Denotes Standing Water Level at the time of boring in July 1971

REVISIONS

| no. | date |
|---|---|
| | |

COPY

reference

| div. | job no. | drg. no. | rev. |
|---|---|---|---|
| G | 3287 SW | 01 | |

Size A2 16½" x 23⅜" — 420mm x 594mm

# APPENDIX C

*Ground and Water Limited - Ground Investigation Report*

**GROUND INVESTIGATION REPORT**

**for the site at**

**73 CONSTANTINE ROAD, HAMPSTEAD, LONDON NW3 2LP**

**on behalf of**

**CG CONTRACTORS LIMITED**

| Report Reference: GWPR824/GIR/FEBRUARY 2014 | | Status: FINAL |
|---|---|---|
| Issue: | Prepared By: | Verified By: |
| V1.02 Feb 2014 | Roger Foord BA (Hons) MSc DIC<br>FGS MSoBRA<br>Senior Geotechnical Engineer | Francis Williams M.Geol. (Hons) FGS<br>CEnv AGS MSoBRA<br>Director |
| File Reference: Ground and Water/Project Files/<br>GWPR824 73 Constantine Road, Hampstead | | |

# CONTENTS

## FIGURES



## APPENDICES

# 1.0 INTRODUCTION

## 1.1 General

Ground and Water Limited were instructed by CG Contractors Limited on the 10th January 2014 to undertake a Ground Investigation on a site at 73 Constantine Road, Hampstead, London NW3 2LP. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref: GWQ1943, dated 16th October 2013.

## 1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The requirements of the London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development (November 2010) were reviewed with respect to this report.

A Desk Study and full scale contamination assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

## 1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

## 2.0 SITE SETTING

### 2.1 Site Location

The site comprised an approximately rectangular shaped plot of land, totalling ~125m$^2$ in area and orientated in a north-west by south-east direction, located on the north-western side of Constantine Road. The site was located topographically at ~57.5m Above Ordnance Datum (AOD) in the Hampstead Heath area of north London within the London Borough of Camden.

The national grid reference for the centre of the site was approximately TQ 27542 85648. A site location plan is given within Figure 1 and a plan. A plan showing the site area is given within Figure 2.

### 2.2 Site Description

The site was occupied by a terraced two storey brick built residential house. A part concreted front garden was noted to be accessed via a relatively narrow gate off the pedestrian footpath running along Constantine Road. Ornamental borders and shrubs were also noted in the front garden. Residential properties were noted to surround the site with Hampstead Heath to the north of the site. An aerial view of the site is provided within Figure 3.

### 2.3 Proposed Development

At the time of reporting, February 2014, the proposed redevelopment is understood to comprise construction of a basement and extension, loft conversion, refurbishment, additions and alterations to the existing property. The basement will be constructed beneath the entire footprint of the house and will extend beneath part of the rear garden area, where it will be covered in decking. Front and rear lightwells with drainage gullies will be included as part of the basement construction. The basement will be ~16.5m long and ~6.0m wide, excluding the front lightwell. The underside of basement slab is anticipated to be constructed at 3.0 - 3.5m below existing ground level (bgl) to the rear of the property and ~1.5m bgl at the front.

A plan view of the proposed development can be seen in Figure 4 and a section view in Figure 5.

The proposed development will not involve any re-profiling of the site and its immediate environs. It is understood that no trees will be removed to facilitate the construction of the basement.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It is understood that trees will be removed to facilitate construction of the basement.

### 2.4 Geology

The geology map of the British Geological Survey of Great Britain for the North London area (Sheet 256) revealed the site to be situated on the London Clay Formation. The site and areas surrounding where noted to have a propensity for Head Deposits. No areas of Made Ground were noted within a 250m radius of the site.

Figure 3 of the Camden Geological, Hydrogeological and Hydrological Study indicated that no Made Ground or Worked Ground was noted within a close proximity of the site. An area of Made Ground was shown ~800m south-east of the site

*Head Deposits*

The majority of Head Deposits are clay-dominated, derived from the London Clay. Generally less than 2m thick, they probably accumulated in shallow mudslides of softened brecciated bedrock in the active layer. They consist of soft, ochreous brown silty clay with blue-grey mottling in places and angular, frost-shattered fragments of flint occur sporadically throughout. At the base of these deposits and interbedded in places, there is a bed of pebbly clay, generally less than 0.2m thick, with well-rounded flint pebbles derived from nearby outcrops of 'high level' gravel such as Stanmore Gravel.

*London Clay Formation*
The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required.

The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

Three BGS boreholes located off Cressy Road, ~150m south of the site, revealed 0.15-0.30m of concrete/hardcore to overlie Made Ground to ~2.20m bgl. The Made Ground was underlain by brown, becoming dark brown with depth, silty clays, which were fissured with depth and contained selenite crystals. The boreholes were drilled to depths ranging between 12.20m bgl and 15.25m bgl.

### 2.5 Slope Stability and Subterranean Developments
The site was not situated within an area where a natural or man-made slope of greater than $7^{o}$ was present (Figure 16 Camden Geological, Hydrogeological and Hydrological Study).

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides.

Figure 18 of the Camden Geological, Hydrogeological and Hydrological Study indicated that no major subterranean infrastructure (including existing and proposed tunnels) was noted within close proximity to the site. The map showed that an over ground train line between Gospel Oak and Hampstead Heath Stations was present in a cutting ~60m north of the site.

### 2.6 Hydrogeology and Hydrology
A study of the aquifer maps on the Environment Agency website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, revealed the site to be located on **Unproductive Strata** comprising the bedrock of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

Unproductive strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

A surface water feature comprising the southern most of the Hampstead Ponds (Hampstead Pond No. 1) was noted ~200m north-west of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study. Figure 11 revealed the site was located ~200m east of the route of the River Fleet.

Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate to deep depth (4-6m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a south-easterly direction in alignment with the local topography and flow of the Fleet River.

Examination of the Environment Agency records showed that the site was not situated within a floodplain or flood warning area. Figure 15 the Camden Geological, Hydrogeological and Hydrological Study revealed that Fleet Road, ~200m west of the site, suffered surface water flooding in 2002 and Mansfield Road ~350m south-east of the site suffered surface water flooding in 1975.

### 2.7 Radon

BRE 211 (2007) Map 5 of the London, Sussex and west Kent area revealed the site was located within an area where mandatory protection measures against the ingress of Radon were **not** required.

## 3.0 FIELDWORK

### 3.1 Scope of Works

Fieldwork was undertaken on the 14th January 2014 and comprised the drilling of two Window Sampler Boreholes, one within the front garden (WS1) to 8.30m bgl and one within the rear garden (WS2) of the property to 6.00m bgl. A Heavy Dynamic Probe (HDP) was undertaken adjacent to WS1 (DP1) to 8.30m bgl. A groundwater monitoring standpipe was installed in both boreholes to a depth of 5.00m bgl to enable the measurement of standing groundwater levels.

The construction of the wells installed can be seen tabulated below.

| Combined Bio-gas and Groundwater Monitoring Well Construction | | | | |
|---|---|---|---|---|
| **Trial Hole** | **Depth of Installation (m bgl)** | **Thickness of slotted piping with gravel filter pack (m)** | **Depth of plain piping with bentonite seal (m bgl)** | **Piping external diameter (mm)** |
| WS1<br>WS2 | 5.0 | 4.0 | 1.0 | 63 |

The approximate locations of the trial holes can be seen within Figure 6.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

### 3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes. Two soil samples were also sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies to provide a general indication of potential contaminants within the near surface soils and for initial waste classification purposes.

## 4.0 ENCOUNTERED GROUND CONDITIONS

### 4.1 Soil Conditions

All exploratory holes were logged by Mathias Gabrat of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site generally conformed to that anticipated from examination of the geology map. A capping of Made Ground was noted to overlie the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. For more complete information about the Made Ground and the London Clay Formation at particular points, reference must be made to the individual trial hole logs within Appendix B.

The trial hole location plan can be viewed in Figure 6.

For the purposes of discussion the succession of conditions encountered in the trial holes in descending order can be summarised as follows:

**Made Ground**
**London Clay Formation**

*Made Ground*
Made Ground was encountered from ground surface in WS1, and below 0.08m thick concrete slab in WS2, to a depth of 1.40m bgl and 2.40m bgl respectively.

The Made Ground generally comprised a dark brown to brown, locally dark grey to dark brown sandy and silty, gravelly to very gravelly clay. The sand was fine grained and the gravel was rare to occasional, fine to coarse, sub-angular to sub-rounded flint, brick and concrete.

*London Clay Formation*
Soils of the London Clay Formation comprising a dark brown to brown, with grey mottling, silty clay with rare to occasional pockets of selenite crystals were encountered underlying the Made Ground for the remaining depth of the boreholes, a depth of 8.30m bgl in WS1 and 6.00m bgl in WS2.

### 4.2 Roots Encountered

Roots were encountered to a depth of 2.00m bgl in WS1 and 2.40m bgl in WS2.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

### 4.4 Groundwater Conditions

A groundwater strike was encountered at a depth of 1.80m bgl in WS2 and WS1 was dry during the intrusive investigation on the 14th January 2014. A return site visit on the 31st January 2014 revealed a standing ground water level of 1.23m bgl in the standpipe installed in WS1. No reading could be taken from the well installed in WS2 because no access to the rear of the property was available at the time of the visit.

However, given the recent periods of prolonged and heavy rainfall during late 2013 and early 2014, the groundwater strike in WS2 and the standing water level in WS1 are likely to represent perched groundwater migrating through the Made Ground and collecting within a standpipe installed within the impermeable soils of the London Clay Formation.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. The investigation was undertaken in January 2014, when groundwater levels are close to their annual maximum (highest elevation).

Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

### 4.5 Obstructions

No artificial or natural sub-surface obstructions were noted during construction of the trial holes.

## 5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

### 5.1 In-Situ Geotechnical Testing

A Heavy Dynamic Probe (HDP) was undertaken adjacent to WS1 (DP1) to 8.30m bgl. The test results are presented on the trial hole logs within Appendix B.

Window Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data. Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 50.0kg hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. *(The Dynamic Probe 'Heavy' (HDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).*

The cohesive soils of the London Clay Formation were classified based on the table below.

| Undrained Shear Strength from Field Inspection/SPT results<br>Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974)) | | |
|---|---|---|
| **Classification** | **Undrained Shear Strength (kPa)** | **Field Indications** |
| Extremely High | >300 | - |
| Very High | 150 – 300 | Brittle or very tough |
| High | 75 – 150 | Cannot be moulded in the fingers |
| Medium | 40 – 75 | Can be moulded in the fingers by strong pressure |
| Low | 20 – 40 | Easily moulded in the fingers |
| Very Low | 10 – 20 | Exudes between fingers when squeezed in the fist |
| Extremely Low | <10 | - |

An interpretation of the in-situ geotechnical testing results is given in the table below.

| In-Situ Geotechnical Testing Results Summary | | | | | |
|---|---|---|---|---|---|
| **Strata** | **Equivalent SPT "N" Blow Counts derived from HDP** | **Undrained Shear Strength kPa (based on Stroud, 1974)** | **Soil Type** | | **Trial Hole** |
| | | | **Cohesive** | **Granular** | |
| London Clay Formation | 2 – 5<br>6 – 8<br>14 – 34 | 10 – 25<br>30 – 40<br>70 – 140 | Very Low – Low<br>Low – Medium<br>Medium – Very High | - | WS/DP1 (1.40 – 3.00m bgl)<br>WS/DP1 (3.00 – 5.00m bgl)<br>WS/DP1 (5.00 – 8.30m bgl) |

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

### 5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and QTS Environmental Limited, was undertaken on samples recovered from the Made Ground and the London Clay Formation. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:1990.

Details of the specific tests used in each case are given below:

| Standard Methodology for Laboratory Geotechnical Testing | | |
|---|---|---|
| **Test** | **Standard** | **Number of Tests** |
| Atterberg Limit Tests | BS1377:1990:Part 2:Clauses 3.2, 4.3 & 5 | 5 |
| Moisture Content | BS1377:1990:Part 2:Clause 3.2 | 4 |
| Water Soluble Sulphate & pH | BS1377:1990:Part 3:Clause 5 | 1 |
| BRE Special Digest 1 (incl. Ph, Electrical Conductivity, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH4, W/S Nitrate, W/S Magnesium) | BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005). | 2 |

### 5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on five samples of the London Clay Formation can be seen tabulated below.

| Atterberg Limit Tests Results Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Stratum/Depth** | **Moisture Content (%)** | **Passing 425 µm sieve (%)** | **Modified PI (%)** | **Soil Class** | **Consistency Index (Ic)** | **Volume Change Potential** | |
| | | | | | | **NHBC** | **BRE** |
| London Clay Formation | 31 - 37 | 97 - 100 | 50.0 – 58.0 | CV | Stiff | High | High |

NB: NP – Non-plastic
BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
Soil Classification based on British Soil Classification System.
Consistency Index (Ic) based on BS EN IS0 14688-2:2004.

### 5.2.2 Comparison of Soil's Moisture Content with Index Properties

#### 5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on five samples of the London Clay Formation were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated overpage.

The test results are presented within Appendix C.

| Liquidity Index Calculations Summary | | | | | |
|---|---|---|---|---|---|
| **Stratum/Trial Hole/Depth** | **Moisture Content (%)** | **Plastic Limit (%)** | **Modified Plasticity Index (%)** | **Liquidity Index** | **Result** |
| **London Clay Formation**<br>**WS1/1.50m bgl**<br>(Brown slightly gravelly CLAY with trace fine brick fragments and roots (gravel is fine and sub-angular)) | 31 | 28 | 50.4 | 0.059 | Heavily Overconsolidated. |
| **London Clay Formation**<br>**WS1/2.50m bgl**<br>(Brown and occasional blue grey CLAY with occasional selenite) | 32 | 29 | 58.0 | 0.051 | Heavily Overconsolidated. |
| **London Clay Formation**<br>**WS1/8.00m bgl**<br>(Brown CLAY with scattered traces of selenite) | 31 | 29 | 50.0 | 0.040 | Heavily Overconsolidated. |
| **London Clay Formation**<br>**WS2/2.50m bgl**<br>(Greyish brown slightly gravelly CLAY with scattered traces of selenite). | 37 | 29 | 52.4 | 0.153 | Heavily Overconsolidated. |
| **London Clay Formation**<br>**WS2/5.50m bgl**<br>(Brown CLAY) | 34 | 30 | 52.0 | 0.077 | Heavily Overconsolidated. |

Liquidity Index testing revealed no evidence for moisture deficit within the heavily overconsolidated samples of the London Clay Formation tested.

#### 5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated overpage.

| Moisture Content vs. Liquid Limit | | | | |
|---|---|---|---|---|
| **Strata/Trial Hole/Depth/Soil Description** | **Moisture Content (MC) (%)** | **Liquid Limit (LL) (%)** | **40% Liquid Limit (LL)** | **Result** |
| **London Clay Formation**<br>**WS1/1.50m bgl**<br>(Brown slightly gravelly CLAY with trace fine brick fragments and roots (gravel is fine and sub-angular)) | 31 | 80 | 32.0 | **MC < 0.4 x LL**<br>**(Potentially significant moisture deficit)** |
| **London Clay Formation**<br>**WS1/2.50m bgl**<br>(Brown and occasional blue grey CLAY with occasional selenite) | 32 | 87 | 34.8 | **MC < 0.4 x LL**<br>**(Potentially significant moisture deficit)** |
| **London Clay Formation**<br>**WS1/8.00m bgl**<br>(Brown CLAY with scattered traces of selenite) | 31 | 79 | 31.6 | **MC < 0.4 x LL**<br>**(Potentially significant moisture deficit)** |
| **London Clay Formation**<br>**WS2/2.50m bgl**<br>(Greyish brown slightly gravelly CLAY with scattered traces of selenite). | 37 | 83 | 33.2 | MC > 0.4 x LL<br>(No significant moisture deficit) |
| **London Clay Formation**<br>**WS2/5.50m bgl**<br>(Brown CLAY) | 34 | 82 | 32.8 | MC > 0.4 x LL<br>(No significant moisture deficit) |

The results in the table above indicate that a potential significant moisture deficit was present within three samples of the London Clay Formation tested (WS1/1.50m, WS1/2.50m, WS1/8.00m bgl). The moisture content values were just below 40% of the liquid limit. .

Roots were noted to 2.00m bgl within WS1. Traces of fine brick fragments were noted in one sample (WS1/1.40m bgl) and scattered traces of selenite crystals were noted for the full depth of the borehole. Therefore, the possible affect of the roots on the London Clay Formation in WS1 to 2.00m bgl cannot be completely discounted. The potential moisture deficits indicated within the London Clay Formation in WS1 below 2.00m are likely to be due to the presence of selenite crystals and the heavily overconsolidated nature of the soils.

The results in the table above indicate that the samples of the London Clay Formation tested from WS2 showed no evidence of a significant moisture deficit.

### 5.2.3 Moisture Content Profiling

The moisture content versus depth plot for WS1 can be seen within Figure 7.

Figure 7 shows a possible moisture deficit in WS1 to a depth of 2.50m bgl due to a lowering of the moisture content. Roots were noted to a depth of 2.00m bgl by the supervising engineer. The strata in the borehole to that depth was generally described as brown and occasionally blue grey clay, slightly gravelly at 1.50m bgl, with occasional selenite crystals. Testing has shown the soils were heavily overconsolidated. Therefore the apparent moisture deficit could be a result of the heavily overconsolidated nature of the soils, the presence of fine gravel patches and selenite crystals within the London Clay Formation and the water demand from the roots.

The moisture variations below 3.00m bgl are likely to be due to natural variations in the sand, silty and gravel content of the soil.

#### 5.2.4 Sulphate and pH Tests

A sulphate and pH test was undertaken on one sample from the London Clay Formation (WS1/2.00m). A sulphate concentration of 2360mg/l with a pH of 8.3 was determined.

#### 5.2.5 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) one sample of the Made Ground (WS1/0.60m) and one sample of the London Clay Formation (WS2/3.00m) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results are given within Appendix D and a summary is tabulated below.

| Summary of Results of BRE Special Digest Testing | | | |
|---|---|---|---|
| **Determinand** | **Unit** | **Minimum** | **Maximum** |
| pH | - | 7.7 | 8.1 |
| Ammonium as $NH_4$ | mg/kg | 0.6 | 0.9 |
| Sulphur | mg/kg | 234 | 834 |
| Chloride (water soluble) | mg/kg | 9 | 26 |
| Magnesium (water soluble) | mg/kg | 50 | 504 |
| Nitrate (water soluble) | mg/kg | <3 | 13 |
| Sulphate (water soluble) | g/l | 0.04 | 1.50 |
| Sulphate (total) | mg/kg | 422 | 2292 |

### 5.3 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by QTS Environmental Limited, was undertaken on two samples of Made Ground (WS1/0.30m and WS2/0.25m).

A Desk Study and full scale contamination assessment were not part of the remit of this report. However, one soil sample was sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies. The samples tested and the reasons for testing can be seen tabulated below.

| Methodology for Sampling Locations and Chemical Laboratory Testing | | |
|---|---|---|
| **Trial Hole** | **Depth (m bgl)** | **Sampling Strategy** |
| WS1 | 0.30m | Representative sample of Made Ground from WS1 |
| WS2 | 0.25 | Representative sample of Made Ground from WS2 |

The area investigated as part of the proposed redevelopment totals 125m$^2$ and with two sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 93.8m$^2$ and a radius of approximately 5.46m would be encountered (CLR 4).

Soil sampling depths were chosen to reflect the receptors of concern, human health, and typically comprised a surface or near surface sample and then at approximately 0.50m depth increments thereafter, extending into the underlying natural soils. The receptors relevant to the sampling depths can be seen below:

| | |
|---|---|
| Near surface samples | Direct ingestion, dermal contact and dust inhalation.<br>Protection of end-users and maintenance workers e.g. Landscape Gardeners.<br>Protection of shallow rooted plants. |
| >0.5m below ground level | Protection of deep rooted plants. |

The depth of soil sampling can be seen within the trial hole logs presented in Appendix B.

The analysis suite is presented below and comprised:

- Semi Metals and Heavy Metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc (WS1/0.30m and WS2/0.25m);
- Fibrous Material Screen & Asbestos identification if suspected material encountered (WS1/0.30m and WS2/0.25m);
- Polycyclic Aromatic Hydrocarbons (PAHs) incl. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene (WS1/0.30m and WS2/0.25m);
- Fuel Oils – Speciated TPH including full aliphatic/aromatic split (WS2/0.25m);
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs) (WS2/0.25m).

**Note**: Fibrous material screening aims at identifying fibres or fibrous material, which are indicative of the presence of asbestos. Should fibres or fibrous material be detected the sample is characterised as “positive” and is subsequently submitted for further analysis for confirmation and speciation if required.

The chemical laboratory results are presented in Appendix D.

### 5.3.1 Soil Assessment Criteria

The derivation of Soil Assessment Criteria used within this report can be seen within Appendix E.

### 5.3.2 Determination of Representative Contamination Concentration

At the time of reporting, February 2014, the proposed redevelopment is understood to comprise construction of a basement and extension, loft conversion, refurbishment, additions and alterations to the existing property.

A plan view of the proposed development can be seen in Figure 4 and a section view in Figure 5.

Therefore the results of the chemical laboratory testing were compared to the Soil Guideline

Values (SGV) and General Assessment Criteria (GAC) for a ***'Residential'*** land-use scenario, as this was considered the most appropriate land-use scenario.

Where a contaminant of concern's SGV/GAC varies according to the soil's Soil Organic Matter (SOM), the SOM recorded for the sample was used to derive the appropriate SGV/GAC. The samples of Made Ground analysed had a SOM of 5.7% and 1.8%, giving an average of 3.8%.

The results of the comparison of the representative contaminants concentrations are presented in the table overpage.

| Soil Guideline Values and General Acceptance Criteria Results | |
|---|---|
| **Substance** | **Sample Location**<br>**Where available SGV or GAC were exceeded for relevant land-use scenario** |
| | **"Residential" Land-Use Scenario** |
| Arsenic | None |
| Boron | None |
| Cadmium | None |
| Chromium (III) | None |
| Hexavalent Chromium (VI) | None |
| **Lead** | **WS1/0.30m** |
| Mercury (Elemental) | None |
| Nickel | None |
| Selenium | None |
| Vanadium | None |
| Copper | None |
| Zinc | None |
| Boron | None |
| Cyanide (Total) | None |
| Phenol | None |
| Naphthalene | None |
| Acenapthylene | None |
| Acenapthene | None |
| Fluorene | None |
| Phenanthrene | None |
| Anthracene | None |
| Fluoranthene | None |
| Pyrene | None |
| Pyrene | None |
| Benzo (a)anthracene | None |
| Benzo(b)fluoranthene | None |
| Benzo(k)fluoranthene | None |
| Indeno(1,2,3-cd)pyrene | None |
| Benzo(ghi)perylene | None |
| **Benzo(a)pyrene** | **WS1/0.30m** |
| Dibenz(a,h)anthracene | None |
| TPH C5 – C6 (aliphatic) | None |
| TPH C6 – C8 (aliphatic) | None |
| TPH C8 - C10 (aliphatic) | None |
| TPH C10 - C12 (aliphatic) | None |
| TPH C12 - C16 (aliphatic) | None |
| TPH C16 - C21 (aliphatic) | None |
| TPH C21 - C34 (aliphatic) | None |
| TPH C5 – C7 (aromatic) | None |
| TPH C7 – C8 (aromatic) | None |
| TPH C8 - C10 (aromatic) | None |
| TPH C10 - C12 (aromatic) | None |
| TPH C12 - C16 (aromatic) | None |
| TPH C16 - C21 (aromatic) | None |
| TPH C21 - C35 (aromatic) | None |
| Benzene | None |
| Toluene | None |
| Ethylbenzene | None |
| Xylene (o, m & p) | None |
| MTBE | None |
| Fibrous Material/Asbestos Screen | None |

Chemical laboratory testing revealed an elevated levels of lead within the one sample of the Made Ground above the guideline level of 450mg/kg for a "Residential with plant uptake" land-use scenario with a concentration of 1930mg/kg in the sample WS1/0.30mbgl. In addition an elevated level of benzo(a)pyrene was noted within one sample of the Made Ground above the guideline level of 0.94mg/kg for a “Residential with plant uptake” land-use scenario. A concentration of 3.23mg/kg was noted in WS1/0.30m bgl.

The engineer’s logs for the investigation revealed that the Made Ground was described as a dark grey to dark brown gravelly clay. The gravel was occasional, fine to coarse, sub-angular to sub-rounded brick, concrete and flint.

Double plot analysis using the ratio of fluoranthene and pyrene plotted against benzo(a)anthrancene and chrysene indicated that the PAH’s encountered in the sample (WS1/0.30m bgl) were from a coal derived source and may be fragments of coal.

Chemical laboratory testing revealed no elevated levels of determinants were noted above the guideline levels for a ***‘Residential’*** land-use scenario in the remaining sample of Made Ground tested (WS2/0.25m bgl) within the rear garden.

In addition, the intrusive investigation did not reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons ($C_5$-$C_{35}$) or BTEX compounds are present in the soils underlying the site.

Given the small size of the site and the limited number of Made Ground samples tested, the use of CLAIRE Statistical Analysis on the results of chemical laboratory testing was considered inappropriate.

**Further testing and sampling is recommended to further examine the distribution of lead and benzo(a)pyrene within the Made Ground. This would allow for statistical analysis of the distribution to be undertaken and possibly remove or reduce any remediation required.**

Given the likely low mobility of lead qualitative risk assessment has indicated that the determinants noted pose no unacceptable risk to groundwater and therefore the Made Ground can remain under areas of permanent hardstanding. In the absence of further chemical analysis, based on the results to-date and given the risks posed to end-users, the following remediation is necessary for the areas of soft landscaping:

The BRE *“Cover Systems for Land Regeneration, Thickness Design of Cover Systems for Contaminated Land, BRE, March 2004”,* allows for the design of cover systems to impacted soils where the concentration of determinands within the ground does not exceed any of the respective SGVs or GACs by more than six.

Since the maximum concentrations of lead (1930 mg/kg) and benzo(a)pyrene (3.23 mg/kg) identified in the Made Ground were not over six times the relevant SGV for a “Residential without plant-uptake” land-use scenario (based on SOM value of 2.5%), the BRE Cover Systems could be applied.

The BRE Cover Systems spreadsheet was based on a mixing zone of 600mm. The lower the concentration of the elevated determinands in the imported Topsoil, the lesser the amount of clean cover will be required.

An **example cover thickness** has been calculated of ~485mm using an approximate assumed concentration of lead (100mg/kg) and benzo(a)pyrene (0.4mg/kg) likely to be present in any imported Topsoil, which can be viewed in Appendix F. **The actual cover thickness would need to be calculated once a source of imported Topsoil was known with available chemical results certificates.**

Excavation of the soft landscaped garden areas must be independently inspected to validate that the calculated depth has been achieved **before any Topsoil is imported onto the site**.

Complete removal of affected Made Ground from the site has not been considered given the cost implications and that a simple capping system could be adopted. This would prevent needless lorry movements and prevent waste unnecessarily being sent to landfills with only a finite capacity.

**Given that the elevated levels of determinants were noted in the front garden remediation may be only applicable to this area, given that targeted sampling of the rear garden revealed no elevated levels of determinants. However, further sampling and testing is considered necessary to prove this.**

## 6.0 ENGINEERING CONSIDERATIONS

### 6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Made Ground was encountered from ground surface in WS1, and below 0.08m thick concrete slab in WS2, to a depth of 1.40m bgl and 2.40m bgl respectively.

  As a result of the inherent variability of Made Ground, it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

- Soils of the London Clay Formation comprising a dark brown to brown, with grey mottling, silty clay with rare to occasional pockets of selenite crystals were encountered underlying the Made Ground for the remaining depth of the boreholes, a depth of 8.30m bgl in WS1 and 6.00m bgl in WS2.

  The results of the in-situ testing showed the undrained shear strength of the London Clay Formation comprised very low to low undrained shear strength (10-25Pa) soils from 1.40-3.00m bgl, low to medium undrained shear strength (30-40kPa) soils between 3.00-5.00m bgl and medium to very high undrained shear strength (70-170kPa) soils from 5.00-8.30m bgl.

  The soils of the London Clay Formation were shown to have a **high** potential for volume change in accordance both BRE240 and NHBC Standards Chapter 4.2.

  Consistency Index calculations indicated the cohesive London Clay Formation to be stiff. Liquidity Index testing revealed the soils to be heavily overconsolidated.

  Geotechnical analysis revealed a potential root exacerbated moisture deficit may have been present within WS1 to ~2.50m bgl.

  The soils of the London Clay Formation are heavily overconsolidated cohesive soils and are therefore likely to be a suitable stratum for the proposed traditional strip, mat or piled foundations for the basement or foundations structurally unattached to the basement. The settlements induced on loading are likely to be low to moderate.

  The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or moisture deficit and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Roots were encountered to a depth of 2.00m bgl in WS1 and 2.40m bgl in WS2.

- A groundwater strike was encountered at a depth of 1.80m bgl in WS2 and WS1 was dry during the intrusive investigation on the 14th January 2014. A return site visit on the 31st January 2014 revealed a standing ground water level of 1.23m bgl in the standpipe installed in WS1. No reading could be taken from the well installed in WS2 because no access to the rear of the property was available at the time of the visit.

However, given the recent periods of prolonged and heavy rainfall during late 2013 and early 2014, the groundwater strike in WS2 and the standing water level in WS1 is likely to represent perched groundwater migrating through the Made Ground and collecting within a standpipe installed within the impermeable soils of the London Clay Formation.

### 6.2 Basement Foundations

At the time of reporting, February 2014, the proposed redevelopment is understood to comprise construction of a basement and extension, loft conversion, refurbishment, additions and alterations to the existing property. The basement will be constructed beneath the entire footprint of the house and will extend beneath part of the rear garden area, where it will be covered in decking. Front and rear lightwells with drainage gullies will be included as part of the basement construction. The basement will be ~16.5m long and ~6.0m wide, excluding the front lightwell. The underside of basement slab is anticipated to be constructed at 3.0 - 3.5m below existing ground level (bgl) to the rear of the property and ~1.5m bgl at the front.

A plan view of the proposed development can be seen in Figure 4 and a section view in Figure 5.

Foundations should be designed in accordance with soils of **high volume change potential** in accordance with BRE Digest 240 and NHBC Chapter 4.2.

Given the cohesive nature of the shallow deposits foundations must therefore **not** be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account (NHBC Standards Chapter 4.2). It is recommended that foundations are taken at least 300mm into non-root penetrated strata.

Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping. Should trees be removed from the footprint of the proposed building then an alternative foundation system, such as piles or isolated pads should be considered.

Geotechnical analysis revealed a potential root exacerbated moisture deficit may have been present within WS1 to ~2.50m bgl. Roots were encountered to a depth of 2.00m bgl in WS1 and 2.40m bgl in WS2. Therefore a minimum foundation depth of ~2.80m bgl is recommended.

**Foundations to rear (WS2):**

It is considered likely the proposed basement will be constructed with load bearing concrete retaining walls with semi-ground bearing concrete floors. The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide footings constructed at 3.00m and 3.50m bgl.

| Limit State: Bearing Capacities Calculated (Based on WS/DP1) | | |
|---|---|---|
| **Depth (m BGL)** | **Foundation System** | **Limit Bearing Capacity (kN/m$^2$)** |
| 3.0 | 5.00m by 0.75m Strip | 92.77 |
| | 5.00m by 1.00m Strip | 92.77 |
| 3.5 | 5.00m by 0.75m Strip | 110.73 |
| | 5.00m by 1.00m Strip | 110.73 |

| Serviceability State: Settlement Parameters Calculated (Based on WS/DP1) | | | |
|---|---|---|---|
| **Depth (m BGL)** | **Foundation System** | **Limit Bearing Capacity (kN/m$^2$)** | **Settlement (mm)** |
| 3.00 | 5.00m by 0.75m Strip | 90 | <18 |
| | 5.00m by 1.00m Strip | 90 | <20 |
| 3.50 | 5.00m by 0.75m Strip | 110 | <21 |
| | 5.00m by 1.00m Strip | 110 | <25 |

It must be noted that a bearing capacity of less than 50kN/m$^2$ at 3.00m bgl and 55kN/m$^2$ at 3.50m bgl may results in heave of the underlying soils.

**Foundations to front (WS1):**
It is considered likely the proposed basement will be constructed with load bearing concrete retaining walls with semi-ground bearing concrete floors. The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide footings constructed at 2.00m bgl. Given the lowe DPH blow counts noted to 2.00m bgl bearing capacities at shallower depth were low (<50kN/m2). Therefore to avoid high load induced settlements a minimum foundation depth of ~2.00m bgl is recommended. Bearing capacities have been given for 2.10m and 2.50m bgl.

| Limit State: Bearing Capacities Calculated (Based on WS/DP1) | | |
|---|---|---|
| **Depth (m BGL)** | **Foundation System** | **Limit Bearing Capacity (kN/m$^2$)** |
| 2.10 | 5.00m by 0.75m Strip | 89.05 |
| | 5.00m by 1.00m Strip | 91.50 |
| 2.50 | 5.00m by 0.75m Strip | 89.05 |
| | 5.00m by 1.00m Strip | 91.50 |

| Serviceability State: Settlement Parameters Calculated (Based on WS/DP1) | | | |
|---|---|---|---|
| Depth (m BGL) | Foundation System | Limit Bearing Capacity (kN/m$^2$) | Settlement (mm) |
| 2.10 | 5.00m by 0.75m Strip | 65 | ~25 |
| | 5.00m by 1.00m Strip | 60 | ~25 |
| 2.50 | 5.00m by 0.75m Strip | 70 | <24 |
| | 5.00m by 1.00m Strip | 65 | ~23 |

Site levels may need to be brought up to underside of proposed slab level using with suitable granular soil (Type I or Type II) rolled in thin layers.

It must be noted that a bearing capacity of less than 30kN/m$^2$ at 2.00m bgl and 35kN/m$^2$ at 2.50m bgl may results in heave of the underlying soils.

A groundwater strike was encountered at a depth of 1.80m bgl in WS2 and WS1 was dry during the intrusive investigation on the 14th January 2014. A return site visit on the 31st January 2014 revealed a standing ground water level of 1.23m bgl in the standpipe installed in WS1. No reading could be taken from the well installed in WS2 because no access to the rear of the property was available at the time of the visit. However, given the recent periods of prolonged and heavy rainfall during late 2013 and early 2014, the groundwater strike in WS2 and the standing water level in WS1 are likely to represent perched groundwater migrating through the Made Ground and collecting within a standpipe installed within the impermeable soils of the London Clay Formation.

Based on the groundwater readings taken during this investigation to-date, it was considered likely that perched groundwater would be encountered within the Made Ground during basement construction. Dewatering from sumps introduced into the floor of the excavation is likely to be required. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement. Consideration could be given to creating a coffer dam using contiguous piled or sheet piled walls to aid basement construction below the perched water table.

**However, given the recent periods of prolonged and heavy rainfall during late 2013 and early 2014, it is recommended that the groundwater level within the wells installed is checked prior to construction of the basement. The groundwater level may be significantly higher due to the prolonged rainfall.**

It must be mentioned that it was assumed that excavations will be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced.

The basement must be suitably tanked to prevent ingress of any groundwater, if applicable, and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement, if applicable.

### 6.3 Piled Foundations

Should the bearing values given above be unsuitable for the proposed development or the potential need for dewatering during excavation of the basement increase costs, then attention should be given to the adoption of a piled foundation.

The construction of a piled foundation is a specialist job, and the advice of a reputable contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the foundation design, as the actual pile working load will depend on the particular type of pile and method of installation adopted.

Additional investigation in the form of a shell and auger borehole would be required to provide data for a pile design.

### 6.4 Basement Excavations & Stability

Shallow excavations in the Made Ground and London Clay Formation are likely to be marginally stable at best. Long, deep excavations, through both of these strata are likely to become unstable.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It is considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on cohesive soils with an appropriate angle of shear resistance ($\Phi'$) for the ground conditions encountered.

The excavations must not affect the integrity of the adjacent structures beyond the boundaries. The excavations must be supported by suitably designed retaining walls. The retaining walls will need to be constructed based on soils encountered with an appropriate angle of shear resistance ($\Phi'$) and effective cohesion ($C'$) for the ground conditions encountered.

Based on the ground conditions encountered within BH1 the following parameters could be used in the design of retaining walls. These have been designed based on the SPT profile recorded, results of geotechnical classification tests and reference to literature.

| Retaining Wall/Basement Design Parameters | | | | | |
|---|---|---|---|---|---|
| **Strata** | **Unit Volume Weight (kN/m$^3$)** | **Cohesion Intercept (c') (kPa)** | **Angle of Shearing Resistance (Ø)** | **Ka** | **Kp** |
| Made Ground | ~15 | 0 | 12 | 0.66 | 1.52 |
| London Clay Formation | ~20-22 | 0 | 24 | 0.42 | 2.37 |

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

Based on the groundwater readings taken during this investigation to-date, it was considered likely that perched groundwater would be encountered within the Made Ground during basement construction. Dewatering from sumps introduced into the floor of the excavation is likely to be required. Consideration could be given to creating a coffer dam using contiguous piled or sheet piled walls to aid basement construction below the perched water table.

### 6.5 Hydrogeological Effects

The proposed development is located on **Unproductive Strata** relating to the London Clay Formation.

The ground conditions encountered generally comprised a capping of cohesive Made Ground over cohesive London Clay Formation. Based on a visual appraisal of the soils encountered the permeability of the London Clay Formation was likely to be negligible.

A groundwater strike was encountered at a depth of 1.80m bgl in WS2 and WS1 was dry during the intrusive investigation on the 14th January 2014. A return site visit on the 31st January 2014 revealed a standing ground water level of 1.23m bgl in the standpipe installed in WS1. No reading could be taken from the well installed in WS2 because no access to the rear of the property was available at the time of the visit. However, given the recent periods of prolonged and heavy rainfall during late 2013 and early 2014, the groundwater strike in WS2 and the standing water level in WS1 are likely to represent perched groundwater migrating through the Made Ground and collecting within a standpipe installed within the impermeable soils of the London Clay Formation.

The Environment Agency records show that the highest recorded tide for the nearest river station on the River Thames at Westminster is 4.50m AOD with high tides generally at ~3.00m AOD. The elevation of the site is ~57.5m AOD. Based on a maximum 3.50m bgl deep basement slab a formation level of 54.0m AOD is assumed. This means that the basement will be constructed above general high tide levels of the River Thames.

Based on the above it is considered likely that perched water will be encountered during basement construction, but the basement will not be constructed below the groundwater table. In relation to the basement, once constructed, the Made Ground will act as a slightly porous medium for water to migrate; however, additional drainage should be considered as the London Clay Formation will act as a barrier for groundwater migration.

### 6.6 Sub-Surface Concrete

Sulphate concentrations measured in 2:1 water/soil extracts taken from the Made Ground and London Clay Formation, from both the geotechnical and chemical laboratory testing, fell into Classes DS-1 to DS-3 of the BRE Special Digest 1, 2005, *'Concrete in Aggressive Ground'*.

Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-2s. For the classification given, the "static" and "natural" case was adopted given the presence of the cohesive Made Ground and residential use of the site. The sulphate concentration in the samples ranged from 40-2360mg/l with a pH range of 7.7-8.5. The total potential sulphate concentrations ranged from 0.04 – 0.23%.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, *'Concrete in Aggressive Ground'* taking into account the pH of the soils.

It is prudent to note that pyrite nodules may be present within the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water soluble sulphate values can rapidly increase during construction.

Therefore rising sulphate values should be taken into account should ferruginous staining/pyrite nodules be encountered within the London Clay Formation.

### 6.7 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaway construction within the cohesive soils of the London Clay Formation is unlikely to prove satisfactory due to negligible to low anticipated infiltration rates. Therefore an alternative method of surface water disposal is required.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The site was occupied by a terraced two storey brick built residential house. A part concreted front garden was noted to be accessed via a relatively narrow gate off the pedestrian footpath running along Constantine Road. Ornamental borders and shrubs were also noted in the front garden. A grassed rear garden was only accessible through the existing building.

At the time of reporting, February 2014, the proposed redevelopment is understood to comprise construction of a basement and extension, loft conversion, refurbishment, additions and alterations to the existing property.

Therefore the proposed development will increase the areas of hardstanding present.

The principles of sustainable urban drainage system (SUDS) should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

### 6.8 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

### 6.9 Waste Disposal

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Based on a preliminary risk phrase analysis of the chemical laboratory test results from the sample of the Made Ground encountered on-site, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, the Made Ground of WS1/0.30m bgl and WS2/0.25m bgl were **NON HAZARDOUS.** The results of the assessment are given within Appendix G.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM2, therefore producing an initial classification in accordance with the guidance, landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

### 6.10 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

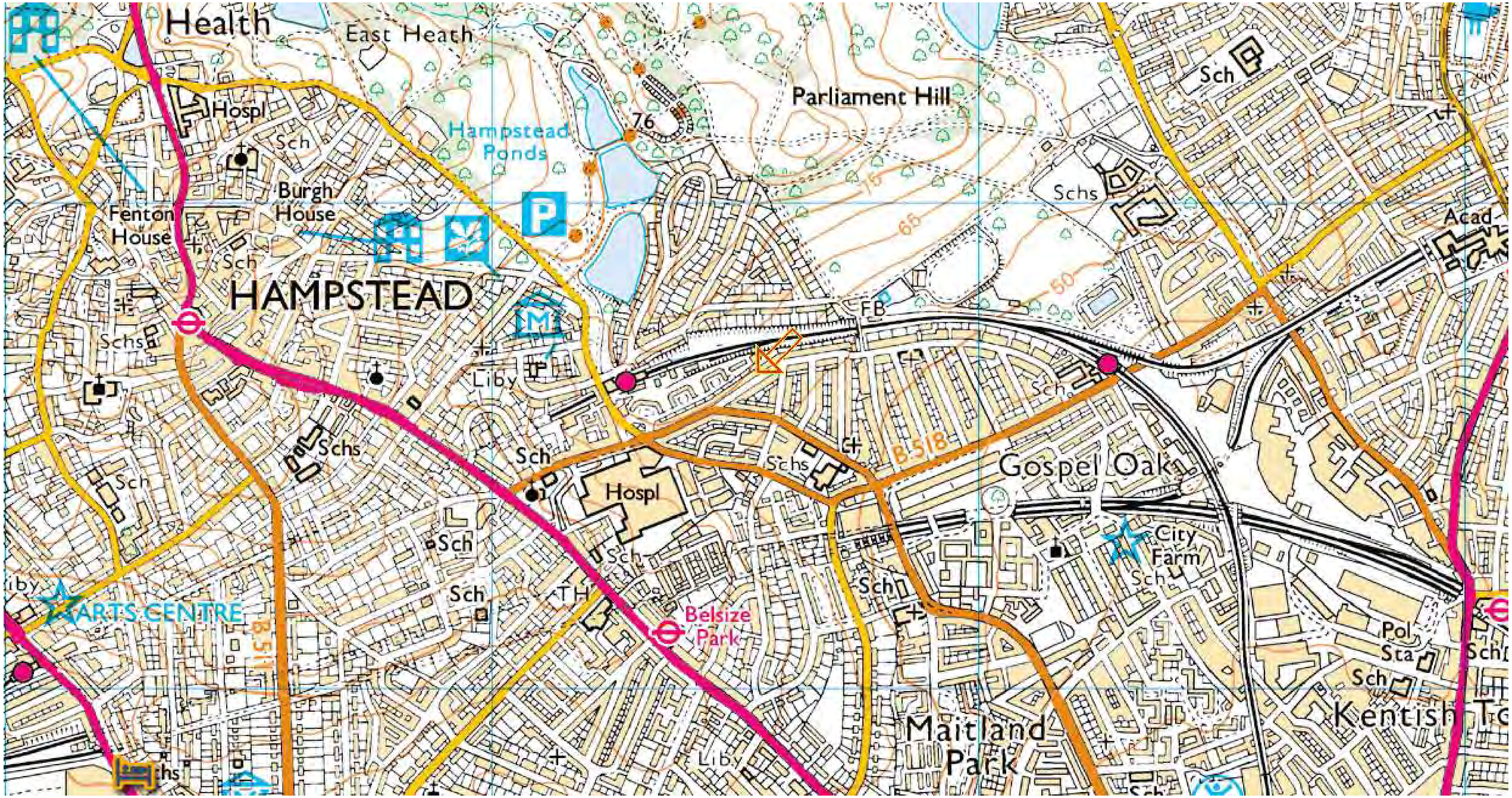
### 6.11 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

N




APPROXIMATE SITE BOUNDARY

NOT TO SCALE

| | | |
|---|---|---|
| **Project:** 73 Constantine Road, Hampstead, London NW3 2LP | | **Figure 1** |
| **Client:** CG Contractors Limited | **Date:** February 2014 | ground&water |
| Site Location Plan | **Ref:** GWPR824 | |


APPROXIMATE SITE BOUNDARY

NOT TO SCALE

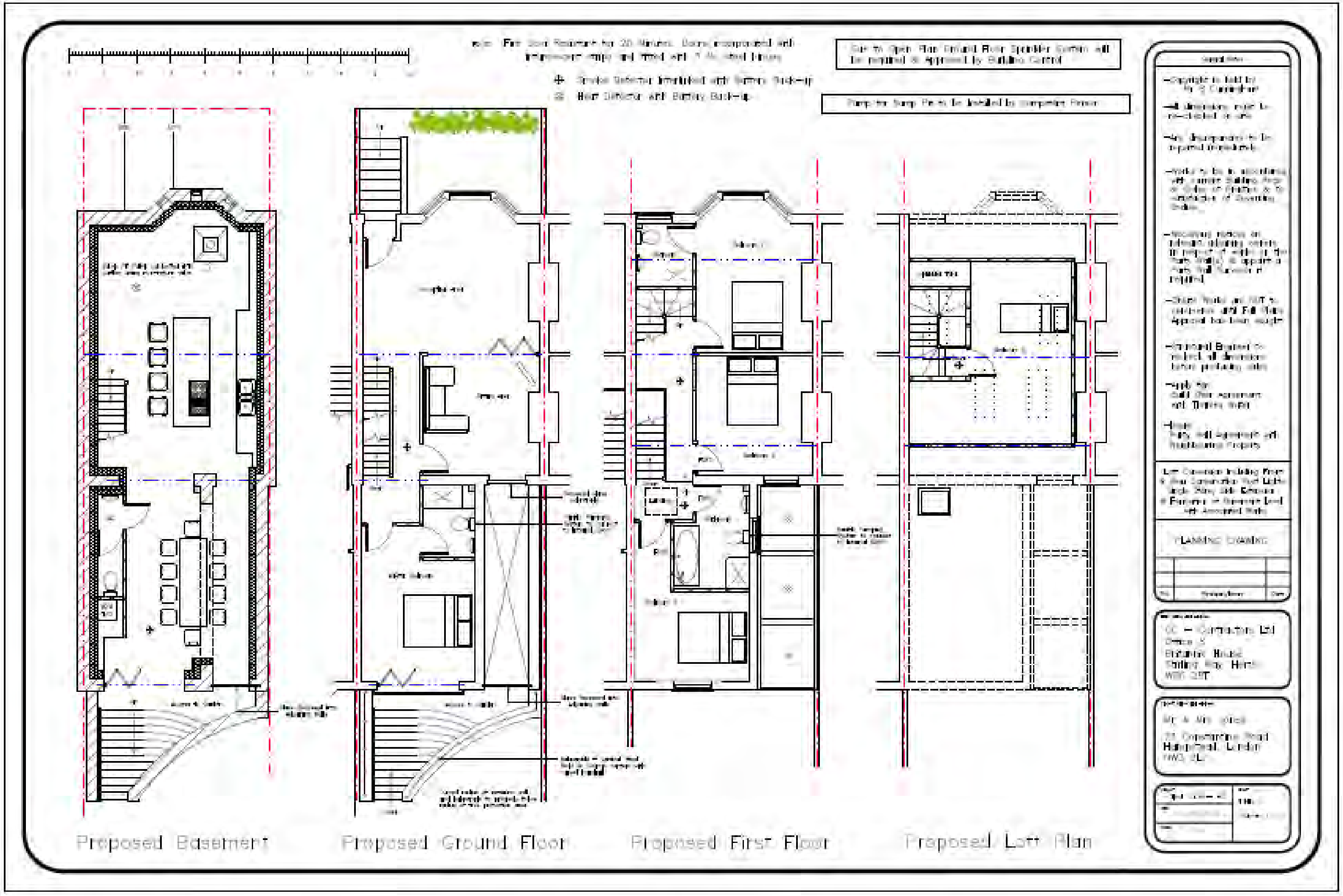
| | |
|---|---|
| **Project:** 73 Constantine Road, Hampstead, London NW3 2LP | **Figure 2** |
| **Client:** CG Contractors Limited / **Date:** February 2014 | ground&water |
| **Site Development Area** / **Ref:** GWPR824 | |


APPROXIMATE SITE BOUNDARY

NOT TO SCALE

| | | |
|---|---|---|
| **Project:** 73 Constantine Road, Hampstead, London NW3 2LP | | **Figure 3** |
| **Client:** CG Contractors Limited | **Date:** February 2014 | ground&water |
| **Aerial View of the Site** | **Ref:** GWPR824 | |

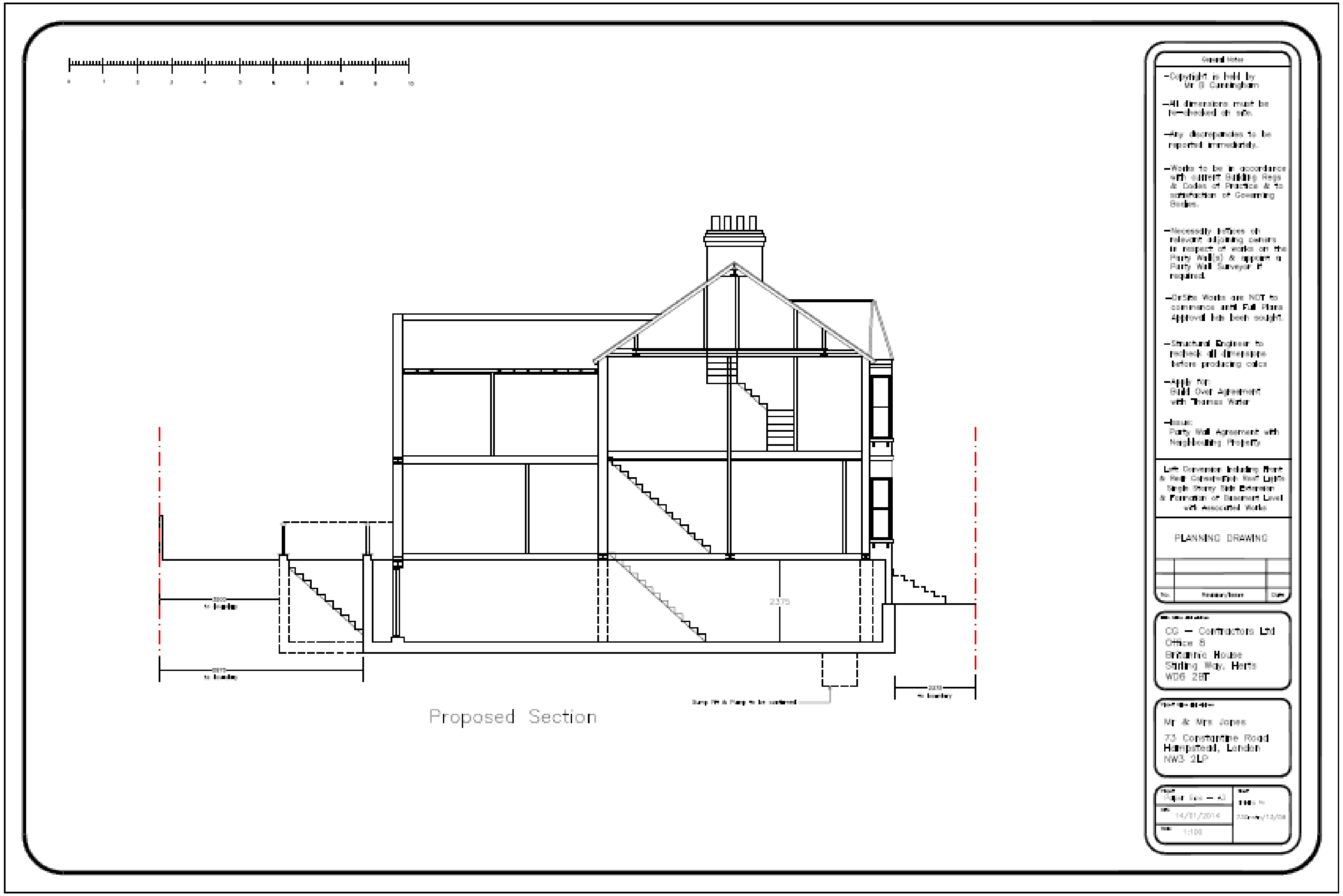
N




NOT TO SCALE

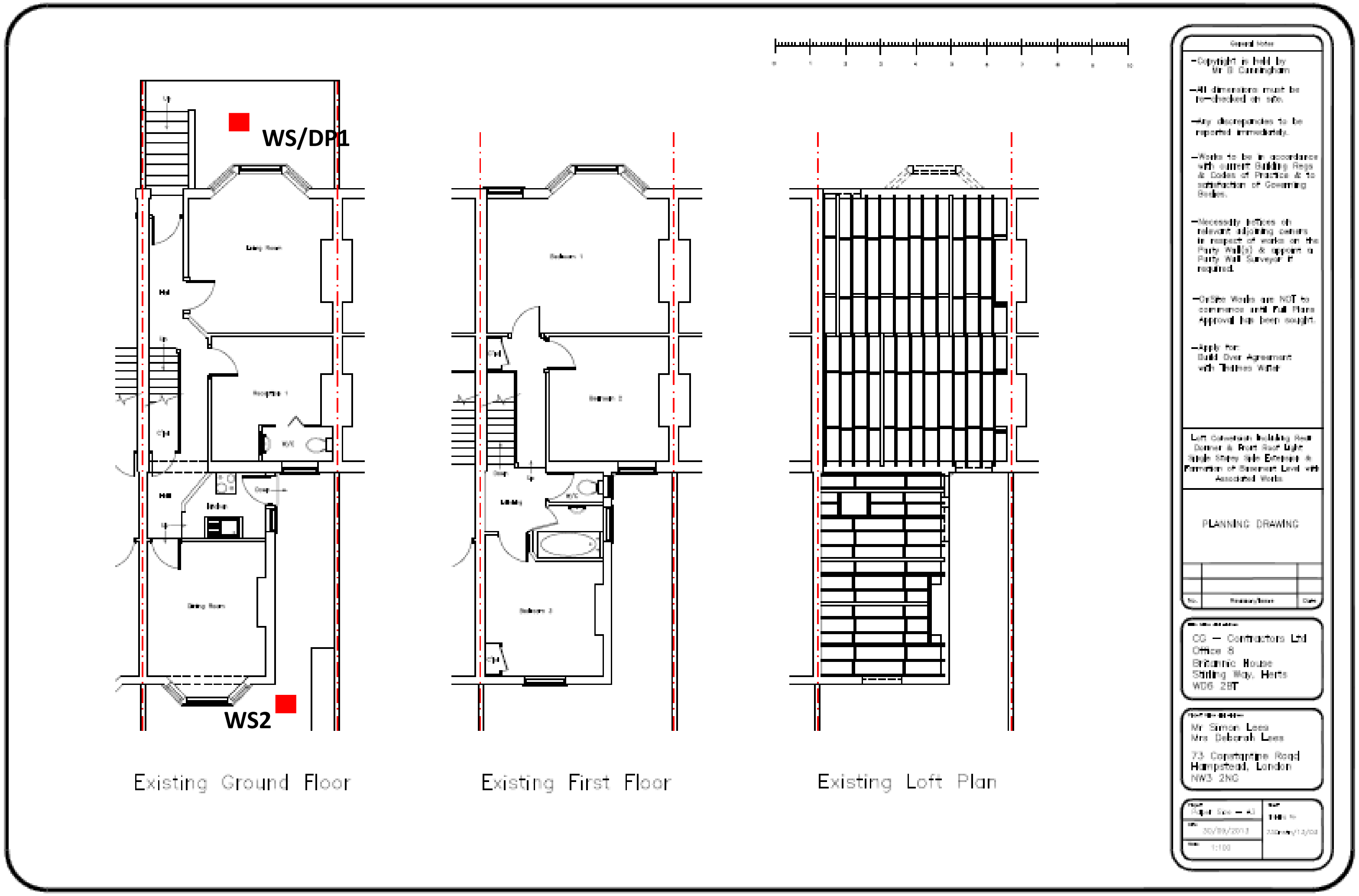
| | | |
|---|---|---|
| **Project:** 73 Constantine Road, Hampstead, London NW3 2LP | | **Figure 4** |
| **Client:** CG Contractors Limited | **Date:** February 2014 | ground&water |
| **Proposed Development Plan – Plan View** | **Ref:** GWPR824 | |

N




NOT TO SCALE

| | | |
|---|---|---|
| **Project:** 73 Constantine Road, Hampstead, London NW3 2LP | | **Figure 5** |
| **Client:** CG Contractors Limited | **Date:** February 2014 | ground&water |
| **Proposed Development Plan – Section View** | **Ref:** GWPR824 | |




| | |
|---|---|
| **Project:** 73 Constantine Road, Hampstead, London NW3 2LP | **Figure 6** |
| **Client:** CG Contractors Limited / **Date:** February 2014 | ground&water |
| **Trial Hole Location Plan** / **Ref:** GWPR824 | |

# Figure 7: Change in Moisture Content With Depth Within WS1

## APPENDIX A
## Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been samples or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 73 Constantine Road, Hampstead, London NW3 2LP.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

# APPENDIX B
# Fieldwork Logs

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Borehole No **WS1**
Sheet 1 of 1

| Project Name | Project No. | Co-ords: - | Hole Type |
|---|---|---|---|
| 73 Constantine Road, Hampstead | GWPR824 | | WS |
| Location: London NW3 2LP | | Level: - | Scale 1:50 |
| Client: CG Constractors Limited | | Dates: 14/01/2014 | Logged By M.G |

| Well | Water Strikes | Sample Depth (m) | Type | Results | Depth (m) | Level (m AOD) | Legend | Stratum Description |
|---|---|---|---|---|---|---|---|---|
| | | 0.30 | D | | 0.40 | | | MADE GROUND: Dark grey to dark brown gravelly clay. Gravel is occasional, fine to coarse, sub-angular to sub-rounded brick, concrete and flint. |
| | | 0.50 | D | | | | | |
| | | 0.80 | D | | 1.40 | | | MADE GROUND:Dark brown to brown gravelly silty clay. Gravel is rare to occasional, fine to coarse, sub-angular to sub-rounded brick, concrete and flint. |
| | | 1.00 | D | | | | | |
| | | 1.50 | D | | 8.30 | | | LONDON CLAY FORMATION: Brown and grey mottled silty CLAY with pockets of selenite crystals. |
| | | 2.00 | D | | | | | |
| | | 2.50 | D | | | | | |
| | | 3.00 | D | | | | | |
| | | 3.50 | D | | | | | |
| | | 4.00 | D | | | | | |
| | | 4.50 | D | | | | | |
| | | 5.00 | D | | | | | |
| | | 6.00 | D | | | | | |
| | | 6.50 | D | | | | | |
| | | 7.00 | D | | | | | |
| | | 7.50 | D | | | | | |
| | | 8.00 | D | | | | | |
| | | 8.30 | D | | | | | End of Borehole at 8.30 m |

Remarks: Fine roots encountered ~2.0m bgl.
No groundwater encountered.

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Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

| Borehole No | WS2 | Sheet 1 of 1 |
|---|---|---|

| | | | |
|---|---|---|---|
| Project Name: 73 Constantine Road, Hampstead | Project No.: GWPR824 | Co-ords: - | Hole Type: WS |
| Location: London NW3 2LP | | Level: - | Scale: 1:50 |
| Client: CG Constractors Limited | | Dates: 14/01/2014 | Logged By: M.G |

| Well | Water Strikes | Samples Depth (m) | Type | Results | Depth (m) | Level (m AOD) | Legend | Stratum Description |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0.08 | | | CONCRETE |
| | | 0.25 | D | | 0.30 | | | MADE GROUND: Dark brown sandy very gravelly clay. Sand is fine grained. Gravel is occasional, fine to coarse, sub-angular to sub-rounded brick, concrete and flint. |
| | | 0.50 | D | | | | | |
| | | 0.80 | D | | | | | MADE GROUND: Dark brown sandy gravelly clay. Sand is fine grained. Gravel is rare to occasional, fine to coarse, sub-angular to sub-rounded brick, concrete and flint. |
| | | 1.00 | D | | | | | |
| | | 1.50 | D | | | | | |
| | ▽ | | | | | | | |
| | | 2.00 | D | | | | | |
| | | | | | 2.40 | | | LONDON CLAY FORMATION: Dark brown to brown and grey mottled silty CLAY with rare to occasional isolated pockets of fine selenite. |
| | | 2.50 | D | | | | | |
| | | 3.00 | D | | | | | |
| | | 3.50 | D | | | | | |
| | | 4.00 | D | | | | | |
| | | 4.50 | D | | | | | |
| | | 5.00 | D | | | | | |
| | | 5.50 | D | | | | | |
| | | | | | 6.00 | | | End of Borehole at 6.00 m |

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

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

Remarks: Fine roots encountered ~2.4m bgl.
Groundwater strike at 1.80m bgl. Possible perched within Made Ground.

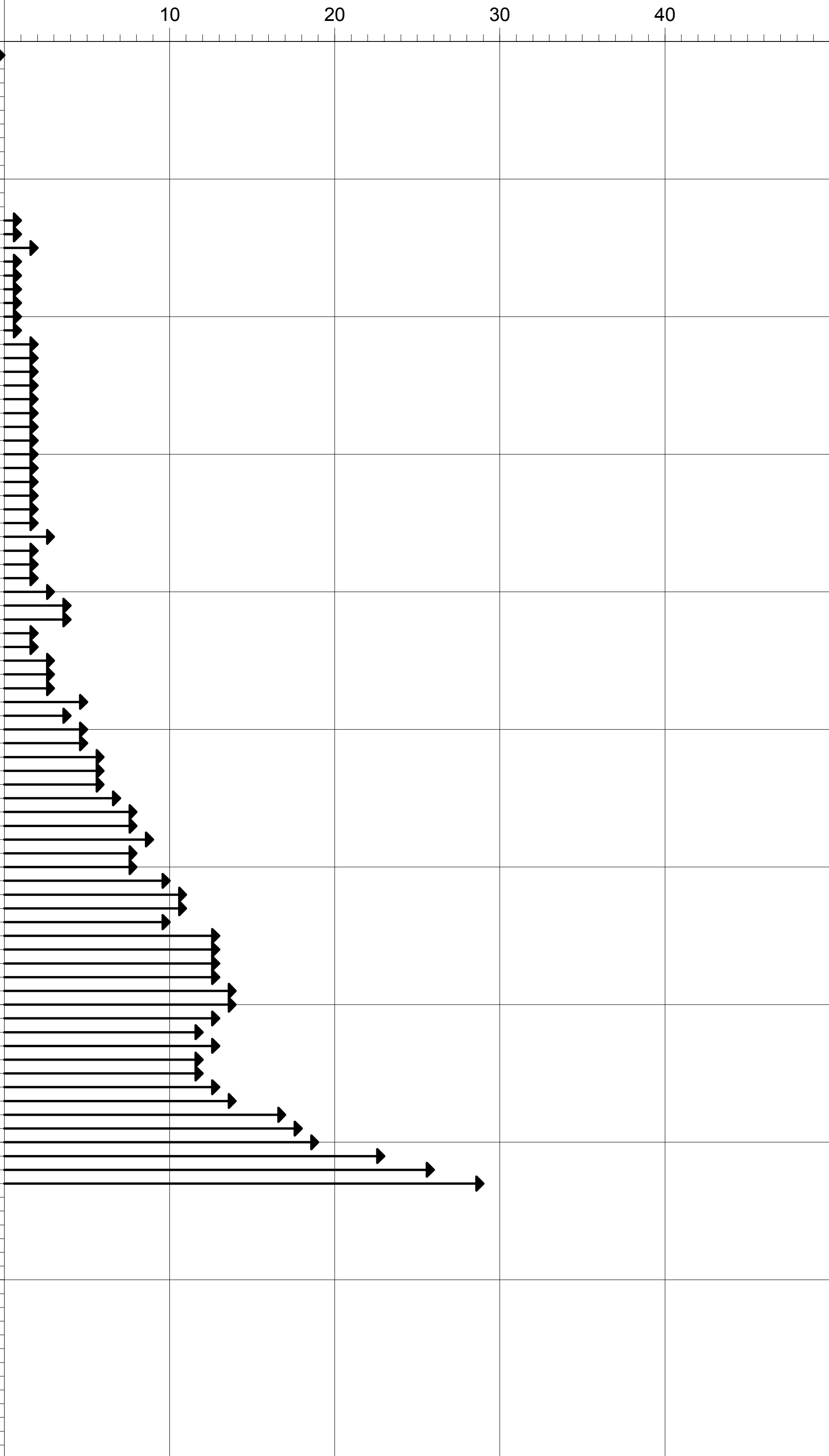
AGS

# DYNAMIC PROBING

| | | | |
|---|---|---|---|
| *Client* **CG Constractors Limited** | | *Probe No* **DP1** | |
| *Site* **73 Constantine Road, Hampstead** | | Sheet 1 of 1 | |
| *E* **-** | *N* **-** | *Project No* **GWPR824** | |
| *Level* **-** | | *Date* **14/01/2014** | *Logged by* |

| *Depth (m)* | *Readings Blows/100mm* | | | | | *Torque (Nm)* |
|---|---|---|---|---|---|---|
| | 0 | - | - | - | - | 0 |
| | - | - | - | - | - | |
| 1.0 | - | - | 1 | 1 | 2 | |
| | 1 | 1 | 1 | 1 | 1 | |
| 2.0 | 1 | 2 | 2 | 2 | 2 | |
| | 2 | 2 | 2 | 2 | 2 | |
| 3.0 | 2 | 2 | 2 | 2 | 2 | |
| | 3 | 2 | 2 | 2 | 3 | |
| 4.0 | 4 | 4 | 2 | 2 | 3 | |
| | 3 | 3 | 5 | 4 | 5 | |
| 5.0 | 5 | 6 | 6 | 6 | 7 | |
| | 8 | 8 | 9 | 8 | 8 | |
| 6.0 | 10 | 11 | 11 | 10 | 13 | |
| | 13 | 13 | 13 | 14 | 14 | |
| 7.0 | 13 | 12 | 13 | 12 | 12 | |
| | 13 | 14 | 17 | 18 | 19 | |
| 8.0 | 23 | 26 | 29 | | | |
| 9.0 | | | | | | |

*Diagram (N100 Values)*





ground &water

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Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk


| | | | |
|---|---|---|---|
| *Fall Height* | **500** | *Cone Base Diameter* | **43** |
| *Hammer Wt* | **50.00** | *Final Depth* | **8.20** |
| *Probe Type* | **DPH** | *Log Scale* | 1:50 |

AGS

# APPENDIX C
## Geotechnical Laboratory Test Results

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project Name:** | 73 Constantine Road, London NW3 2NG | | | **Samples Received:** | 22/01/2014 | K4 SOILS | |
| | | | | **Project Started:** | 22/01/2014 | | |
| **Client:** | Ground and Water Ltd | | | **Testing Started:** | 30/01/2014 | | |
| **Project No:** | GWPR824 | **Our job/report no:** | 15982 | **Date Reported:** | 31/01/2014 | | |

| Borehole No: | Sample No: | Depth (m) | Description | Moisture content (%) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) | Passing 0.425 mm (%) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| WS1 | - | 1.50 | Brown slightly gravelly CLAY with trace fine brick fragments and roots (gravel is fine and sub-angular) | 31 | 80 | 28 | 52 | 97 | |
| WS1 | - | 2.00 | Brown CLAY with occasional selenite | 32 | | | | | |
| WS1 | - | 2.50 | Brown and occasional blue grey CLAY with occasional selenite | 32 | 87 | 29 | 58 | 100 | |
| WS1 | - | 3.00 | Brown CLAY with occasional selenite | 34 | | | | | |
| WS1 | - | 3.50 | Brown and occasional orange brown CLAY with occasional selenite crystals | 29 | | | | | |
| WS1 | - | 4.00 | Brown CLAY | 30 | | | | | |
| WS1 | - | 8.00 | Brown CLAY with scattered traces of selenite | 31 | 79 | 29 | 50 | 100 | |
| WS2 | - | 2.50 | Greyish brown slightly gravelly CLAY with scattered traces of selenite (gravel is fine and sub-angular) | 37 | 83 | 29 | 54 | 97 | |
| WS2 | - | 5.50 | Brown CLAY | 34 | 82 | 30 | 52 | 100 | |

UKAS TESTING 2519

## Summary of Test Results

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

**Checked and Approved**
Initials: K.P
Date: 31/01/2014

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

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

| | | | | | |
|---|---|---|---|---|---|
| Project Name: | 73 Constantine Road, London NW3 2NG | | | | K4 SOILS |
| Client: | Ground and Water Ltd | Project no: GWPR824 | | | |
| | | Our job no: 15982 | | | |

| Borehole No: | Sample No: | Depth m | Description | pH | Sulphate content (g/l) |
|---|---|---|---|---|---|
| WS1 | - | 2.00 | Brown CLAY with occasional selenite crystals | 8.3 | 2.36 |

| | | |
|---|---|---|
| Date<br>31/01/2014 | **Summary of Test Results**<br>BS 1377 : Part 3 :Clause 5 : 1990<br>Determination of sulphate content of soil and ground water : gravimetric method | Checked and Approved<br>Initials : kp |

## APPENDIX D
### Chemical Laboratory Test Results

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**QTS Environmental Ltd**
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**t:** 01622 850410
russell.jarvis@qtsenvironmental.com

# QTS Environmental Report No: 14-18864

| | |
|---|---|
| **Site Reference:** | 73 Constantine Road, Hampstead Heath, London NW3 2NG |
| **Project / Job Ref:** | GWPR824 |
| **Order No:** | None Supplied |
| **Sample Receipt Date:** | 22/01/2014 |
| **Sample Scheduled Date:** | 22/01/2014 |
| **Report Issue Number:** | 1 |
| **Reporting Date:** | 28/01/2014 |

**Authorised by:**

Russell Jarvis
Director
**On behalf of QTS Environmental Ltd**

**Authorised by:**

Kevin Old
Director
**On behalf of QTS Environmental Ltd**

**QTS Environmental Ltd**
**Unit 1, Rose Lane Industrial Estate**
**Rose Lane**
**Lenham Heath**
**Maidstone**
**Kent ME17 2JN**
**Tel : 01622 850410**

| **Soil Analysis Certificate** | | | | | | |
|---|---|---|---|---|---|---|
| **QTS Environmental Report No: 14-18864** | **Date Sampled** | 14/01/14 | 14/01/14 | 14/01/14 | 14/01/14 | |
| **Ground & Water Ltd** | **Time Sampled** | None Supplied | None Supplied | None Supplied | None Supplied | |
| **Site Reference: 73 Constantine Road, Hampstead Heath, London NW3 2NG** | **TP / BH No** | WS1 | WS2 | WS1 | WS2 | |
| **Project / Job Ref: GWPR824** | **Additional Refs** | None Supplied | None Supplied | None Supplied | None Supplied | |
| **Order No: None Supplied** | **Depth (m)** | 0.80 | 3.00 | 0.30 | 0.25 | |
| **Reporting Date: 28/01/2014** | **QTSE Sample No** | 91097 | 91098 | 91099 | 91100 | |

| **Determinand** | **Unit** | **RL** | **Accreditation** | | | | | |
|---|---|---|---|---|---|---|---|---|
| Asbestos Screen | N/a | N/a | **ISO17025** | | | Not Detected | Not Detected | |
| pH | pH Units | N/a | **MCERTS** | 8.1 | 7.7 | 7.9 | 8.5 | |
| Total Cyanide | mg/kg | < 2 | NONE | | | < 2 | < 2 | |
| Total Sulphate as $SO_4$ | mg/kg | < 200 | NONE | 422 | 2292 | | | |
| W/S Sulphate as $SO_4$ (2:1) | g/l | < 0.01 | NONE | 0.04 | 1.50 | 0.04 | 0.07 | |
| Total Sulphur | mg/kg | < 200 | NONE | 234 | 834 | | | |
| Organic Matter | % | < 0.1 | NONE | | | 5.7 | 1.8 | |
| Total Organic Carbon (TOC) | % | < 0.1 | NONE | | | 3.3 | 1.1 | |
| Ammonium as $NH_4$ | mg/kg | < 0.5 | NONE | 0.6 | 0.9 | | | |
| W/S Chloride (2:1) | mg/kg | < 1 | **MCERTS** | 9 | 26 | | | |
| Water Soluble Nitrate (2:1) as $NO_3$ | mg/kg | < 3 | **MCERTS** | 13 | < 3 | | | |
| Arsenic (As) | mg/kg | < 2 | **MCERTS** | | | 13 | 6 | |
| W/S Boron | mg/kg | < 1 | NONE | | | 1.7 | < 1 | |
| Cadmium (Cd) | mg/kg | < 0.5 | **MCERTS** | | | 0.6 | < 0.5 | |
| Chromium (Cr) | mg/kg | < 2 | **MCERTS** | | | 29 | 27 | |
| Chromium (hexavalent) | mg/kg | < 2 | NONE | | | < 2 | < 2 | |
| Copper (Cu) | mg/kg | < 4 | **MCERTS** | | | 55 | 28 | |
| Lead (Pb) | mg/kg | < 3 | **MCERTS** | | | 1930 | 207 | |
| W/S Magnesium | mg/kg | < 10 | NONE | 50 | 504 | | | |
| Mercury (Hg) | mg/kg | < 1 | NONE | | | < 1 | < 1 | |
| Nickel (Ni) | mg/kg | < 3 | **MCERTS** | | | 19 | 16 | |
| Selenium (Se) | mg/kg | < 3 | NONE | | | < 3 | < 3 | |
| Vanadium (V) | mg/kg | < 2 | NONE | | | 57 | 48 | |
| Zinc (Zn) | mg/kg | < 3 | **MCERTS** | | | 363 | 75 | |
| Total Phenols (monohydric) | mg/kg | < 2 | NONE | | | < 2 | < 2 | |

Analytical results are expressed on a dry weight basis where samples are dried at less than 30$^{O}$C

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Javeed Malik

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis [(S)]

**QTS Environmental Ltd**
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**Lenham Heath**
**Maidstone**
**Kent ME17 2JN**
**Tel : 01622 850410**

| **Soil Analysis Certificate - Speciated PAHs** | | | | | | |
|---|---|---|---|---|---|---|
| **QTS Environmental Report No: 14-18864** | **Date Sampled** | 14/01/14 | 14/01/14 | | | |
| **Ground & Water Ltd** | **Time Sampled** | None Supplied | None Supplied | | | |
| **Site Reference: 73 Constantine Road, Hampstead Heath, London NW3 2NG** | **TP / BH No** | WS1 | WS2 | | | |
| **Project / Job Ref: GWPR824** | **Additional Refs** | None Supplied | None Supplied | | | |
| **Order No: None Supplied** | **Depth (m)** | 0.30 | 0.25 | | | |
| **Reporting Date: 28/01/2014** | **QTSE Sample No** | 91099 | 91100 | | | |

| **Determinand** | **Unit** | **RL** | **Accreditation** | | | | | |
|---|---|---|---|---|---|---|---|---|
| Naphthalene | mg/kg | < 0.1 | **MCERTS** | 0.47 | < 0.1 | | | |
| Acenaphthylene | mg/kg | < 0.1 | **MCERTS** | < 0.1 | < 0.1 | | | |
| Acenaphthene | mg/kg | < 0.1 | **MCERTS** | 2.28 | < 0.1 | | | |
| Fluorene | mg/kg | < 0.1 | **MCERTS** | 2.10 | < 0.1 | | | |
| Phenanthrene | mg/kg | < 0.1 | **MCERTS** | 18.20 | 0.34 | | | |
| Anthracene | mg/kg | < 0.1 | **MCERTS** | 4.41 | < 0.1 | | | |
| Fluoranthene | mg/kg | < 0.1 | **MCERTS** | 15.30 | 0.91 | | | |
| Pyrene | mg/kg | < 0.1 | **MCERTS** | 11 | 0.70 | | | |
| Benzo(a)anthracene | mg/kg | < 0.1 | **MCERTS** | 6.26 | 0.39 | | | |
| Chrysene | mg/kg | < 0.1 | **MCERTS** | 4.57 | 0.41 | | | |
| Benzo(b)fluoranthene | mg/kg | < 0.1 | **MCERTS** | 4.32 | 0.47 | | | |
| Benzo(k)fluoranthene | mg/kg | < 0.1 | **MCERTS** | 1.59 | 0.18 | | | |
| Benzo(a)pyrene | mg/kg | < 0.1 | **MCERTS** | 3.23 | 0.31 | | | |
| Indeno(1,2,3-cd)pyrene | mg/kg | < 0.1 | **MCERTS** | 1.48 | 0.17 | | | |
| Dibenz(a,h)anthracene | mg/kg | < 0.1 | **MCERTS** | 0.23 | < 0.1 | | | |
| Benzo(ghi)perylene | mg/kg | < 0.1 | **MCERTS** | 1.15 | 0.13 | | | |
| Total EPA-16 PAHs | mg/kg | < 1.6 | **MCERTS** | 76.6 | 4 | | | |

Analytical results are expressed on a dry weight basis where samples are dried at less than 30$^{O}$C

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**Maidstone**
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**Tel : 01622 850410**

| **Soil Analysis Certificate - TPH CWG Banded** | | | | | | |
|---|---|---|---|---|---|---|
| **QTS Environmental Report No: 14-18864** | **Date Sampled** | 14/01/14 | | | | |
| **Ground & Water Ltd** | **Time Sampled** | None Supplied | | | | |
| **Site Reference: 73 Constantine Road, Hampstead Heath, London NW3 2NG** | **TP / BH No** | WS2 | | | | |
| **Project / Job Ref: GWPR824** | **Additional Refs** | None Supplied | | | | |
| **Order No: None Supplied** | **Depth (m)** | 0.25 | | | | |
| **Reporting Date: 28/01/2014** | **QTSE Sample No** | 91100 | | | | |

| **Determinand** | **Unit** | **RL** | **Accreditation** | | | | | |
|---|---|---|---|---|---|---|---|---|
| Aliphatic >C5 - C6 | mg/kg | < 0.01 | NONE | < 0.01 | | | | |
| Aliphatic >C6 - C8 | mg/kg | < 0.05 | NONE | < 0.05 | | | | |
| Aliphatic >C8 - C10 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aliphatic >C10 - C12 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aliphatic >C12 - C16 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aliphatic >C16 - C21 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aliphatic >C21 - C34 | mg/kg | < 6 | NONE | < 6 | | | | |
| Aliphatic (C5 - C34) | mg/kg | < 12 | NONE | < 12 | | | | |
| Aromatic >C5 - C7 | mg/kg | < 0.01 | NONE | < 0.01 | | | | |
| Aromatic >C7 - C8 | mg/kg | < 0.05 | NONE | < 0.05 | | | | |
| Aromatic >C8 - C10 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aromatic >C10 - C12 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aromatic >C12 - C16 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aromatic >C16 - C21 | mg/kg | < 1 | NONE | < 1 | | | | |
| Aromatic >C21 - C35 | mg/kg | < 6 | NONE | < 6 | | | | |
| Aromatic (C5 - C35) | mg/kg | < 12 | NONE | < 12 | | | | |
| Total >C5 - C35 | mg/kg | < 24 | NONE | < 24 | | | | |

Analytical results are expressed on a dry weight basis where samples are dried at less than 30°C

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4480

| **Soil Analysis Certificate - BTEX / MTBE** | | | | | | |
|---|---|---|---|---|---|---|
| **QTS Environmental Report No: 14-18864** | **Date Sampled** | 14/01/14 | | | | |
| **Ground & Water Ltd** | **Time Sampled** | None Supplied | | | | |
| **Site Reference: 73 Constantine Road, Hampstead Heath, London NW3 2NG** | **TP / BH No** | WS2 | | | | |
| **Project / Job Ref: GWPR824** | **Additional Refs** | None Supplied | | | | |
| **Order No: None Supplied** | **Depth (m)** | 0.25 | | | | |
| **Reporting Date: 28/01/2014** | **QTSE Sample No** | 91100 | | | | |

| **Determinand** | **Unit** | **RL** | **Accreditation** | | | | | |
|---|---|---|---|---|---|---|---|---|
| Benzene | ug/kg | < 2 | **MCERTS** | < 2 | | | | |
| Toluene | ug/kg | < 5 | **MCERTS** | < 5 | | | | |
| Ethylbenzene | ug/kg | < 10 | **MCERTS** | < 10 | | | | |
| p & m-xylene | ug/kg | < 10 | **MCERTS** | < 10 | | | | |
| o-xylene | ug/kg | < 10 | **MCERTS** | < 10 | | | | |
| MTBE | ug/kg | < 5 | **MCERTS** | < 5 | | | | |

Analytical results are expressed on a dry weight basis where samples are dried at less than 30$^{O}$C

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| **Soil Analysis Certificate - Sample Descriptions** |
|---|
| **QTS Environmental Report No: 14-18864** |
| **Ground & Water Ltd** |
| **Site Reference: 73 Constantine Road, Hampstead Heath, London NW3 2NG** |
| **Project / Job Ref: GWPR824** |
| **Order No: None Supplied** |
| **Reporting Date: 28/01/2014** |

| QTSE Sample No | TP / BH No | Additional Refs | Depth (m) | Moisture Content (%) | Sample Matrix Description |
|---|---|---|---|---|---|
| 91097 | WS1 | None Supplied | 0.80 | 18.7 | Brown clay |
| 91098 | WS2 | None Supplied | 3.00 | 23.3 | Brown clay |
| 91099 | WS1 | None Supplied | 0.30 | 20.6 | Grey clayey loam with vegetation and brick |
| 91100 | WS2 | None Supplied | 0.25 | 17.9 | Brown clayey gravel with stones and rubble |

Insufficient sample I/S
Unsuitable Sample U/S

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4480

| **Soil Analysis Certificate - Methodology & Miscellaneous Information** |
|---|
| **QTS Environmental Report No: 14-18864** |
| **Ground & Water Ltd** |
| **Site Reference: 73 Constantine Road, Hampstead Heath, London NW3 2NG** |
| **Project / Job Ref: GWPR824** |
| **Order No: None Supplied** |
| **Reporting Date: 28/01/2014** |

| Matrix | Analysed On | Determinand | Brief Method Description | Method No |
|---|---|---|---|---|
| Soil | D | Boron - Water Soluble | Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES | E012 |
| Soil | AR | BTEX | Determination of BTEX by headspace GC-MS | E001 |
| Soil | D | Cations | Determination of cations in soil by aqua-regia digestion followed by ICP-OES | E002 |
| Soil | D | Chloride - Water Soluble (2:1) | Determination of chloride by extraction with water & analysed by ion chromatography | E009 |
| Soil | AR | Chromium - Hexavalent | Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry | E016 |
| Soil | AR | Cyanide - Complex | Determination of complex cyanide by distillation followed by colorimetry | E015 |
| Soil | AR | Cyanide - Free | Determination of free cyanide by distillation followed by colorimetry | E015 |
| Soil | AR | Cyanide - Total | Determination of total cyanide by distillation followed by colorimetry | E015 |
| Soil | D | Cyclohexane Extractable Matter (CEM) | Gravimetrically determined through extraction with cyclohexane | E011 |
| Soil | AR | Diesel Range Organics (C10 - C24) | Determination of hexane/acetone extractable hydrocarbons by GC-FID | E004 |
| Soil | AR | Electrical Conductivity | Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement | E022 |
| Soil | AR | Electrical Conductivity | Determination of electrical conductivity by addition of water followed by electrometric measurement | E023 |
| Soil | D | Elemental Sulphur | Determination of elemental sulphur by solvent extraction followed by GC-MS | E020 |
| Soil | AR | EPH (C10 – C40) | Determination of acetone/hexane extractable hydrocarbons by GC-FID | E004 |
| Soil | AR | EPH Product ID | Determination of acetone/hexane extractable hydrocarbons by GC-FID | E004 |
| Soil | AR | EPH TEXAS | Determination of acetone/hexane extractable hydrocarbons by GC-FID | E004 |
| Soil | D | Fluoride - Water Soluble | Determination of Fluoride by extraction with water & analysed by ion chromatography | E009 |
| Soil | D | FOC (Fraction Organic Carbon) | Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate | E010 |
| Soil | D | Loss on Ignition @ 450oC | Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace | E019 |
| Soil | D | Magnesium - Water Soluble | Determination of water soluble magnesium by extraction with water followed by ICP-OES | E025 |
| Soil | D | Metals | Determination of metals by aqua-regia digestion followed by ICP-OES | E002 |
| Soil | AR | Mineral Oil (C10 - C40) | Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge | E004 |
| Soil | AR | Moisture Content | Moisture content; determined gravimetrically | E003 |
| Soil | D | Nitrate - Water Soluble (2:1) | Determination of nitrate by extraction with water & analysed by ion chromatography | E009 |
| Soil | D | Organic Matter | Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate | E010 |
| Soil | AR | PAH - Speciated (EPA 16) | Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards | E005 |
| Soil | AR | PCB - 7 Congeners | Determination of PCB by extraction with acetone and hexane followed by GC-MS | E008 |
| Soil | D | Petroleum Ether Extract (PEE) | Gravimetrically determined through extraction with petroleum ether | E011 |
| Soil | AR | pH | Determination of pH by addition of water followed by electrometric measurement | E007 |
| Soil | AR | Phenols - Total (monohydric) | Determination of phenols by distillation followed by colorimetry | E021 |
| Soil | D | Phosphate - Water Soluble (2:1) | Determination of phosphate by extraction with water & analysed by ion chromatography | E009 |
| Soil | D | Sulphate (as SO4) - Total | Determination of total sulphate by extraction with 10% HCl followed by ICP-OES | E013 |
| Soil | D | Sulphate (as SO4) - Water Soluble (2:1) | Determination of sulphate by extraction with water & analysed by ion chromatography | E009 |
| Soil | D | Sulphate (as SO4) - Water Soluble (2:1) | Determination of water soluble sulphate by extraction with water followed by ICP-OES | E014 |
| Soil | AR | Sulphide | Determination of sulphide by distillation followed by colorimetry | E018 |
| Soil | D | Sulphur - Total | Determination of total sulphur by extraction with aqua-regia followed by ICP-OES | E024 |
| Soil | AR | SVOC | Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS | E006 |
| Soil | AR | Thiocyanate (as SCN) | Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry | E017 |
| Soil | D | Toluene Extractable Matter (TEM) | Gravimetrically determined through extraction with toluene | E011 |
| Soil | D | Total Organic Carbon (TOC) | Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate | E010 |
| Soil | AR | TPH CWG | Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge | E004 |
| Soil | AR | TPH LQM | Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge | E004 |
| Soil | AR | VOCs | Determination of volatile organic compounds by headspace GC-MS | E001 |
| Soil | AR | VPH (C6 - C10) | Determination of hydrocarbons C6-C10 by headspace GC-MS | E001 |

**D** **Dried**
**AR** **As Received**

## APPENDIX E

**Soil Assessment Criteria**

**Appendix E**
**Soil Guideline Values and Genera Assessment Criteria**

## E1 Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

### E1.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

1) EA Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil.*
2) EA Science Report SC050021/SR3: *Updated technical background to the CLEA model.*
3) EA CLEA Bulletin (2009).
4) CLEA software version 1.06 (2009)
5) Toxicological reports and SGV technical notes.

The CLEA guidance and tools:

- *do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.*
- *do not cover risks to the environment, such as groundwater, ecosystems or buildings.*
- *do not provide a definitive test for telling when human health risks are significant.*
- *are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.*

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

### E1.2 Land-use Scenarios

The CLEA model uses a range of standard land-use scenarios to develop conceptual exposure models as follows:

***1 Residential***

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil and indoor dust ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
- Building type is a two-storey small terraced house.

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

***2) Allotments***

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
- There is no building.

***3) Commercial/Industrial***

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

- Critical receptor is a working female adult (aged 16 to 65 years old).
- Exposure duration is a working lifetime of 49 years.
- Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
- Building type is a three-storey office (pre 1970).

### E1.3 Soil Guideline Values

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less that the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

### E1.4 Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health or CL:AIRE, the Environment Industries Commission (EIC) and The Association of Geotechnical and Geo-environmental Specialists (AGS) will be used:

For derivation of these Generic Assessment Criteria reference must be made to:

Nathanial, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition)*. **Land Quality Press**. 2009.

CL:AIRE, *The Soil Generic Assessment Criteria for Human Health Risk Assessment.* **Contaminated Land: Applications in the Real Environment**. 2009.

In the case of Lead, no SGV or GAC has been published to date. This is likely to be due to the toxicity review that is currently being undertaken by the Environment Agency. In the absence of updated toxicity information the SGV derived using CLEA 1.01 methodology and related toxicity will be used.

### E1.5 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses then a DQRA may be undertaking to develop site specific values for relevant soil contaminants.

⇒ Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.

⇒ Developing more accurate parameters using site data.

### E1.6 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published.

Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

⇒ GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.

⇒ SGV reports may give values that differ from the GAC's used in this report.

⇒ These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.

**E1.7 Phytotoxicity**

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

- ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing*.

**E1.8 Statistical Tests**

DEFRA R&D Publication CLR 7 (DOE 1994) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95$^{th}$ percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CLAIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CLAIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

**Treatment of Hot-Spots**

⇒ A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.

⇒ Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.

## E2 Soil Guideline Values and General Acceptance Criteria

Soil Guideline Values and General Acceptance Criteria used in the preparation of this report is tabulated in the following pages:

## DEFRA CLEA 1.04 Soil Guideline Values (as at January 2011)

| Soil Guideline Values CLEA 1.06 (Sandy Loam, pH 7, SOM 6%) | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg DW)** | **Allotments (mg/kg DW)** | **Commercial (mg/kg DW)** |
| Inorganic | | | |
| **Arsenic** | 32 | 43 | 640 |
| **Cadmium** | 10 | 1.8 | 230 |
| **Mercury** | | | |
| - Elemental | 1.0 | 26 | 26 |
| - Inorganic | 170 | 80 | 3600 |
| - Methyl | 11 | 8 | 410 |
| **Nickel** | 130 | 230 | 1800 |
| **Selenium** | 350 | 120 | 13000 |
| **Organic** May not be protective if SOM <6% | | | |
| **Phenol** | 420 | 280 | 3200 (38,000*) |
| **Benzene** | 0.33 | 0.07 | 95 |
| **Toluene** | 610 | 120 | 4400 |
| **Ethylbenzene** | 350 | 90 | 2800 |
| **Xylenes** | | | |
| - o-xylene | 250 | 160 | 2600 |
| -m-xylene | 240 | 180 | 3500 |
| -p-xylene | 230 | 160 | 3200 |
| **Dioxins, Furans and diozin-like PCB's**** | 8 | 8 | 240 |

* Based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health affects following long term exposure provided for illustration only)
**SGV should be compared with the sum of the soil concentration of all congeners – Table 2 Science Report SC050021/Dioxins SGV.

## DEFRA CLEA 1.01 Soil Guideline Values

| Soil Guideline Values CLEA 1.01 | | | | |
|---|---|---|---|---|
| **Contaminant** | **Residential With Plant Uptake (mg/kg)** | **Residential Without Plant Uptake (mg/kg)** | **Commercial & Industrial (mg/kg)** | **Allotments (mg/kg)** |
| | | | | |
| **Lead** | 450 | 450 | 750 | 450 |
| | | | | |

**Cont'd Overleaf**

## LQM CIEH General Assessment Criteria (2nd edition)

| LQM CIEH General Assessment Criteria | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Metals:*** | | | |
| | | | |
| **Beryllium** | 51 | 55 | 420 |
| **Boron** | 291 | 45 | 192000 |
| **Chromium (III)** | 3000 | 34600 | 30400 |
| **Chromium (VI)** | 4.3 | 2.1 | 35 |
| **Copper** | 2330 | 524 | 71700 |
| **Vanadium** | 75 | 18 | 3160 |
| **Zinc** | 3750 | 618 | 665000 |
| | | | |

| CL:AIRE Soil Generic Assessment Criteria | | | | |
|---|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Residential without plant uptake (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Metals:*** | | | | |
| | | | | |
| **Antimony** | ND | 550 | ND | 7500 |
| **Barium** | ND | 1300 | ND | 22000 |
| **Molybdenum** | ND | 670 | ND | 17000 |
| | | | | |

ND – Not Derived.
NA – Not Applicable

## Phytotoxicity Recommendations

**ICRCL 70/90 *Restoration of metalliferous mining areas***

| Phytotoxicity (Harmful to Plants) Threshold Trigger Values | |
|---|---|
| **Copper** | 250mg/kg |
| **Zinc** | 1000mg/kg |

Notes:
Many cultivars and specifically grasses have a high tolerance and there will be no ill-effect at the threshold trigger values given for neutral or near neutral pH. Site observation of plant vitality may give additional guidance.

**Cont'd Overleaf**

| General Assessment Criteria For Polycyclic Aromatic Hydrocarbons (PAH's) | | | | |
|---|---|---|---|---|
| **Determinants** | | **Residential (mg/kg)** | **Allotments (mg/kg)** | **Commercial (mg/kg)** |
| **Acenapthene** | 1.0% SOM | 210 | 34 | 85,000 (57) sol |
| | 2.5% SOM | 480 | 85 | 98,000 (141) sol |
| | 6.0% SOM | 100 | 200 | 100,000 |
| **Acenapthylene** | 1.0% SOM | 170 | 28 | 84,000 (86) sol |
| | 2.5% SOM | 400 | 69 | 97,000 (212) sol |
| | 6.0% SOM | 850 | 160 | 100,000 |
| **Anthracene** | 1.0% SOM | 2,300 | 380 | 530,000 |
| | 2.5% SOM | 4,900 | 950 | 540,000 |
| | 6.0% SOM | 9,200 | 2200 | 540,000 |
| **Benzo(a)anthracene** | 1.0% SOM | 3.1 | 2.5 | 90 |
| | 2.5% SOM | 4.7 | 5.5 | 95 |
| | 6.0% SOM | 5.9 | 10 | 97 |
| **Benzo(a)pyrene** | 1.0% SOM | 0.83 | 0.6 | 14 |
| | 2.5% SOM | 0.94 | 1.2 | 14 |
| | 6.0% SOM | 1.0 | 2.1 | 14 |
| **Benzo(b)flouranthene** | 1.0% SOM | 5.6 | 3.5 | 100 |
| | 2.5% SOM | 6.5 | 7.4 | 100 |
| | 6.0% SOM | 7.0 | 13 | 100 |
| **Benzo(ghi)perylene** | 1.0% SOM | 44 | 70 | 650 |
| | 2.5% SOM | 46 | 120 | 660 |
| | 6.0% SOM | 47 | 160 | 660 |
| **Benzo(k)flouranthene** | 1.0% SOM | 8.5 | 6.8 | 140 |
| | 2.5% SOM | 9.6 | 14 | 140 |
| | 6.0% SOM | 10 | 23 | 140 |
| **Chrysene** | 1.0% SOM | 6.0 | 2.6 | 140 |
| | 2.5% SOM | 8.0 | 5.8 | 140 |
| | 6.0% SOM | 9.3 | 12 | 140 |
| **Dibenzo(ah)anthracene** | 1.0% SOM | 0.76 | 0.76 | 13 |
| | 2.5% SOM | 0.86 | 1.5 | 13 |
| | 6.0% SOM | 0.90 | 2.3 | 13 |

**Cont'd Overleaf**

| General Assessment Criteria For Polycyclic Aromatic Hydrocarbons (PAH's) Cont'd | | | | |
|---|---|---|---|---|
| **Determinants** | | **Residential (mg/kg)** | **Allotments (mg/kg)** | **Commercial (mg/kg)** |
| **Flouranthene** | 1.0% SOM | 260 | 52 | 23,000 |
| | 2.5% SOM | 460 | 130 | 23,000 |
| | 6.0% SOM | 670 | 290 | 23,000 |
| **Flourene** | 1.0% SOM | 160 | 27 | 64,000 (31) sol |
| | 2.5% SOM | 380 | 67 | 69,000 |
| | 6.0% SOM | 780 | 160 | 71,000 |
| **Indeno(123-cd)pyrene** | 1.0% SOM | 3.2 | 1.8 | 60 |
| | 2.5% SOM | 3.9 | 3.8 | 61 |
| | 6.0% SOM | 4.2 | 7.1 | 62 |
| **Napthalene** | 1.0% SOM | 1.5 | 4.1 | 200 (76) sol |
| | 2.5% SOM | 3.7 | 9.9 | 480 (183) sol |
| | 6.0% SOM | 8.7 | 23 | 1100 (432) sol |
| **Phenanthrene** | 1.0% SOM | 92 | 16 | 22,000 |
| | 2.5% SOM | 200 | 38 | 22,000 |
| | 6.0% SOM | 380 | 90 | 23,000 |
| **Pyrene** | 1.0% SOM | 560 | 110 | 54,000 |
| | 2.5% SOM | 1,000 | 270 | 54,000 |
| | 6.0% SOM | 1,600 | 620 | 54,000 |

vap – GAC presented exceeds the vapour saturation limit, which is presented in brackets.
sol – GAC presented exceeds the soil saturation limit, which is presented in brackets.

## LQM CIEH General Assessment Criteria (cont.)

| General Assessment Criteria For TPH | | | | |
|---|---|---|---|---|
| **Aliphatic** | | **Residential (mg/kg)** | **Allotments (mg/kg)** | **Commercial (mg/kg)** |
| **EC 5-6** | 1.0% SOM | 30 | 740 | 3,400 (304) sol |
| | 2.5% SOM | 55 | 1,700 | 6,200 (558) sol |
| | 6.0% SOM | 110 | 3,900 | 13,000 (1150) sol |
| **EC >6-8** | 1.0% SOM | 73 | 2,300 | 8,300 (144) sol |
| | 2.5% SOM | 160 | 5,600 | 18,000 (322) sol |
| | 6.0% SOM | 370 | 13,000 | 42,000 (736) sol |
| **EC >8-10** | 1.0% SOM | 19 | 320 | 2,100 (78) sol |
| | 2.5% SOM | 46 | 770 | 5,100 (118) vap |
| | 6.0% SOM | 110 | 1,700 | 12,000 (451) vap |
| **EC >10-12** | 1.0% SOM | 93 (48) vap | 2,200 | 10,000 (48) sol |
| | 2.5% SOM | 230 (118) vap | 4,400 | 24,000 (118) vap |
| | 6.0% SOM | 540 (283) vap | 7,300 | 49,000 (283) vap |
| **EC >12-16** | 1.0% SOM | 740 (24) sol | 11,000 | 61,000 (24) sol |
| | 2.5% SOM | 1,700 (59) sol | 13,000 | 83,000 (59) sol |
| | 6.0% SOM | 3,000 (142) sol | 13,000 | 91,000 (142) sol |
| **EC >16-35** | 1.0% SOM | 45,000 (8.48) sol | 260,000 | 1,600,000 |
| | 2.5% SOM | 64,000 (21) sol | 270,000 | 1,800,000 |
| | 6.0% SOM | 76,000 | 270,000 | 1,800,000 |
| **EC >35-44** | 1.0% SOM | 45,000 (8.48) sol | 260,000 | 1,600,000 |
| | 2.5% SOM | 64,000 (21) sol | 270,000 | 1,800,000 |
| | 6.0% SOM | 76,000 | 270,000 | 1,800,000 |

**Cont'd Overleaf**

## General Assessment Criteria For TPH Cont'd

| Aromatic | | Residential (mg/kg) | Allotments (mg/kg) | Commercial (mg/kg) |
|---|---|---|---|---|
| **EC 5-7** | 1.0% SOM | 65 | 13 | 28,000 (1220) sol |
| | 2.5% SOM | 130 | 27 | 49,000 (2260) sol |
| | 6.0% SOM | 280 | 57 | 90,000 (4710) sol |
| **EC >7-8** | 1.0% SOM | 120 | 22 | 59,000 (869) vap |
| | 2.5% SOM | 270 | 51 | 110,000 (1920) sol |
| | 6.0% SOM | 611 | 120 | 190,000 (4360) vap |
| **EC >8-10** | 1.0% SOM | 27 | 8.6 | 3,700 (613) vap |
| | 2.5% SOM | 65 | 21 | 8,600 (1500) vap |
| | 6.0% SOM | 151 | 51 | 18,000 (3580) vap |
| **EC >10-12** | 1.0% SOM | 69 | 13 | 17,000 (364) sol |
| | 2.5% SOM | 160 | 31 | 29,000 (899) sol |
| | 6.0% SOM | 346 | 74 | 34,500 (2150) sol |
| **EC >12-16** | 1.0% SOM | 140 | 23 | 36,000 (169) sol |
| | 2.5% SOM | 480 | 57 | 37,000 |
| | 6.0% SOM | 770 | 130 | 37,800 |
| **EC >16-21** | 1.0% SOM | 250 | 46 | 28,000 |
| | 2.5% SOM | 480 | 110 | 28,000 |
| | 6.0% SOM | 770 | 260 | 28,000 |
| **EC >21-35** | 1.0% SOM | 890 | 370 | 28,000 |
| | 2.5% SOM | 1,100 | 820 | 28,000 |
| | 6.0% SOM | 1,230 | 1,600 | 28,000 |
| **EC >35-44** | 1.0% SOM | 890 | 370 | 28,000 |
| | 2.5% SOM | 1,100 | 820 | 28,000 |
| | 6.0% SOM | 1,230 | 1,600 | 28,000 |

## General Assessment Criteria For TPH Cont'd

| Determinant | | Residential (mg/kg) | Allotments (mg/kg) | Commercial (mg/kg) |
|---|---|---|---|---|
| **Aromatic & Aliphatic EC >44 - 70** | 1.0% SOM | 1200 | 1200 | 28,000 |
| | 2.5% SOM | 1300 | 2100 | 28,000 |
| | 5.0% SOM | 1300 | 3000 | 28,000 |

Note: *SOM = Soil Organic Matter Content (%)*
*LQM CIEH GAC not set for Allotment land-use*

**Cont'd Overleaf**

| LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Chloroalkanes & alkenes*** | | | |
| | | | |
| **1,2 Dichloroethane** | | | |
| 1.0% SOM | 0.0054 | 0.0046 | 0.71 |
| 2.5% SOM | 0.0080 | 0.0083 | 1.00 |
| 6.0% SOM | 0.014 | 0.016 | 1.80 |
| | | | |
| **1,1,2,2 Tetrachloroethane** | | | |
| 1.0% SOM | 1.4 | 0.41 | 290 |
| 2.5% SOM | 2.9 | 0.89 | 580 |
| 6.0% SOM | 6.3 | 2.0 | 1200 |
| | | | |
| **1,1,1,2 Tetrachloroethane** | | | |
| 1.0% SOM | 0.90 | 0.79 | 120 |
| 2.5% SOM | 2.1 | 1.9 | 260 |
| 6.0% SOM | 4.8 | 4.4 | 590 |
| | | | |
| **Tetrachloroethene** | | | |
| 1.0% SOM | 0.94 | 1.6 | 130 |
| 2.5% SOM | 2.1 | 3.7 | 290 |
| 6.0% SOM | 4.8 | 8.7 | 660 |
| | | | |
| **1,1,1 Trichloroethane** | | | |
| 1.0% SOM | 6.2 | 48 | 700 |
| 2.5% SOM | 13 | 110 | 1400 |
| 6.0% SOM | 28 | 240 | 3100 |
| | | | |
| **Tetrachloromethene** | | | |
| 1.0% SOM | 0.018 | 0.16 | 3.0 |
| 2.5% SOM | 0.039 | 0.37 | 6.6 |
| 6.0% SOM | 0.089 | 0.85 | 15 |
| | | | |
| **Trichloroethene** | | | |
| 1.0% SOM | 0.11 | 0.43 | 12 |
| 2.5% SOM | 0.22 | 0.95 | 25 |
| 6.0% SOM | 0.49 | 2.2 | 55 |
| | | | |
| **Trichloromethane** | | | |
| 1.0% SOM | 0.75 | 0.36 | 110 |
| 2.5% SOM | 1.3 | 0.70 | 190 |
| 6.0% SOM | 2.7 | 1.5 | 370 |
| | | | |
| **Vinyl Chloride** | | | |
| 1.0% SOM | 0.00047 | 0.00055 | 0.063 |
| 2.5% SOM | 0.00064 | 0.0010 | 0.081 |
| 6.0% SOM | 0.00099 | 0.0018 | 0.12 |

**Cont'd Overleaf**

| LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Explosives*** | | | |
| | | | |
| **2,4,6 Trinitrotoluene** | | | |
| 1.0% SOM | 1.6 | 0.24 | 1000 |
| 2.5% SOM | 3.7 | 0.58 | 1000 |
| 6.0% SOM | 8.0 | 1.4 | 1100 |
| | | | |
| **RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)** | | | |
| 1.0% SOM | 3.5 | 0.52 | 6400 |
| 2.5% SOM | 7.4 | 1.1 | 6400 |
| 6.0% SOM | 16 | 2.5 | 6400 |
| | | | |
| **HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)** | | | |
| 1.0% SOM | 5.7 | 0.86 | 110,000 |
| 2.5% SOM | 13 | 1.9 | 110,000 |
| 6.0% SOM | 26 | 3.9 | 110,000 |
| | | | |
| **Atrazine** | | | |
| 1.0% SOM | 0.24 | 0.037 | 870 |
| 2.5% SOM | 0.56 | 0.085 | 880 |
| 6.0% SOM | 1.3 | 0.20 | 880 |
| | | | |
| ***Pesticides*** | | | |
| | | | |
| **Aldrin** | | | |
| 1.0% SOM | 1.7 | 1.3 | 54 |
| 2.5% SOM | 2.0 | 2.6 | 54 |
| 6.0% SOM | 2.1 | 4.0 | 54 |
| | | | |
| **Dieldrin** | | | |
| 1.0% SOM | 0.69 | 0.13 | 90 |
| 2.5% SOM | 1.4 | 0.32 | 91 |
| 6.0% SOM | 2.2 | 0.73 | 92 |
| | | | |
| **Dichlorvos** | | | |
| 1.0% SOM | 0.29 | 0.044 | 942 |
| 2.5% SOM | 0.6 | 0.091 | 972 |
| 6.0% SOM | 1.3 | 0.2 | 983 |
| | | | |
| **Alpha - Endosulfan** | | | |
| 1.0% SOM | 2.9 | 0.47 | 2310 (0.003)$^{vap}$ |
| 2.5% SOM | 7.0 | 1.2 | 2990 (0.007)$^{vap}$ |
| 6.0% SOM | 16 | 2.7 | 3390 |
| | | | |

**Cont'd Overleaf**

| LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Pesticides*** | | | |
| | | | |
| **Beta - Endosulfan** | | | |
| 1.0% SOM | 2.8 | 0.44 | 2580 (0.00007)$^{vap}$ |
| 2.5% SOM | 6.6 | 1.1 | 3160 (0.0002)$^{vap}$ |
| 6.0% SOM | 15 | 2.6 | 3480 |
| | | | |
| **Alpha -Hexachlorocyclohexanes** | | | |
| 1.0% SOM | 19 | 3.0 | 14000 |
| 2.5% SOM | 46 | 7.4 | 14600 |
| 6.0% SOM | 100 | 18 | 14900 |
| | | | |
| **Beta -Hexachlorocyclohexanes** | | | |
| 1.0% SOM | 1.7 | 0.26 | 1120 |
| 2.5% SOM | 3.9 | 0.64 | 1130 |
| 6.0% SOM | 8.5 | 1.5 | 1130 |
| | | | |
| **Gamma - Hexachlorocyclohexanes** | | | |
| 1.0% SOM | 0.58 | 0.089 | 532 |
| 2.5% SOM | 1.4 | 0.22 | 546 |
| 6.0% SOM | 3.0 | 0.52 | 552 |
| | | | |
| ***Chlorobenzenes*** | | | |
| | | | |
| **Chlorobenzene** | | | |
| 1.0% SOM | 0.33 | 5.9 | 59 |
| 2.5% SOM | 0.73 | 14 | 32 |
| 6.0% SOM | 59 | 130 | 310 |
| | | | |
| **1,2-Dichlorobenzene** | | | |
| 1.0% SOM | 16 | 94 | 2100 (571)$^{sol}$ |
| 2.5% SOM | 39 | 230 | 5100 (1370)$^{sol}$ |
| 6.0% SOM | 91 | 540 | 12000 (3240)$^{sol}$ |
| | | | |
| **1,3-Dichlorobenzene** | | | |
| 1.0% SOM | 0.29 | 0.25 | 32 |
| 2.5% SOM | 0.70 | 0.61 | 77 |
| 6.0% SOM | 1.7 | 1.5 | 180 |
| | | | |
| **1,4-Dichlorobenzene** | | | |
| 1.0% SOM | 30 | 15 | 4500 (224)$^{vap}$ |
| 2.5% SOM | 72 | 37 | 10000 (540)$^{vap}$ |
| 6.0% SOM | 167 | 88 | 22000 (1280)$^{vap}$ |
| | | | |
| **1,2,3,-Trichlorobenzene** | | | |
| 1.0% SOM | 1.0 | 4.7 | 110 |
| 2.5% SOM | 2.6 | 12 | 270 |
| 6.0% SOM | 6.1 | 28 | 620 |
| | | | |

**Cont'd Overleaf**

| LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Chlorobenzenes*** | | | |
| | | | |
| **1,2,4,-Trichlorobenzene** | | | |
| 1.0% SOM | 1.8 | 31 | 230 |
| 2.5% SOM | 4.5 | 75 | 560 |
| 6.0% SOM | 11 | 180 | 1300 |
| | | | |
| **1,3,5,-Trichlorobenzene** | | | |
| 1.0% SOM | 0.23 | 4.7 | 24 |
| 2.5% SOM | 0.57 | 12 | 57.8 |
| 6.0% SOM | 1.3 | 28 | 140 |
| | | | |
| **1,2,3,4,-Tetrachlorobenzene** | | | |
| 1.0% SOM | 12 | 4.4 | 1800 (122)$^{vap}$ |
| 2.5% SOM | 4.5 | 75 | 3200 (304)$^{vap}$ |
| 6.0% SOM | 11 | 180 | 4500 (728)$^{vap}$ |
| | | | |
| **1,2,3,5,- Tetrachlobenzene** | | | |
| 1.0% SOM | 0.49 | 0.38 | 52 (39.4)$^{vap}$ |
| 2.5% SOM | 1.2 | 0.94 | 120 (98.1)$^{vap}$ |
| 6.0% SOM | 2.8 | 2.2 | 250 (235)$^{vap}$ |
| | | | |
| **1,2,4, 5,- Tetrachlobenzene** | | | |
| 1.0% SOM | 0.30 | 0.064 | 44 (19.7)$^{sol}$ |
| 2.5% SOM | 0.68 | 0.16 | 73 (49.1)$^{sol}$ |
| 6.0% SOM | 1.4 | 0.37 | 97 |
| | | | |
| **Pentachlrobenzene** | | | |
| 1.0% SOM | 5.2 | 1.2 | 650 (43.0)$^{sol}$ |
| 2.5% SOM | 10 | 3.1 | 770 (107)$^{sol}$ |
| 6.0% SOM | 17 | 7.1 | 830 |
| | | | |
| **Hexachlorobenzene** | | | |
| 1.0% SOM | 0.59 (0.20)$^{vap}$ | 0.18 | 48 (0.20)$^{vap}$ |
| 2.5% SOM | 1.0 (0.50)$^{vap}$ | 0.42 | 53 |
| 6.0% SOM | 1.4 | 0.92 | 55 |
| | | | |

**Cont'd Overleaf**

| LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | |
|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| ***Phenols & Chlorophenols*** | | | |
| | | | |
| **Chlorophenols (4 Congeners)** | | | |
| 1.0% SOM | 0.87 | 0.13 | 3500 |
| 2.5% SOM | 2.0 | 0.30 | 4000 |
| 6.0% SOM | 4.4 | 0.70 | 4200 |
| | | | |
| **Pentachlorophenols** | | | |
| 1.0% SOM | 0.55 | 0.084 | 1200 |
| 2.5% SOM | 1.3 | 0.21 | 0.49 |
| 6.0% SOM | 1200 | 1300 | 1400 |
| | | | |
| ***Others*** | | | |
| | | | |
| **Carbon Disulphide** | | | |
| 1.0% SOM | 0.10 | 4.8 | 12 |
| 2.5% SOM | 0.20 | 10 | 23 |
| 6.0% SOM | 0.44 | 23 | 50 |
| | | | |
| **Hexachloro-1,3-Butadiene** | | | |
| 1.0% SOM | 0.21 | 0.25 | 32 |
| 2.5% SOM | 0.51 | 0.61 | 69 |
| 6.0% SOM | 1.2 | 1.4 | 120 |
| | | | |

**Cont'd Overleaf**

| CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | | |
|---|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Residential without plant uptake (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| | | | | |
| **1,1,2 Trichloroethane** | | | | |
| 1.0% SOM | 0.6 | 0.88 | 0.28 | 94 |
| 2.5% SOM | 1.2 | 1.8 | 0.61 | 190 |
| 6.0% SOM | 2.7 | 3.9 | 1.4 | 400 |
| | | | | |
| **1,1-Dichloroethane** | | | | |
| 1.0% SOM | 2.4 | 2.5 | 9.2 | 280 |
| 2.5% SOM | 3.9 | 4.1 | 17 | 450 |
| 6.0% SOM | 7.4 | 7.7 | 35 | 850 |
| | | | | |
| **1,1-Dichloroethene** | | | | |
| 1.0% SOM | 0.23 | 0.23 | 2.8 | 26 |
| 2.5% SOM | 0.40 | 0.41 | 5.6 | 46 |
| 6.0% SOM | 0.82 | 0.82 | 12 | 92 |
| | | | | |
| **1,2,4-Trimethylbenzene** | | | | |
| 1.0% SOM | 0.35 | 0.41 | 0.38 | 42 |
| 2.5% SOM | 0.85 | 0.99 | 0.93 | 99 |
| 6.0% SOM | 2.0 | 2.3 | 2.2 | 220 |
| | | | | |
| **1,2-Dichloropropane** | | | | |
| 1.0% SOM | 0.024 | 0.024 | 0.62 | 3.3 |
| 2.5% SOM | 0.042 | 0.042 | 1.2 | 5.9 |
| 6.0% SOM | 0.084 | 0.085 | 2.6 | 12 |
| | | | | |
| **2,4-Dimethylphenol** | | | | |
| 1.0% SOM | 19 | 210 | 3.1 | 16000* |
| 2.5% SOM | 43 | 410 | 7.2 | 24000* |
| 6.0% SOM | 97 | 730 | 17 | 30000* |
| | | | | |
| **2,4-Dinitrotoluene** | | | | |
| 1.0% SOM | 1.5 | 170* | 0.22 | 3700* |
| 2.5% SOM | 3.2 | 170 | 0.49 | 3700* |
| 6.0% SOM | 7.2 | 170 | 1.1 | 3800* |
| | | | | |
| **2,6-Dinitrotoluene** | | | | |
| 1.0% SOM | 0.78 | 78 | 0.12 | 1900* |
| 2.5% SOM | 1.7 | 84 | 0.27 | 1900* |
| 6.0% SOM | 3.9 | 87 | 0.61 | 1900* |
| | | | | |
| **2-Chloronapthalene** | | | | |
| 1.0% SOM | 3.7 | 3.8 | 40 | 390* |
| 2.5% SOM | 9.2 | 9.3 | 98 | 960* |
| 6.0% SOM | 22 | 22 | 230 | 2200* |

**Cont'd Overleaf**

| CL:AIRE General Assessment Criteria:<br>Volatile and Semi-Volatile Organic Compounds | | | | |
|---|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Residential without plant uptake (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| | | | | |
| **Biphenyl** | | | | |
| 1.0% SOM | 66* | 220* | 14 | 18000* |
| 2.5% SOM | 160 | 500* | 35 | 33000* |
| 6.0% SOM | 360 | 980* | 83 | 48000* |
| | | | | |
| **Bis (2-ethylhexyl) phthalate** | | | | |
| 1.0% SOM | 280* | 2700* | 47* | 85000* |
| 2.5% SOM | 610* | 2800* | 120* | 86000* |
| 6.0% SOM | 1100* | 2800* | 280* | 86000* |
| | | | | |
| **Bromobenzene** | | | | |
| 1.0% SOM | 0.87 | 0.91 | 3.2 | 97 |
| 2.5% SOM | 2.0 | 2.1 | 7.6 | 220 |
| 6.0% SOM | 4.7 | 4.9 | 18 | 520 |
| | | | | |
| **Bromodichloromethane** | | | | |
| 1.0% SOM | 0.016 | 0.019 | 0.016 | 2.1 |
| 2.5% SOM | 0.030 | 0.034 | 0.032 | 3.7 |
| 6.0% SOM | 0.061 | 0.070 | 0.068 | 7.6 |
| | | | | |
| **Bromoform** | | | | |
| 1.0% SOM | 2.8 | 5.2 | 0.95 | 760 |
| 2.5% SOM | 5.9 | 11 | 2.1 | 1500 |
| 6.0% SOM | 13 | 23 | 4.6 | 3100 |
| | | | | |
| **Butyl benzyl phthalate** | | | | |
| 1.0% SOM | 1400* | 42000* | 220* | 940000* |
| 2.5% SOM | 3300* | 44000* | 550* | 940000* |
| 6.0% SOM | 7200* | 44000* | 1300* | 950000* |
| | | | | |
| **Chloroethane** | | | | |
| 1.0% SOM | 8.3 | 8.4 | 110 | 960 |
| 2.5% SOM | 11 | 11 | 200 | 1300 |
| 6.0% SOM | 18 | 18 | 380 | 2100 |
| | | | | |
| **Chloromethane** | | | | |
| 1.0% SOM | 0.0083 | 0.0085 | 0.066 | 1.0 |
| 2.5% SOM | 0.0098 | 0.0099 | 0.13 | 1.2 |
| 6.0% SOM | 0.013 | 0.013 | 0.23 | 1.6 |
| | | | | |
| ***Cis* 1,2 Dichloroethene** | | | | |
| 1.0% SOM | 0.11 | 0.12 | 0.26 | 14 |
| 2.5% SOM | 0.19 | 0.20 | 0.50 | 24 |
| 6.0% SOM | 0.37 | 0.39 | 1.0 | 47 |

**Cont'd Overleaf**

| CL:AIRE General Assessment Criteria:<br>Volatile and Semi-Volatile Organic Compounds | | | | |
|---|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Residential without plant uptake (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| | | | | |
| **Dichloromethane** | | | | |
| 1.0% SOM | 0.58 | 2.1 | 0.10 | 270 |
| 2.5% SOM | 0.98 | 2.8 | 0.19 | 360 |
| 6.0% SOM | 1.7 | 4.5 | 0.34 | 560 |
| | | | | |
| **Diethyl Phthalate** | | | | |
| 1.0% SOM | 120* | 1800* | 19* | 150000* |
| 2.5% SOM | 260* | 3500* | 41* | 220000* |
| 6.0% SOM | 570* | 6300* | 94* | 290000* |
| | | | | |
| **Di-*n*-butyl phthalate** | | | | |
| 1.0% SOM | 13* | 450* | 2.0 | 15000* |
| 2.5% SOM | 31* | 450* | 5.0 | 15000* |
| 6.0% SOM | 67* | 450* | 12 | 15000* |
| | | | | |
| **Di-*n*-octyl phthalate** | | | | |
| 1.0% SOM | 2300* | 3400* | 940* | 89000* |
| 2.5% SOM | 2800* | 3400* | 2100* | 89000* |
| 6.0% SOM | 3100* | 3400* | 3900* | 89000* |
| | | | | |
| **Hexachloroethane** | | | | |
| 1.0% SOM | 0.20 | 0.22 | 0.27 | 22* |
| 2.5% SOM | 0.48 | 0.54 | 0.67 | 53* |
| 6.0% SOM | 1.1 | 1.3 | 1.6 | 120* |
| | | | | |
| **Isopropylbenzene** | | | | |
| 1.0% SOM | 11 | 12 | 32 | 1400* |
| 2.5% SOM | 27 | 28 | 79 | 3300* |
| 6.0% SOM | 64 | 67 | 190 | 7700* |
| | | | | |
| **Methyl *tert*-butyl ether** | | | | |
| 1.0% SOM | 49 | 73 | 23 | 7900 |
| 2.5% SOM | 84 | 120 | 44 | 13000 |
| 6.0% SOM | 160 | 220 | 90 | 24000 |
| | | | | |
| **Propylbenzene** | | | | |
| 1.0% SOM | 34 | 40 | 34 | 4100* |
| 2.5% SOM | 82 | 97 | 83 | 9700* |
| 6.0% SOM | 190 | 230 | 200 | 21000* |
| | | | | |
| **Styrene** | | | | |
| 1.0% SOM | 8.1 | 35 | 1.6 | 3300* |
| 2.5% SOM | 19 | 78 | 3.7 | 6500* |
| 6.0% SOM | 43 | 170 | 8.7 | 11000* |

**Cont'd Overleaf**

| CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds | | | | |
|---|---|---|---|---|
| **Contaminant** | **Residential (mg/kg)** | **Residential without plant uptake (mg/kg)** | **Allotment (mg/kg)** | **Commercial (mg/kg)** |
| | | | | |
| **Total Cresols (2-, 3-, and 4-methylphenol)** | | | | |
| 1.0% SOM | 80 | 3700 | 12 | 160000 |
| 2.5% SOM | 180 | 5400 | 27 | 180000* |
| 6.0% SOM | 400 | 6900 | 63 | 180000* |
| | | | | |
| ***Trans* 1,2 Dichloroethene** | | | | |
| 1.0% SOM | 0.19 | 0.19 | 0.93 | 22 |
| 2.5% SOM | 0.34 | 0.35 | 1.9 | 40 |
| 6.0% SOM | 0.70 | 0.71 | 0.24 | 81 |
| | | | | |
| **Tributyl tin oxide** | | | | |
| 1.0% SOM | 0.25 | 1.4 | 0.042 | 130* |
| 2.5% SOM | 0.59 | 3.1 | 0.1 | 180* |
| 6.0% SOM | 1.3 | 5.7 | 0.24 | 200* |
| | | | | |

Notes: *Soil concentration above soil saturation limit

## APPENDIX F
## BRE Cover Systems Spreadsheet

| Calculations based on mixed zone (M) | 600 | mm |
|---|---|---|

| Contaminant | Site Data | | | | Expressed as a Factor of Target Guideline Value | | | | Cover Thickness Required for Compliance to Specified Target Guideline Value | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Contamination of Ground (Cg) | Contamination of Cover (Cc) | Target Guideline Value 1 | Target Guideline Value 2 | Soil / Target Guideline Value 1 | Cover / Target Guideline Value 1 | Soil / Target Guideline Value 2 | Cover / Target Guideline Value 2 | Target Guideline Value 1 | Target Guideline Value 2 |
| | Units | | Units | | Fraction | | | | (mm) | |
| Arsenic | | | 20 | 20 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Cadmium (Soil pH8) | | | 2 | 2 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Chromium | | | 130 | 130 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Chromium (VI) | | | | | | | | | | |
| Mercury | | | 8 | 8 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Selenium | | | 35 | 35 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Copper | | | 250 | 250 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Nickel | | | 50 | 50 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Zinc | | | 1000 | 1000 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Lead | 1930 | 100 | 450 | 450 | 4.3 | 0.2 | 4.3 | 0.2 | 485 | 485 |
| Boron (Water sol) | | | 3 | 3 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| Sulphate (total) | | | | | | | | | | |
| Phenols | | | | | | | | | | |
| Sulphide | | | | | | | | | | |
| Cyanide | | | | | | | | | | |
| Solvent Extractable Matter | | | | | | | | | | |
| Benzo(a)pyrene | 3.23 | 0.4 | 0.94 | 0.94 | 3.4 | 0.4 | 3.4 | 0.4 | 486 | 486 |
| Benzo(a)pyrene | | | 0.83 | 0.83 | No Cg | No Cc | No Cg | No Cc | No Cg | No Cg |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| Summary | | |
|---|---|---|
| | Target Guideline Value 1 | Target Guideline Value 2 |
| Number of contaminants | 18 | 18 |
| Number of contaminants **with no** thickness calculation | 16 | 16 |
| Breakdown - Number for which no TV specfied | 6 | 6 |
| Breakdown - Number for which no soil specified | 16 | 16 |
| Breakdown - Number for which no cover specified | 16 | 16 |
| Breakdown - Number for which cover > TV | 0 | 0 |
| | | |
| Number of contaminants **with** thickness calculation | 2 | 2 |
| Breakdown - Number for which no cover required | 0 | 0 |
| Breakdown - Number for which cover required | 2 | 2 |

| **Overall thickness of cover required** | **486** | **486** |
|---|---|---|

**APPENDIX G**
**Waste Hazard Assessment**

## Job name

GWPR824 73 Constantine Road, Hampstead, London NW3 2LP

## Waste stream

Ground and Water Standard v3

## Comments

## Report

Created by: Foord, Roger
Created date: 26/02/2014 16:06

## Job summary

| # | Sample name | Depth | Classification result | Hazardous properties |
|---|---|---|---|---|
| 1 | GWPR824 WS1@0.30m | | Non Hazardous | |
| 2 | GWPR824 WS2@0.25m | | Non Hazardous | |

## Classification

**Non Hazardous Waste**
Classified as **17 05 04**
in the European Waste Catalogue 2002

## Classified by

Name:
**Foord, Roger**
Date:
**26/02/2014 16:05**
Telephone:
**07979 754715**

Company:
**Ground and Water**
**15 Bow Street**
**Alton**
**GU34 1NY**

## Sample details

Sample Name:
**GWPR824 WS1@0.30m**
Site:

Project:

Sample Depth:
**0 m**
Dry Weight Moisture Content:
**0%**
Comments:

EWC 2002 code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

## Hazard properties

None identified

**Additional: Additional Risk Phrases** "This is an additional risk phrase and such a risk phrases alone will not cause a waste to be hazardous."

Risk phrases hit:

**R14** "Reacts violently with water"

Because of determinand:

Boron tribromide/trichloride/trifluoride (combined risk phrases): (compound conc.:0.00228%)

**R33** "Danger of cumulative effects"

Because of determinand:

Lead compounds (with the exception of those listed separately in this Annex): (compound conc.:0.291%)

## Determinands (Dry Weight Moisture Content: 0%)

pH: (Whole concentration entered as: 7.9 pH or 7.9 pH)
Cyanides (with the exception of complex cyanides): (Whole concentration entered as: <2 mg/kg or <0.0002%)
IGNORED Because: "<LOD"
Arsenic trioxide: (Cation conc. entered: 13 mg/kg, converted to compound conc.:17.164 mg/kg or 0.00172%)
Boron tribromide/trichloride/trifluoride (combined risk phrases): (Cation conc. entered: 1.7 mg/kg, converted to compound conc.:22.831 mg/kg or 0.00228%)
Cadmium sulphide: (Cation conc. entered: 0.6 mg/kg, converted to compound conc.:0.771 mg/kg or 0.0000771%, "Note 1" conc.: 0.00006%)

Chromium(III) oxide: (Cation conc. entered: 29 mg/kg, converted to compound conc.:42.385 mg/kg or 0.00424%)
Copper (I) oxide: (Cation conc. entered: 55 mg/kg, converted to compound conc.:61.924 mg/kg or 0.00619%)
Lead compounds (with the exception of those listed separately in this Annex): (Cation conc. entered: 1930 mg/kg, converted to compound conc.:2914.3 mg/kg or 0.291%, "Note 1" conc.: 0.193%)
Mercury dichloride: (Cation conc. entered: <1 mg/kg, converted to compound conc.:<1.353 mg/kg or <0.000135%) IGNORED Because: "<LOD"
Nickel dihydroxide: (Cation conc. entered: 19 mg/kg, converted to compound conc.:30.01 mg/kg or 0.003%)
Selenium compounds (with the exception of cadmium sulphoselenide and sodium selenite): (Cation conc. entered: <3 mg/kg, converted to compound conc.:<4.5 mg/kg or <0.00045%) IGNORED Because: "<LOD"
Zinc oxide: (Cation conc. entered: 363 mg/kg, converted to compound conc.:451.831 mg/kg or 0.0452%)
Phenol: (Whole concentration entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
Naphthalene: (Whole concentration entered as: 0.47 mg/kg or 0.000047%)
Acenaphthylene: (Whole concentration entered as: <1 mg/kg or <0.0001%) IGNORED Because: "<LOD"
Acenaphthene: (Whole concentration entered as: 2.28 mg/kg or 0.000228%)
Fluorene: (Whole concentration entered as: 2.1 mg/kg or 0.00021%)
Phenanthrene: (Whole concentration entered as: 18.2 mg/kg or 0.00182%)
Anthracene: (Whole concentration entered as: 4.41 mg/kg or 0.000441%)
Fluoranthene: (Whole concentration entered as: 15.3 mg/kg or 0.00153%)
Pyrene: (Whole concentration entered as: 11 mg/kg or 0.0011%)
Benzo[a]anthracene: (Whole concentration entered as: 6.26 mg/kg or 0.000626%)
Chrysene: (Whole concentration entered as: 4.57 mg/kg or 0.000457%)
Benzo[b]fluoranthene: (Whole concentration entered as: 4.32 mg/kg or 0.000432%)
Benzo[k]fluoranthene: (Whole concentration entered as: 1.59 mg/kg or 0.000159%)
Benzo[a]pyrene; benzo[def]chrysene: (Whole concentration entered as: 3.23 mg/kg or 0.000323%)
Indeno[123-cd]pyrene: (Whole concentration entered as: 1.48 mg/kg or 0.000148%)
Dibenz[a,h]anthracene: (Whole concentration entered as: 0.23 mg/kg or 0.000023%)
Benzo[ghi]perylene: (Whole concentration entered as: 1.15 mg/kg or 0.000115%)

## User Defined and non CLP Substances

### pH

Comments: Appendix C, C4.5
Data source: WM2 - Interpretation of the definition and classification of hazardous waste (Second Edition, version2.2), Environment Agency
Data source date: 30/05/2008
Classification: pH; pH

### Boron tribromide/trichloride/trifluoride (combined risk phrases)

Comments: Combines the risk phrases and the average of the conversion factors for Boron tribromide, Boron trichloride and Boron trifluoride
Data source: N/A
Data source date: 10/01/2011
Classification: R14, T+; R26/28, C; R34, C; R35

### Chromium(III) oxide (CAS Number: 1308-38-9)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=33806&HarmOnly=no?fc=true&lang=en
Data source date: 26/11/2012
Classification: R20, R22, R36, R37, R38, R42, R43, R50/53, R60, R61

### Acenaphthylene (CAS Number: 208-96-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=59285&HarmOnly=no
Data source date: 16/07/2012
Classification: R22, R26, R27, R36, R37, R38

**Acenaphthene** (CAS Number: 83-32-9)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=133563&HarmOnly=no
Data source date: 16/07/2012
Classification: R36, R37, R38, N; R50/53, N; R51/53

**Fluorene** (CAS Number: 86-73-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=81845&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R53

**Phenanthrene** (CAS Number: 85-01-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=109754&HarmOnly=no
Data source date: 16/07/2012
Classification: R22, R36, R37, R38, R40, R43, N; R50/53

**Anthracene** (CAS Number: 120-12-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=101102&HarmOnly=no
Data source date: 08/03/2013
Classification: R36, R37, R38, R43, N; R50/53

**Fluoranthene** (CAS Number: 206-44-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=56375&HarmOnly=no
Data source date: 16/07/2012
Classification: R20, R22, R36, N; R50/53

**Pyrene** (CAS Number: 129-00-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=87484&HarmOnly=no
Data source date: 16/07/2012
Classification: R23, N; R50/53

**Indeno[123-cd]pyrene** (CAS Number: 193-39-5)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=128806&HarmOnly=no
Data source date: 08/03/2013
Classification: R40

**Benzo[ghi]perylene** (CAS Number: 191-24-2)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=15793&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53

## Notes utilised in assessment

**Additional Risk Phrase Comments**
from section: Table 2.2 in the document: "WM2 - Hazardous Waste Technical Guidance"

"This is an additional risk phrase and such a risk phrase alone will not cause a waste to be hazardous."

Note used on:

Test: "Additional on R14" for determinand: "Boron tribromide/trichloride/trifluoride (combined risk phrases)"
Test: "Additional on R33" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

**C14.3: Step 4**
from section: C14.3 in the document: "WM2 - Hazardous Waste Technical Guidance"
"identify whether any individual ecotoxic substance is present below a cut-off value shown in Table C14.1"

Note used on:

Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Nickel dihydroxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Zinc oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Naphthalene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Anthracene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Phenanthrene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Acenaphthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Pyrene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[a]anthracene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Chrysene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[b]fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[k]fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Dibenz[a,h]anthracene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Chromium(III) oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[ghi]perylene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[a]pyrene; benzo[def]chrysene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Arsenic trioxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Copper (I) oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Fluorene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Cadmium sulphide"

**Note 1**
from section: 1.1.3.2, Annex VI in the document: "CLP Regulations"
"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Note used on:

Test: "H5 on R20, R21, R22, R65" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H6 on R23, R24, R25" for determinand: "Cadmium sulphide"
Test: "H7 on R45" for determinand: "Cadmium sulphide"
Test: "H10 on R60, R61" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H10 on R62, R63" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H11 on R68" for determinand: "Cadmium sulphide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

## Substance notes

**Note 1**
from section: 1.1.3.2, Annex VI in the document: "CLP Regulations"
"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Note used on:

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
determinand: "Cadmium sulphide"

**Note A**
from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"
"Without prejudice to Article 17(2), the name of the substance must appear on the label in the form of one of the designations given in Part 3. In Part 3, use is sometimes made of a general description such as '... compounds' or '... salts'. In this case, the supplier is required to state on the label the correct name, due account being taken of section 1.1.1.4."

Note used on:

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

**Note E (Table 3.2)**
from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"
"Substances with specific effects on human health (see Chapter 4 of Annex VI to Directive 67/548/EEC) that are classified as carcinogenic, mutagenic and/or toxic for reproduction in categories 1 or 2 are ascribed Note E if they are also classified as very toxic (T+), toxic (T) or harmful (Xn). For these substances, the risk phrases R20, R21, R22, R23, R24, R25, R26, R27, R28, R39, R68 (harmful), R48 and R65 and all combinations of these risk phrases shall be preceded by the word 'Also'."

Note used on:

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
determinand: "Nickel dihydroxide"
determinand: "Cadmium sulphide"
determinand: "Arsenic trioxide"

## Version

Classification utilises the following:
WM2 - Hazardous Waste Technical Guidance, 3rd Edition, August 2013
CLP Regulations - Regulation (EC) No 1272/2008 of the European Parliament and of the Council: 16 December 2008
1st ATP - 1st Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 26 September 2009; binding date 1 Dec 2010
2nd ATP - 2nd Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 30 March 2011; binding date 1 Dec 2012 in respect of substances and 1 June 2015 in respect of mixtures
3rd ATP - 3rd Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 31 July 2012; binding date 1 Dec 2013
4th ATP - 4th Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 20 June 2013; binding date 1 Jun 2015
5th ATP - 5th Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 13 August 2013; binding date 13 Aug 2013

HazWasteOnline Engine: WM2 version 3 (Aug 2013)
HazWasteOnline Engine Version: 1.0.2399.5226 (19 Feb 2014)
HazWasteOnline Database: 1.0.2399.5226 (19 Feb 2014)

## Classification

**Non Hazardous Waste**
Classified as **17 05 04**
in the European Waste Catalogue 2002

## Classified by

Name:
**Foord, Roger**
Date:
**26/02/2014 16:05**
Telephone:
**07979 754715**

Company:
**Ground and Water**
**15 Bow Street**
**Alton**
**GU34 1NY**

## Sample details

Sample Name:
**GWPR824 WS2@0.25m**
Site:

Project:

Sample Depth:
**0 m**
Dry Weight Moisture Content:
**17.9%**
Comments:

EWC 2002 code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

## Hazard properties

None identified

**Additional: Additional Risk Phrases** "This is an additional risk phrase and such a risk phrases alone will not cause a waste to be hazardous."

Risk phrases hit:

**R33** "Danger of cumulative effects"

Because of determinand:

Lead compounds (with the exception of those listed separately in this Annex): (compound conc.:0.0265%)

## Determinands (Dry Weight Moisture Content: 17.9%)

pH: (Whole concentration entered as: 8.5 pH or 8.5 pH)
Cyanides (with the exception of complex cyanides): (Whole concentration entered as: <2 mg/kg or <0.00017%) IGNORED Because: "<LOD"
Arsenic trioxide: (Cation conc. entered: 6 mg/kg, converted to compound conc.:6.719 mg/kg or 0.000672%)
Boron tribromide/trichloride/trifluoride (combined risk phrases): (Cation conc. entered: <1 mg/kg, converted to compound conc.:<11.391 mg/kg or <0.00114%) IGNORED Because: "<LOD"
Cadmium sulphide: (Cation conc. entered: <0.5 mg/kg, converted to compound conc.:<0.545 mg/kg or <0.0000545%, "Note 1" conc.: <0.0000424%) IGNORED Because: "<LOD"
Chromium(III) oxide: (Cation conc. entered: 27 mg/kg, converted to compound conc.:33.471 mg/kg or 0.00335%)
Copper (I) oxide: (Cation conc. entered: 28 mg/kg, converted to compound conc.:26.739 mg/kg or 0.00267%)
Lead compounds (with the exception of those listed separately in this Annex): (Cation conc. entered: 207 mg/kg, converted to compound conc.:265.115 mg/kg or 0.0265%, "Note 1" conc.: 0.0176%)

Mercury dichloride: (Cation conc. entered: <1 mg/kg, converted to compound conc.:<1.148 mg/kg or <0.000115%) IGNORED Because: "<LOD"
Nickel dihydroxide: (Cation conc. entered: 16 mg/kg, converted to compound conc.:21.435 mg/kg or 0.00214%)
Selenium compounds (with the exception of cadmium sulphoselenide and sodium selenite): (Cation conc. entered: <3 mg/kg, converted to compound conc.:<3.817 mg/kg or <0.000382%) IGNORED Because: "<LOD"
Zinc oxide: (Cation conc. entered: 75 mg/kg, converted to compound conc.:79.18 mg/kg or 0.00792%)
Phenol: (Whole concentration entered as: <2 mg/kg or <0.00017%) IGNORED Because: "<LOD"
Naphthalene: (Whole concentration entered as: <0.1 mg/kg or <0.00000848%) IGNORED Because: "<LOD"
Acenaphthylene: (Whole concentration entered as: <0.1 mg/kg or <0.00000848%) IGNORED Because: "<LOD"
Acenaphthene: (Whole concentration entered as: <0.1 mg/kg or <0.00000848%) IGNORED Because: "<LOD"
Fluorene: (Whole concentration entered as: <0.1 mg/kg or <0.00000848%) IGNORED Because: "<LOD"
Phenanthrene: (Whole concentration entered as: 0.34 mg/kg or 0.0000288%)
Anthracene: (Whole concentration entered as: <0.1 mg/kg or <0.00000848%) IGNORED Because: "<LOD"
Fluoranthene: (Whole concentration entered as: 0.91 mg/kg or 0.0000772%)
Pyrene: (Whole concentration entered as: 0.7 mg/kg or 0.0000594%)
Benzo[a]anthracene: (Whole concentration entered as: 0.39 mg/kg or 0.0000331%)
Chrysene: (Whole concentration entered as: 0.41 mg/kg or 0.0000348%)
Benzo[b]fluoranthene: (Whole concentration entered as: 0.47 mg/kg or 0.0000399%)
Benzo[k]fluoranthene: (Whole concentration entered as: 0.18 mg/kg or 0.0000153%)
Benzo[a]pyrene; benzo[def]chrysene: (Whole concentration entered as: 0.31 mg/kg or 0.0000263%)
Indeno[123-cd]pyrene: (Whole concentration entered as: 0.17 mg/kg or 0.0000144%)
Dibenz[a,h]anthracene: (Whole concentration entered as: <0.1 mg/kg or <0.00000848%) IGNORED Because: "<LOD"
Benzo[ghi]perylene: (Whole concentration entered as: 0.13 mg/kg or 0.000011%)
Benzene: (Whole concentration entered as: <0.002 mg/kg or <0.00000017%) IGNORED Because: "<LOD"
Toluene: (Whole concentration entered as: <0.005 mg/kg or <0.000000424%) IGNORED Because: "<LOD"
Ethylbenzene: (Whole concentration entered as: <0.01 mg/kg or <0.000000848%) IGNORED Because: "<LOD"
Xylene: (Whole concentration entered as: <0.01 mg/kg or <0.000000848%) IGNORED Because: "<LOD"
Diesel Petroleum Group: (Whole concentration entered as: <1 mg/kg or <0.0000848%) IGNORED Because: "<LOD"
TPH (C6 to C40) Petroleum Group: (Whole concentration entered as: <24 mg/kg or <0.00204%) IGNORED Because: "<LOD"

## User Defined and non CLP Substances

### pH

Comments: Appendix C, C4.5
Data source: WM2 - Interpretation of the definition and classification of hazardous waste (Second Edition, version2.2), Environment Agency
Data source date: 30/05/2008
Classification: pH; pH

### Boron tribromide/trichloride/trifluoride (combined risk phrases)

Comments: Combines the risk phrases and the average of the conversion factors for Boron tribromide, Boron trichloride and Boron trifluoride
Data source: N/A
Data source date: 10/01/2011
Classification: R14, T+; R26/28, C; R34, C; R35

### **Chromium(III) oxide** (CAS Number: 1308-38-9)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=33806&HarmOnly=no?fc=true&lang=en
Data source date: 26/11/2012
Classification: R20, R22, R36, R37, R38, R42, R43, R50/53, R60, R61

**Acenaphthylene** (CAS Number: 208-96-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=59285&HarmOnly=no
Data source date: 16/07/2012
Classification: R22, R26, R27, R36, R37, R38

**Acenaphthene** (CAS Number: 83-32-9)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=133563&HarmOnly=no
Data source date: 16/07/2012
Classification: R36, R37, R38, N; R50/53, N; R51/53

**Fluorene** (CAS Number: 86-73-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=81845&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R53

**Phenanthrene** (CAS Number: 85-01-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=109754&HarmOnly=no
Data source date: 16/07/2012
Classification: R22, R36, R37, R38, R40, R43, N; R50/53

**Anthracene** (CAS Number: 120-12-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=101102&HarmOnly=no
Data source date: 08/03/2013
Classification: R36, R37, R38, R43, N; R50/53

**Fluoranthene** (CAS Number: 206-44-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=56375&HarmOnly=no
Data source date: 16/07/2012
Classification: R20, R22, R36, N; R50/53

**Pyrene** (CAS Number: 129-00-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=87484&HarmOnly=no
Data source date: 16/07/2012
Classification: R23, N; R50/53

**Indeno[123-cd]pyrene** (CAS Number: 193-39-5)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=128806&HarmOnly=no
Data source date: 08/03/2013
Classification: R40

**Benzo[ghi]perylene** (CAS Number: 191-24-2)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=15793&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53

**Diesel Petroleum Group**

Comments: Risk phrase data given in table A3, page A41
Data source: WM2 3rd edition, 2013
Data source date: 01/08/2013
Classification: R40, R51/53, R65, R66

**TPH (C6 to C40) Petroleum Group**

Comments: Risk phrase data given on page A41
Data source: WM2 3rd edition, 2013
Data source date: 01/08/2013
Classification: R10, R45, R46, R51/53, R63, R65

## Notes utilised in assessment

**Additional Risk Phrase Comments**
from section: Table 2.2 in the document: "WM2 - Hazardous Waste Technical Guidance"
"This is an additional risk phrase and such a risk phrase alone will not cause a waste to be hazardous."

Note used on:

Test: "Additional on R33" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

**C14.3: Step 4**
from section: C14.3 in the document: "WM2 - Hazardous Waste Technical Guidance"
"identify whether any individual ecotoxic substance is present below a cut-off value shown in Table C14.1"

Note used on:

Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Nickel dihydroxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Zinc oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Pyrene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[a]anthracene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[b]fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Chrysene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Chromium(III) oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[a]pyrene; benzo[def]chrysene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Arsenic trioxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Copper (I) oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Phenanthrene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[ghi]perylene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[k]fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

**Note 1**
from section: 1.1.3.2, Annex VI in the document: "CLP Regulations"
"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Note used on:

Test: "H5 on R20, R21, R22, R65" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

Test: "H10 on R60, R61" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H10 on R62, R63" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

## Substance notes

**Note 1**
from section: 1.1.3.2, Annex VI in the document: "CLP Regulations"
"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Note used on:

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

**Note A**
from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"
"Without prejudice to Article 17(2), the name of the substance must appear on the label in the form of one of the designations given in Part 3. In Part 3, use is sometimes made of a general description such as '... compounds' or '... salts'. In this case, the supplier is required to state on the label the correct name, due account being taken of section 1.1.1.4."

Note used on:

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

**Note E (Table 3.2)**
from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"
"Substances with specific effects on human health (see Chapter 4 of Annex VI to Directive 67/548/EEC) that are classified as carcinogenic, mutagenic and/or toxic for reproduction in categories 1 or 2 are ascribed Note E if they are also classified as very toxic (T+), toxic (T) or harmful (Xn). For these substances, the risk phrases R20, R21, R22, R23, R24, R25, R26, R27, R28, R39, R68 (harmful), R48 and R65 and all combinations of these risk phrases shall be preceded by the word 'Also'."

Note used on:

determinand: "Nickel dihydroxide"
determinand: "Arsenic trioxide"
determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

## Version

Classification utilises the following:
WM2 - Hazardous Waste Technical Guidance, 3rd Edition, August 2013
CLP Regulations - Regulation (EC) No 1272/2008 of the European Parliament and of the Council: 16 December 2008
1st ATP - 1st Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 26 September 2009; binding date 1 Dec 2010
2nd ATP - 2nd Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 30 March 2011; binding date 1 Dec 2012 in respect of substances and 1 June 2015 in respect of mixtures
3rd ATP - 3rd Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 31 July 2012; binding date 1 Dec 2013
4th ATP - 4th Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 20 June 2013; binding date 1 Jun 2015
5th ATP - 5th Adaptation to Technical Progress for European Regulation 1272/2008: Date entered into force 13 August 2013; binding date 13 Aug 2013

HazWasteOnline Engine: WM2 version 3 (Aug 2013)
HazWasteOnline Engine Version: 1.0.2399.5226 (19 Feb 2014)
HazWasteOnline Database: 1.0.2399.5226 (19 Feb 2014)

# APPENDIX D

*Loading Information*

3 Shetland Hous ,Pioneer way, Watford , WD18 6SF Tel: 01923 441727 Email: info@satinc.co.uk



**Job Ref: CG-13-01**

**PROPOSED BASEMENT CONSTRUCTION, EXTENSION AND INTERNAL ALTERATIONS**

**For**

**73 CONSTANTINE ROAD, HAMPSTEAD, LONDON, NW3 2NG**

## Contents

**Page**

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|---|---|---|---|---|---|
| Project: | PROPOSED BASEMENT CONSTRUCTION, EXTENSION A | Prepared | Date | Page No | Of |
| Location: | 73 CONSTANTINE ROAD, HAMPSTEAD, LONDON, NW3 1 | AT | 26-Oct-14 | 3.00 | 75.00 |
| Part | A: **Load Data** | Checked AT | Date 26-Oct-14 | Job Ref CG-13-01 | Rev. - |

| Memb Ref | Calculations | | | | | | | | | Output | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Characteristic Loads** | | | | | | | | | | |
| **Pitched** | **UDL:** | | | | | | $kg/m^2/mm$ | $kN/m^2/mm$ | $kN/m^2$ | Characteristic | |
| **Roof** | Dead Load : | DL | | | | | | | | Loads | |
| | Clay Tiles | | | | | | | | 0.64 | | |
| | Roofing felt | | | | | | 3.2 | | 0.03 | | |
| | Rafters | 50 | x | | 200 x | | 400 c/c | 7.0 | 0.18 | | |
| | Battens | 38 | x | | 38 x | | 100 c/c | 7.0 | 0.10 | | |
| | Plaster/ B ceiling | 9.5 | | | | | 0.87 | 0.009 | 0.08 | | |
| Between & | Celotex - Tuff-R GA3050Z | | | | | | 1.6 | | 0.02 | Roof pitch | |
| Under rafter | Celotex - Tuff-R GA3035Z | | | | | | 1.1 | | 0.01 | 42 | Degrees |
| | | | Imposed load | | Additional loads | | | Total DL | **1.06** | **1.42** | |
| | Live Load | LL | 0.75 | + | 0 | | | Total LL | | **0.75** | |
| | | | | | | | | Total DL + LL | | **2.17** | $kN/m^2$ |
| **Flat** | **UDL:** | | | | | | $kg/m^2/mm$ | $kN/m^2/mm$ | $kN/m^2$ | Characteristic | |
| **Roof** | Dead Load : | DL | | | | | | | | Loads | |
| | Celtex - Tuff-R deck TD3080Z | | | | | | 5.7 | | 0.06 | | |
| | Chipping | 75 | x | | | | 16 | | 1.20 | | |
| | Asphalt | 25 | x | | | | 21 | | 0.53 | | |
| | Rafters | 50 | x | 200 | x | 400 c/c | | 7.0 | 0.18 | | |
| | Noggins | 50 | x | 200 | x | 1000 c/c | | 7.0 | 0.07 | | |
| | Plaster/ B ceiling | 19 | | | | | 17 | | 0.32 | | |
| | | | | | | | | Total DL | **2.35** | **2.35** | |
| | Live Load | LL | | | | | | Total LL | | **0.75** | |
| | | | | | | | | Total DL + LL | | **3.10** | $kN/m^2$ |
| **Timber** | **UDL:** | Thick | Width | | | c/c | $kg/m^2/mm$ | $kN/m^2/mm$ | $kN/m^2$ | | |
| **Floor** | Dead Load : | DL | | | | | | | | | |
| | Laminate floor | 10 | | | | | | 0.007 | 0.07 | | |
| | T&G boarding | 22 | | | | | | 0.009 | 0.20 | | |
| | Resilient flooring | | | | | | | | 0.15 | | |
| | Gypsum board | | | | | | | | 0.14 | | |
| | Resilient layer /batterens | 50 | x | 50 | x | 400 c/c | | 7.0 | 0.04 | | |
| | OSB walker timber perforated | | | | | | | | 0.03 | | |
| | Mineral wool | 50 | x | | | | 0.02 | 0.0002 | 0.01 | | |
| | Floor Joist | 50 | x | 225 | x | 400 c/c | | 7.0 | 0.20 | | |
| | Noggins | 50 | x | 225 | x | 1000 c/c | | 7.0 | 0.08 | | |
| | P/Board resilient ceiling | 15 | | | | | 0.87 | 0.009 | 0.13 | | |
| | Isowool Insulation | 50 | x | | | | 0.02 | 0.0002 | 0.01 | | |
| | Movable partitions | | | | | | | | 0.50 | | |
| | | | | | | | | Total DL | **1.56** | **1.56** | |
| | Live Load | LL | | | | | | Total LL | | **1.50** | |
| | | | | | | | | Total DL + LL | | **3.06** | $kN/m^2$ |

| Project: | PROPOSED BASEMENT CONSTRUCTION, EXTENSION A | Prepared | Date | Page No | Of |
|---|---|---|---|---|---|
| Location: | 73 CONSTANTINE ROAD, HAMPSTEAD, LONDON, NW3 | AT | 26-Oct-14 | 4.00 | 75.00 |
| Part | **A:** **Load Data** | Checked AT | Date 26-Oct-14 | Job Ref CG-13-01 | Rev. - |

| Memb Ref | Calculations | | | | | | | | | Output | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *External cavity wall - Block/ Block* | | | | | | | *kg/m² /mm* | *kN/m² /mm* | | | |
| **Cavity** | Blockwork | | | 140 | | x | 19 | | 2.66 | | |
| **Wall** | Brickwork(Stock) | | | 103 | | x | 20 | | 2.06 | | |
| Load bearing | Plaster | | | | | | *kg/m² /mm* | *kN/m² /mm* | | | |
| | Insulation | | | 80 | | | 0.27 | 0.003 | 0.21 | | |
| | Multi finish plaster | | | 30 | | x | 16 | | 0.48 | | |
| | | | | | | | | Total DL | **5.41** | **5.41** | *kN/m²* |
| *Internal Wall* | | | | | | | | | | | |
| **Internal** | Turbo Blockwork/ brickwork | | | 150 | | x | 20 | | 3.00 | | |
| **Wall** | Plaster | | | 30 | | x | 16 | | 0.48 | | |
| | | | | | | | | Total DL | 3.48 | **3.48** | *kN/m²* |
| *Timber Stud Wall - 1 Hr Fire resistant* | | | | | | | *kg/m² /mm* | *kN/m² /mm* | | | |
| **Internal** | Plaster board | | 2 | 15 | | x | 0.88 | 0.009 | 0.26 | | |
| **Stud** | Timber studs | 100 | 50 | 400 | | | | 0.007 | 0.09 | | |
| **Partitions** | Timber transoms | 100 | 50 | 600 | | | | 0.007 | 0.06 | | |
| Non-Load beari | Insulation | | | 50 | | | 0.27 | 0.003 | 0.13 | | |
| | Multi finish plaster | | | 10 | | x | 16 | | 0.16 | | |
| | | | | | | | | Total DL | 0.70 | **0.70** | *kN/m²* |
| **In-situ** | **UDL:** | *Thick* | *Width* | | *c/c* | | *kg/m² /mm* | *kN/m² /mm* | *kN/m²* | Loads | |
| **Concrete** | Dead Load : | DL | | | | | | | | | |
| **Floor** | Laminate floor | 10 | | | | | | 0.007 | 0.07 | | |
| (Grd Flr) | Plaster/ B ceiling | 15 | | | | | 0.87 | 0.009 | 0.13 | | |
| | In-situ Concrete | 250 | | 24 *kN/m³* | | | | | 6.00 | | |
| | screed | 40 | | 24 *kN/m³* | | | | | 0.96 | | |
| | Ceiling Joist | 50 | x | 100 | x | 400 c/c | | 7.0 | 0.09 | | |
| | Isowool Insulation | 50 | x | | | | 0.02 | 0.0002 | 0.01 | | |
| | | | | | | | | Total DL | **7.26** | **7.26** | |
| | Live Load | LL | | | | | | Total LL | | **1.50** | |
| | | | | | | | | Total DL + LL | | **8.76** | *kN/m²* |
| *External Wall* | | | | | | | | | | | |
| **Solid** | Turbo Blockwork/ brickwork | | | 215 | | x | 20 | | 4.30 | | |
| **Wall** | Plaster | | | 65 | | x | 16 | | 1.04 | | |
| | | | | | | | | Total DL | 5.34 | **5.34** | *kN/m²* |
| **In-situ** | **UDL:** | *Thick* | *Width* | | *c/c* | | *kg/m² /mm* | *kN/m² /mm* | *kN/m²* | Loads | |
| **Concrete** | Dead Load : | DL | | | | | | | | | |
| **Floor** | Laminate floor | 10 | | | | | | 0.007 | 0.07 | | |
| (Basment F | Plaster/ B ceiling | 15 | | | | | 0.87 | 0.009 | 0.13 | | |
| | In-situ Concrete | 150 | | 24 *kN/m³* | | | | | 3.60 | | |
| | screed | 40 | | 24 *kN/m³* | | | | | 0.96 | | |
| | Insulation | 50 | x | | | | 0.02 | 0.0002 | 0.01 | | |
| | | | | | | | | Total DL | **4.77** | **4.77** | |
| | Live Load | LL | | | | | | Total LL | | **1.50** | |
| | | | | | | | | Total DL + LL | | **6.27** | *kN/m²* |

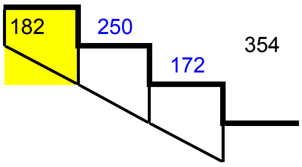
| Project: | PROPOSED BASEMENT CONSTRUCTION, EXTENSION A | Prepared | Date | Page No | Of |
|---|---|---|---|---|---|
| Location: | 73 CONSTANTINE ROAD, HAMPSTEAD, LONDON, NW3 2 | AT | 26-Oct-14 | 5.00 | 75.00 |
| Part | **A:** | Checked | Date | Job Ref | Rev. |
| | **Load Data** | AT | 26-Oct-14 | CG-13-01 | - |

| Memb Ref | Calculations | | | | | | Output | |
|---|---|---|---|---|---|---|---|---|
| | **Characteristic Loads Continued ...** | | | | | | | |
| **Retaining** | Concrete Wall | 350 | x | 24 | | 8.40 | | |
| **Wall** | Plaster | 30 | x | 16 | | 0.48 | | |
| | | | | | Total DL | 8.88 | **8.88** | *kN/m²* |
| *Glass Wall* | | | | | | | | |
| | Glass | 80 | x | 16 | | 1.28 | | |
| | | | | | Total DL | 1.28 | **1.28** | *kN/m²* |
| Boundry wall | | | | | | | | |
| | Brickwork | 100 | x | 19 | | 1.90 | | |
| | | | | | Total DL | 1.90 | **1.90** | *kN/m²* |

Concrete Stair

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stair** | **UDL:** | *Module* 250 mm | | *kN/m²/mm* | | | | *kN/m²* | Characteristic |
| **Flight** | Dead Load : | DL | | | | kN/module | | | Loads |
| | Finishing | Step | 15 x | 250 | 0.01 | 0.03 | | | |
| | | Riser | 15 x | 172 | 0.01 | 0.02 | | | |
| | | Soffit | 15 x | 172 | 0.01 | 0.02 | | | |
| | Levelling screed | | 10 x | 0.42 | 24 | 0.10 | | | |
| | Concrete | | | 0.07 | 24 | 1.61 | | | |
| | | | | | | 1.77 | Total DL | 7.09 | Stairs pitch |
| | | | | | | | | | 34.5 Degrees |

Waist = 150




| | | | | |
|---|---|---|---|---|
| Live Load : | LL | Total LL | 3.00 | |
| | | Total DL + LL | **10.09** | |
| | | Total DL + LL | | **10.09** *kN/m²* |

| Memb Ref | Calculations | Output |
|---|---|---|

Module = 1000 mm

**Party Wall**

| | | | | | | | | | Total Characteristic Load (kN) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | DL | LL | DL + LL |
| ***Roof*** | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Roof Load | = | 1.4 | | 3000 | 3000 | = | 4.3 | | | | |
| | | Total DL | | | | | 4.3 | 4.3 | 4.3 | | |
| Live Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Roof Load | = | 0.8 | | 3000 | 3000 | = | 2.3 | | | | |
| | | Total DL | | | | | 2.3 | 2.3 | | 2.3 | |
| | | | | Total | DL+LL | U/S | Roof | | 4.3 | 2.3 | 6.5 |
| ***Loft Floor*** | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.6 | | 3500 | 3500 | = | 5.5 | | | | |
| Sw of Wall | = | 1.0 | x | 3100 | Height | = | 3.1 | | | | |
| | | Total DL | | | | | 8.6 | 8.6 | 8.6 | | |
| Live Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.5 | | 3500 | 3500 | = | 5.3 | | | | |
| | | Total DL | | | | | 5.3 | 5.3 | | 5.3 | |
| | | | | Total | DL+LL | U/S | Loft Floor | | 8.6 | 5.3 | 13.8 |
| ***1st Floor*** | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.6 | | 5150 | 5150 | = | 8.0 | | | | |
| Sw of Wall | = | 5.4 | x | 3100 | Height | = | 16.8 | | | | |
| | | Total DL | | | | | 24.8 | 24.8 | 24.8 | | |
| Live Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.5 | | 5150 | 5150 | = | 7.7 | | | | |
| | | Total DL | | | | | 7.7 | 7.7 | | 7.7 | |
| | | | | Total | DL+LL | U/S | 1st Floor | | 33.4 | 13.0 | 46.3 |
| ***Ground Floor*** | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 0.0 | | 0 | 0 | = | 0.0 | | | | |
| Sw of Wall | = | 5.4 | x | 3100 | Height | = | 16.8 | | | | |
| | | Total DL | | | | | 16.8 | 16.8 | 16.8 | | |
| Live Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | | | 0 | 0 | = | 0.0 | | | | |
| | | Total DL | | | | | 0.0 | 0.0 | | 0.0 | |
| | | | | Total | DL+LL | U/S | Ground Floor | | 50.1 | 13.0 | 63.1 |
| ***Basement*** | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | | | 0 | 0 | = | 0.0 | | | | |
| Sw of Wall | = | 8.9 | x | 3500 | Height | = | 31.1 | | | | |
| | | Total DL | | | | | 31.1 | 31.1 | 31.1 | | |
| Live Load: | | *kN/m²* | | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | | | 0 | 0 | = | 0.0 | | | | |
| | | Total DL | | | | | 0.0 | 0.0 | | 0.0 | |
| | | | | Total | DL+LL | T/S | Basement | | 81.2 | 13.0 | 94.2 |

| | | | |
|---|---|---|---|
| Allowable Bearing Capacity of Soil | = | 91 | kN/m2 *(Refer Site Investgation Report)* |
| Required Width of Foundation | = | 1.0 | m |
| Provided foundation width | = | 1.5 | m |

| Memb Ref | Calculations | Output |
|---|---|---|

Module = 1000 mm

***Front Wall***

| | | | | | | | | DL | LL | DL + LL |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Total Characteristic Load (kN)** | | |
| ***Roof*** | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Roof Load | = | 1.4 | 0 | 5296 | = | 3.8 | | | | |
| | Total DL | | | | | 3.8 | 3.8 | 3.8 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Roof Load | = | 0.8 | 0 | 5296 | = | 2.0 | | | | |
| | Total DL | | | | | 2.0 | 2.0 | | 2.0 | |
| | | | Total | DL+LL | U/S | Roof | | 3.8 | 2.0 | 5.8 |
| ***Loft Floor*** | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.6 | 0 | 5296 | = | 4.1 | | | | |
| Sw of Wall | = | 1.0 | x 3100 | Height | = | 3.1 | | | | |
| | Total DL | | | | | 7.2 | 7.2 | 7.2 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.5 | 0 | 5296 | = | 4.0 | | | | |
| | Total DL | | | | | 4.0 | 4.0 | | 4.0 | |
| | | | Total | DL+LL | U/S | Loft Floor | | 11.0 | 6.0 | 17.0 |
| ***1st Floor*** | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.6 | 0 | 5296 | = | 4.1 | | | | |
| Sw of Wall | = | 5.4 | x 3100 | Height | = | 16.8 | | | | |
| | Total DL | | | | | 20.9 | 20.9 | 20.9 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 1.5 | 0 | 5296 | = | 4.0 | | | | |
| | Total DL | | | | | 4.0 | 4.0 | | 4.0 | |
| | | | Total | DL+LL | U/S | 1st Floor | | 20.9 | 4.0 | 24.9 |
| ***Ground Floor*** | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | 0.0 | 0 | 0 | = | 0.0 | | | | |
| Sw of Wall | = | 5.4 | x 3100 | Height | = | 16.8 | | | | |
| | Total DL | | | | | 16.8 | 16.8 | 16.8 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | | 0 | 0 | = | 0.0 | | | | |
| | Total DL | | | | | 0.0 | 0.0 | | 0.0 | |
| | | | Total | DL+LL | U/S | Ground Floor | | 37.7 | 4.0 | 41.7 |
| ***Basement*** | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | | 0 | 0 | = | 0.0 | | | | |
| Sw of Wall | = | 8.9 | x 3500 | Height | = | 31.1 | | | | |
| | Total DL | | | | | 31.1 | 31.1 | 31.1 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | kN/m | kN | | | |
| Floor Load | = | | 0 | 0 | = | 0.0 | | | | |
| | Total DL | | | | | 0.0 | 0.0 | | 0.0 | |
| | | | Total | DL+LL | T/S | Basement | | 68.8 | 4.0 | 72.7 |

| | | | |
|---|---|---|---|
| Allowable Bearing Capacity of Soil | = | 92 | kN/m2 *(Refer Site Investgation Report)* |
| Required Width of Foundation | = | 0.8 | m |
| Provided foundation width | = | 1.5 | m |

| Memb Ref | Calculations | Output |
|---|---|---|

Module = 1000 mm

***Party Wall***

| | | | | | | | | | | DL | LL | DL + LL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Roof*** | | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Roof Load | = | 1.4 | 3000 | 3000 | | = | 4.3 | | | | | |
| | | Total DL | | | | | 4.3 | 4.3 | | 4.3 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Roof Load | = | 0.8 | 3000 | 3000 | | = | 2.3 | | | | | |
| | | Total DL | | | | | 2.3 | 2.3 | | | 2.3 | |
| | | | Total | DL+LL | U/S | | Roof | | | 4.3 | 2.3 | 6.5 |
| ***Loft Floor*** | | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 1.6 | 3500 | 3500 | | = | 5.5 | | | | | |
| Sw of Wall | = | 1.0 x | 3100 | Height | | = | 3.1 | | | | | |
| | | Total DL | | | | | 8.6 | 8.6 | | 8.6 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 1.5 | 3500 | 3500 | | = | 5.3 | | | | | |
| | | Total DL | | | | | 5.3 | 5.3 | | | 5.3 | |
| | | | Total | DL+LL | U/S | | Loft Floor | | | 8.6 | 5.3 | 13.8 |
| ***1st Floor*** | | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 1.6 | 5150 | 5150 | | = | 8.0 | | | | | |
| Sw of Wall | = | 5.4 x | 3100 | Height | | = | 16.8 | | | | | |
| | | Total DL | | | | | 24.8 | 24.8 | | 24.8 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 1.5 | 5150 | 5150 | | = | 7.7 | | | | | |
| | | Total DL | | | | | 7.7 | 7.7 | | | 7.7 | |
| | | | Total | DL+LL | U/S | | 1st Floor | | | 33.4 | 13.0 | 46.3 |
| ***Ground Floor*** | | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 7.3 | 0 | 5150 | | = | 18.7 | | | | | |
| Sw of Wall | = | 5.4 x | 3100 | Height | | = | 16.8 | | | | | |
| | | Total DL | | | | | 35.5 | 35.5 | | 35.5 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 1.5 | 0 | 5150 | | = | 3.9 | | | | | |
| | | Total DL | | | | | 3.9 | 3.9 | | | 3.9 | |
| | | | Total | DL+LL | U/S | | Ground Floor | | | 68.8 | 16.8 | 85.7 |
| ***Basement*** | | | | | | | | | | | | |
| Dead Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 4.8 | 0 | 3650 | | = | 8.7 | | | | | |
| Sw of Wall | = | 8.9 x | 3500 | Height | | = | 31.1 | | | | | |
| | | Total DL | | | | | 39.8 | 39.8 | | 39.8 | | |
| Live Load: | | *kN/m²* | *LHS span* | *RHS span* | | | kN/m | kN | | | | |
| Floor Load | = | 1.5 | 0 | 3650 | | = | 2.7 | | | | | |
| | | Total DL | | | | | 2.7 | 2.7 | | | 2.7 | |
| | | | Total | DL+LL | T/S | | Basement | | | 108.6 | 19.6 | 128.2 |

Header for output columns: Total Characteristic Load (kN)

Allowable Bearing Capacity of Soil = 91.5 kN/m2 *(Refer Site Investigation Report)*
Required Width of Foundation = 1.4 m
Provided foundation width = 1.5 m

Memb Ref | Calculations | Output

Module = 1000 mm

**Front Wall**

| | | | | | | | | Total Characteristic Load (kN) DL | LL | DL + LL |
|---|---|---|---|---|---|---|---|---|---|---|
| **Roof** | | | | | | | | | | |
| Dead Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Roof Load | = | 1.4 | 0 | 5296 | = | 3.8 | | | | |
| | | Total DL | | | | 3.8 | 3.8 | 3.8 | | |
| Live Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Roof Load | = | 0.8 | 0 | 5296 | = | 2.0 | | | | |
| | | Total DL | | | | 2.0 | 2.0 | | 2.0 | |
| | | | Total | DL+LL | U/S | Roof | | 3.8 | 2.0 | 5.8 |
| **Loft Floor** | | | | | | | | | | |
| Dead Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 1.6 | 0 | 5296 | = | 4.1 | | | | |
| Sw of Wall | = | 1.0 | x 3100 | Height | = | 3.1 | | | | |
| | | Total DL | | | | 7.2 | 7.2 | 7.2 | | |
| Live Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 1.5 | 0 | 5296 | = | 4.0 | | | | |
| | | Total DL | | | | 4.0 | 4.0 | | 4.0 | |
| | | | Total | DL+LL | U/S | Loft Floor | | 7.2 | 4.0 | 11.2 |
| **1st Floor** | | | | | | | | | | |
| Dead Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 1.6 | 0 | 5296 | = | 4.1 | | | | |
| Sw of Wall | = | 5.4 | x 3100 | Height | = | 16.8 | | | | |
| | | Total DL | | | | 20.9 | 20.9 | 20.9 | | |
| Live Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 1.5 | 0 | 5296 | = | 4.0 | | | | |
| | | Total DL | | | | 4.0 | 4.0 | | 4.0 | |
| | | | Total | DL+LL | U/S | 1st Floor | | 28.1 | 7.9 | 36.1 |
| **Ground Floor** | | | | | | | | | | |
| Dead Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 7.3 | 0 | 3000 | = | 10.9 | | | | |
| Sw of Wall | = | 5.4 | x 3100 | Height | = | 16.8 | | | | |
| | | Total DL | | | | 27.7 | 27.7 | 27.7 | | |
| Live Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 1.5 | 0 | 3000 | = | 2.3 | | | | |
| | | Total DL | | | | 2.3 | 2.3 | | 2.3 | |
| | | | Total | DL+LL | U/S | Ground Floor | | 55.8 | 10.2 | 66.0 |
| **Basement** | | | | | | | | | | |
| Dead Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 4.8 | 0 | 3650 | = | 8.7 | | | | |
| Sw of Wall | = | 8.9 | x 3500 | Height | = | 31.1 | | | | |
| | | Total DL | | | | 39.8 | 39.8 | 39.8 | | |
| Live Load: | | $kN/m^2$ | LHS span | RHS span | | kN/m | kN | | | |
| Floor Load | = | 1.5 | 0 | 3650 | = | 2.7 | | | | |
| | | Total DL | | | | 2.7 | 2.7 | | 2.7 | |
| | | | Total | DL+LL | T/S | Basement | | 95.6 | 12.9 | 108.5 |

Allowable Bearing Capacity of Soil = 91.5 kN/m2 *(Refer Site Investgation Report)*
Required Width of Foundation = 1.2 m
Provided foundation width = 1.5 m

| Project: | PROPOSED BASEMENT CONSTRUCTION, EXTENSION AND INTERNAL | Prepared | Date | Page No | Of |
|---|---|---|---|---|---|
| Location: | 73 CONSTANTINE ROAD, HAMPSTEAD, LONDON, NW3 2NG | AT | 26-Oct-14 | 10.00 | 18.00 |
| Part | E: | Checked | Date | Job Ref | Rev. |
| | **Under Pinning Temporary Lateral Prop Design** | AT | 26-Oct-14 | MS-13-59 | CG-13-01 |

Memb Ref | Calculations | Output

***Worse Case Loading***

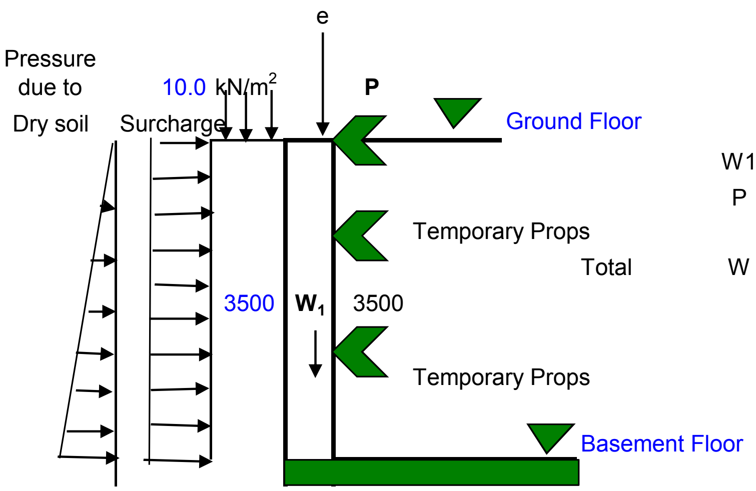
UDL Module = 1000 mm

| | | | | Total Characteristic Load (kN) | | |
|---|---|---|---|---|---|---|
| Dead Load | | kN | DL | LL | DL + LL |
| Wall Load | = | 109 | 108.6 | | |
| | | | 0.0 | | |
| Live Load: | | | | | |
| Wall Load | = | 19.6 | | 19.6 | |
| | | | | 0.0 | |
| | | | 108.6 | 19.6 | 128.2 |

`

Allowable Bearing Capacity of Soil = 115 kN/m2 *(Refer Site Investigation Report)*

Required Width of Foundation = 1.1 m




W1 = 25.2 kN/m

P = 128.2 kN/m

Total W = 153.4 kN/m

**Under Pinning Design:** 300

| | | | | |
|---|---|---|---|---|
| Unit weight of concrete | | = | 24.0 $kN/m^3$ | |
| Dry density of soil | ρ | = | 16.0 $kN/m^3$ | |
| Surcharged | w | = | 10.0 $kN/m^2$ | |
| Specific weight of water | Ỳw | = | 9.8 $kN/m^2$ | |
| Co efficient of active earth pressure | $k_a$ | = | (1-sinφ)/(1+sinφ) | |
| | | = | 0.406 | φ = 25 degree |
| Pressure due to surcharge | | = | $k_a$ w | |
| | | = | 4.06 kN/m | |
| Lateral earth pressure due to dry soil | | = | $K_a$ h ρ | |
| | | = | 22.7 kN/m | |

| Project: | PROPOSED BASEMENT CONSTRUCTION, EXTENSION AND INTERNAL | Prepared | Date | Page No | Of |
|---|---|---|---|---|---|
| Prepared By | 73 CONSTANTINE ROAD, HAMPSTEAD, LONDON, NW3 2NG | AT | 26-Oct-14 | **11.00** | **18.00** |
| Part | D: | Checked | Date | Job Ref | Rev. |
| | **Under Pinning Temporary Lateral Prop Design** | AT | 26-Oct-14 | **MS-13-59** | **A** |
| Memb Ref | **Cont…** | | | Output | |

**Loading**

**Total Lateral Load per Linear meter**

| | | | |
|---|---|---|---|
| Lateral load due to surcharge | = | 14.2 | kN |
| Lateral earth pressure due to dry soil | = | 39.8 | kN |
| Total | | 54.0 | kN |

**Use heavy duty adjustable Steel Trench Struts (Acrow Props)**

(Acrow Prop type 3: 2170 – 3975 mm)

**Safe Working Load (kN) Per Prop** = 35 kN

No of Props Required per Linear meter = 1.54

**Provide : 3 Nos** per Linear meter